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The Impact of Commercial Credit on Firm Innovation: Evidence from Chinese A-Share Listed Companies

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Abstract: This paper analyses the data on Chinese A-share listed companies from 1996 to 2019, using fixed-effect regression and the double-difference method to systematically examine the impact of commercial credit on enterprise technological innovation. The study found that the acquisition and provision of commercial credit has promoted the number of enterprise technological innovations and significantly improved their quality. In particular, the innovation of highly constrained companies is promoted by financing. Our findings help to solve the obstacles enterprises face in breaking through financing constraints and improving the efficiency and quality of their innovative efforts. The financing system has a significant influence on promoting the sustainable development of innovative enterprises.

Keywords: commercial credit; technological innovation; sustainable development; China

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1. Introduction

Numerous researchers have argued that innovation is becoming progressively more essential for long-term endurance and growth in extremely competitive and ambiguous environments [1,2]. In order to increase consumer awareness and stakeholder anticipations in regard to sustainable development, management of sustainable innovation is becoming a key issue for both corporations and policy makers [3–5]. General Secretary Xi Jinping has repeatedly emphasized that "Innovation is the soul of a nation's progress, the unlimited driving force for a country's prosperity and development, and the deepest endowment of the Chinese nation" [6]. The Chinese economy has developed rapidly in the past two decades and seems to have become the world's "manufacturing plant." research on enterprise technological innovation behavior and influencing factors have always been the focus of scholarly attention. Godin [7] stated that many researchers have tried to clarify enterprise innovation behavior and influencing factors. Schumpeter examined the particular groundbreaking research innovation behavior of enterprises. Scherer [8] studied factors such as enterprise size and market structure on innovation. The deepening of this research gradually expanded to firms' market power, industry, system status, enterprise characteristics, and other aspects. It can be seen that the factors that affect enterprise innovation involve multiple levels and aspects, and involve the impact of the external environment as well.

Undoubtedly, strengthening an enterprise's technological innovation requires the support of a large amount of its continuous capital. Following the global financial crisis which broke out in 2008, banking credit has increasingly moved towards state-owned enterprises (SOEs). Many enterprises in China face difficulties obtaining financing due to its rising cost. Because of information asymmetry, the credit of enterprises is restricted, bank loans are more likely to go to fixed credit assets, and high-cost funds seriously affect enterprises' technological innovation [9]. Promoting enterprise technological innovation is

more important today due to the slow economic growth in many economies. Nowadays, informal finance is an effective way for enterprises to carry out external financing. The international market, global competition and the value chain maturity for commercial credit will enhance informal finance, flexible financing terms and easy procedures.

To avoid endogenous problems in commercial credit and enterprise technology innovation research, researchers have used such exogenous policies for quasi-natural experiments [10–12]. China's reform of the security property system was marked by the introduction of the "Property Law of the People's Republic of China", adopted by the Fifth Session of the Tenth National People's Congress of the People's Republic of China on 16th March 2007 and which came into force on 1st October 2007; it is subsequently referred to as the "Property Law". This law has expanded the scope of secured property and added new accounts receivable to be pledged. The promulgation of this law helps to create a fair legal system environment, promote commercial credit, and provide a rare opportunity for a quasi-natural experiment, which can overcome the endogenous problems of this research to a certain extent. Specifically, this article will consider the 2007 introduction of the Property Law as a quasi-natural experiment with a cleverly constructed experimental group and control group, using the double-difference method (Difference i the n-Difference, DiD) to assess the impact on commercial credit of technological innovation. This study will mainly include whether commercial credit promotes an enterprise's actual technological innovation behavior, especially the impact of commercial credit provision on the enterprise's innovative behavior and the heterogeneity of enterprises with different ownership types. Several robustness tests were carried out to support the validity of our results.

This study provides several contributions to the existing literature. First, this article is not limited to the impact of commercial credit acquisition on technological innovation in the dimension of commercial credit; it explores the provision of commercial credit towards corporate technological innovation. Second, at the level of technological innovation, it is limited to the impact on the quantity of innovation and explores whether it substantially affects the quality of innovation. Third, this paper takes the promulgation of the Property Law as a quasi-natural experiment with the use of the double-difference method for empirical research to overcome the limitations of endogenous research to a certain extent. Finally, this article collects data on Guotai An-listed companies from 1996 to 2019 and uses TONG's manual collation of patent data.

This paper is ordered into seven headings. Section 2 contains a literature review, and Section 3 summarizes the data and research methodology. Empirical results and analysis are shown in Section 4. The robustness analysis is explained in Section 5. Finally, Section 6 provides the conclusions of the research.

2. Literature Review

In the previous literature, the critical role of innovation in promoting a country's economic development has been widely recognized [13–15]. Enterprise innovation has a significant role in sustainable economic development. Technological innovation requires companies to be supported by continuous and robust funding. Moreover, as external behaviour, innovation has a certain degree of moral hazard and adverse selection problems. After the 2008 financial crisis, enterprises generally faced financing constraints. Banks and financial institutions are very careful when providing loans on the basis of intellectual property such as patents and copyrights [16]. The "comparative advantage theory" and "credit rationing theory" [17] reveal the financing role of commercial credit in terms of obtaining commercial credit and financing constraints. Hall and Vredenburg [18] showed that it is difficult to rely on enterprises' internal funds to support innovation and sustainable development investments. During periods of currency tightening, banks and other formal financing channels will have a certain degree of corporate loan restrictions. Therefore, commercial credit will play a role as an alternative to formal finance. SOEs and large enterprises will pass their funds through commercial credit.

To a certain extent, small and medium-sized enterprises (non-SOEs) realize the secondary allocation to provide technological innovation funds. Companies with greater commercial credit can deliver additional credit to banks and financial institutions. Moreover, it is easier for companies to obtain innovative funds through formal financing channels in order to ease financing constraints. However, the funds received through commercial credit represent short-term financing. Innovation requires long-term and stable capital investment. Therefore, companies may not use short-term financing such as commercial credit to fund innovation. Wu and An [19] stated that commercial credit tends to bring debt repayment pressure to enterprises in the short term, and to carry specific risks.

In the case of asymmetric information, commercial credit has the advantage of obtaining information. Petersen and Rajan [20] showed that demand-oriented commercial bank loans credit is prompted as an alternative financing method when the capital market is not optimal or under conditions of monetary tightening. Sun, Li, and Guiling [21] suggested that Chinese companies can use commercial credit as a financing channel and that commercial credit is more evident for companies in low financial environments. Lu and Yang [22] showed that for a developing country commercial credit has a significant supporting effect on the national economy's development, especially the non-state economy during tight monetary periods. Therefore, companies may prefer to use commercial credit as lower-cost capital to support technological innovation. Liu [23] examined the impact of business credit on innovative financing using Shanghai and Shenzhen-listed companies and found that Chinese enterprises innovatively use commercial credit to avoid financing constraints. Zhang, Ding and Wang [24] studied the relationship between commercial credit obtained by listed companies and R&D investment. Empirical results showed a significant positive correlation between commercial credit obtained by listed companies and R&D investment. However, Wu and An [19] found a negative relationship in that the more business credit a company obtains, the greater a disadvantage it is to increase the intensity of the company's R&D investment.

An enterprise's provision of business credit will have a specific effect on its technological innovation. First, providing commercial credit creates incentives for price reduction. Further, this can increase sales volume, enhance market competitiveness, and improve both an enterprise's profitability and the availability of funds to invest in product development. Second, commercial credit has a comparative advantage in obtaining information as a financial supply chain. Enterprises have close links in production and sales. Enterprises can monitor each other, which can overcome the possibility of asymmetric information to a certain extent. In this supply chain, companies that provide commercial credit want to maintain their industrial chain, and must guarantee the goods they provide and reduce the substitutability of their products. Therefore, enterprises will be motivated towards technological innovation by this sense of crisis. Furthermore, a good cooperative relationship can be established with the counterparty by providing commercial credit. Fan [25] explained that a stable collaborative relationship reduces fluctuations in firm share prices. Production is relatively continuous, which is conducive to maintaining the sustainability of enterprise innovation.

However, not all corporate commercial credit offers are proactive. Some SMEs do not have sufficient funds to provide commercial credit compared to SOEs and other enterprises with more stable financing channels. Nevertheless, due the importance of the strong substitutability of products and the bargaining power which are at stake, it is necessary to maintain sales volume and market share to support regular operations. A company may find it "compulsory" to provide commercial credit during a period of currency tightening. Love, Preve and Sarria-Allende [26] stated that the other party's malicious default on funds, coupled with insufficient funds, will passively provide commercial credit to limit innovation investment.

A country's legal system can affect the development of a country's financial system in different ways. With the continuous reform and improvement of Chinese law, a few scholars have begun to explore the legal system's role in enterprise. Gao, Xu and Kong [27]

found that protecting intellectual property rights at the legal level significantly promoted enterprises' innovative behavior. Tian and Ran [28], using the implementation of the "Patent Law" as a quasi-natural experiment, found that the amendment of the law significantly improved companies' innovation with more substantial debt-servicing capabilities. China has promulgated and revised many laws to effectively improve enterprises' development environment during economic transformation and development as an emerging market country. In particular, in China's 1995 "Guarantee Law of the People's Republic of China," the concept of a mortgage pledge received specific provisions; after ten years of discussion, in 2007 the Tenth National People's Congress formally promulgated the Property Law. The promulgation of the Property Law, based on the existing legal provisions, made explicit provision for security property rights, mortgage rights, and a pledge system, and constructed a relatively systematic and perfected property rights system in China [29].

Jiang, Shen and Jiang [30] examined the implementation of the Property Law as a quasi-natural experiment testing the protection of creditors, innovation performance of enterprises, and efforts to strengthen creditor protection and thereby promote innovation. Wang and Zhang [31] examined the increase in corporate debt financing and the impact on enterprise innovation efficiency and found that debt financing with the introduction of the Property Law is beneficial to Chinese listed companies in improving innovation efficiency. Nevertheless, the existing research [32,33] has not drawn definite conclusions on whether commercial credit promotes or inhibits innovation. Second, the existing literature mostly studies commercial credit from the perspective of commercial credit acquisition. The impact of corporate innovation on commercial credit has seen little research. Third, most of the impact on innovation is limited to the role of R&D input, and the literature exploring the impact on corporate innovation output is limited. Furthermore, most of the exploration of technological innovation focuses on the number of impacts, and ignores technological innovation's role in furthering enterprise quality.

Specifically, the Property Law mainly manifests in the following points. First, the Property Law stipulates property ownership and emphasizes the protection of the property rights of the right-holder, which will help enterprises to use debt financing and expand the company's ownership and sources of financing. Jiang, Shen and Jiang [30] showed that the Property Law has improved creditor protection, which is conducive to promoting enterprises' technological innovation. Moreover, the improvement of this protection will help creditors provide more funds for enterprises and promote technological innovation of enterprises. Second, this law expands the scope of the property guarantee, clearly stating that inventory, accounts receivable, and property rights in intellectual property such as patents and copyrights can be mortgaged and pledged [34]. The scope of pledged assets in mortgage loans is not limited to their fixed assets and expands to corporate mortgage assets, which is conducive to alleviating enterprises' financing difficulties. Furthermore, the protection of accounts receivable has increased enterprises' willingness to use commercial credit as a financing channel. Corporate financing is no longer limited to formal financial channels such as bank loans. Enterprises that use commercial credit as a financing channel will tend to have more funds available to invest in innovation.

Although the legal provisions of the Property Law do not directly involve the acquisition of commercial credit, they provide support and protection for commercial credit, which is conducive to initiative on the part of enterprises [35]. Providing commercial credit increases the possibility that some enterprises with relatively low fixed asset accounts will obtain increased commercial credit. Therefore, the promulgation of the Property Law indirectly affects the acquisition of commercial credit, which is conducive to the acquisition of commercial credit by certain enterprises, easing financing constraints and promoting enterprise technological innovation.

Based on the above analysis, this paper proposes the following research hypotheses:

Hypothesis 1 (H1). *Provision of commercial credit and holding of enterprise funds positively impact an enterprise's technological innovation.*

Hypothesis 2 (H2). *A firm's obtaining of commercial credit positively impacts its technological innovation.*

Hypothesis 3 (H3). *After implementation of the Property Law, enterprises will increase their use of commercial credit, promoting technological innovation.*

3. Data and Variables

Companies listed on the Shanghai Stock Exchange and Shenzhen Stock Exchange from 1996 to 2019 were selected for this article. The enterprise financial data was derived from the GTA database, property rights data from CCER (Xenophon) database, and data related to innovation variables are obtained from GTA, and Tong databases. Several companies were omitted from the sample due to a lack of financial indicators. In order to avoid extreme values affecting the regression results, following Chuluun, Prevost and Upadhyay [36], we conducted a tailing at 1% and 99% percentiles on selected variables. The variables used in this study are given in Table 1.

Table 1. Definition of variables.

Variable	Variable Definitions	Source	Transformation
PTNT	Total number of patent applications	CSMRCVB & TONG	+1 log
PTNTI	Number of invention patent applications	CSMRCVB & TONG	+1 log
PTNTNI	Number of non-invention patent applications	CSMRCVB & TONG	+1 log
GRNT	Total number of patents granted	CSMRCVB & TONG	+1 log
GRNTI	Number of invention patents granted	CSMRCVB & TONG	+1 log
GRNTNI	Number of non-invention patents granted	CSMRCVB & TONG	+1 log
RCVB	(Accounts receivable + notes receivable + prepaid accounts)/total assets	CSMRCVB	Bilateral tailing
PYBL	(Payables + notes payable + deposits received)/total assets	CSMRCVB	Bilateral tailing
SIZE	Total assets	CSMRCVB	Logarithm
ROA	Net profit/total assets	CSMRCVB	Bilateral tailing
LEV	Asset–liability ratio = total liabilities /total assets	CSMRCVB	Bilateral tailing
AGE	Current year + 1- the year of establishment	CSMRCVB	Ln (Age + 1)
LIQ	Current ratio = current assets/current liabilities	CSMRCVB	Bilateral tailing
GROW	Operating revenue annual growth rate	CSMRCVB	Bilateral tailing
R&D	R&D investment/total assets	CSMRCVB	Bilateral tailing
BANK	Bank loans payable/total assets	CSMRCVB	Bilateral tailing
SBSDY	Government subsidies/total assets	CSMRCVB	Bilateral tailing
IND	Industry code (dummy variable)	CSMRCVB	
SOE	State-owned enterprises (dummy variable)	CCER	
TIME	If time is before 2007 = 0, and time = 1 in 2007 and later (dummy variable).		

Enterprise technological innovation is the dependent variable. Tong, He, He and Lu [30] selected the number of patent applications as an indicator of technological innovation. Chinese patent applications are divided into invention patents, utility model patents, and design patents. The quality of invention patents is the highest; the application is difficult and takes a more extended period. We measured the quality of firm innovation by considering these three categories separately. Li and Zheng [31] used the number of enterprise patent applications to measure the number of enterprise technological innovations and the number of invention patent applications to measure the enterprise technological innovation quality. In the robustness section, the number of patent applications will be replaced by the number of patent authorizations in the robustness part in order to increase the robustness of the regression results.

The independent variables PYBL and RCVB mainly refer to the acquisition of commercial credit and commercial credit provision. Following Lu and Yang [22], we considered the variables PYBL, i.e., (accounts payable + bills payable + advance receipts)/total assets, and RCVB, i.e., (accounts receivable + bills receivable + prepaid accounts/total assets, as commercial credit indicators. Additionally, we conducted several robustness tests suggested by Chen and Ma [37]. Furthermore, several variables were selected as control variables in this study, such as an enterprise's size (SIZE), its profitability as measured by return on assets (ROA), its debt status (LEV), solvency (LIQ), growth status (GROW), growth (AGE), industry, and whether or not it was state-owned (SOE). Moreover, in the robustness analysis three control variables were used: R&D investment (R&D), bank loans (BANK), and government subsidies (SBSDY). As the R&D investment statistics dated back to 2007, considered time interval for the three control variables was 2007–2017.

The control and experimental groups were grouped according to the double-difference method and used to examine the impact of tenure reform under the Property Law in 2007, examining changes in the protection of commercial credit and in enterprises' innovation level. Under these quasi-natural experimental conditions, comparing the difference between the experimental and control groups can avoid endogenous problems to a certain extent and can be used to measure the causal relationship between the two. Due to the declaration at the legal level, all companies may be affected; thus, only relatively reasonable indicators can be adopted to set up the control and experimental groups. If a company's commercial credit use is high, it means that the company's fixed assets are relatively small. Moreover, it is not easy to raise funds through formal channels such as bank loans. Qian, Tang and Fang [35] adopted a grouping calculation method to show the impact of the Property Law on different enterprises. Furthermore, we divided the provided and obtained commercial data into three equal subcategories based on these values, with the highest third group as the experimental group and the lowest third as the control group.

Following the methodology adopted by [37,38], we first used the benchmark regression model to estimate the impact of commercial credit provision and acquisition on the quantity and quality of corporate innovation. Then, in line with previous studies, we adopted the fixed-effect model and comparative analysis in different ownership structures (SOE and non-SOE).

The benchmark regressions are as follows:

$$Innovation_{it} = \beta_{it} + RCVB_{it} + \lambda_y + \lambda_{\text{ind}} + Control_{it} + \varepsilon_{it} \quad (1)$$

$$Innovation_{it} = \beta_{it} + PYBL_{it} + +\lambda_y + \lambda_{\text{ind}} + Control_{it} + \varepsilon_{it} \quad (2)$$

The dependent variable is innovation as the innovation index. PTNT is the total number of enterprise patent applications, PTNTI is the number of invention patent applications, and PTNTNI is the number of non-invention patent applications; these variables are used as a proxy for innovation index. The independent variables PYBL and RCVB mainly refer to the acquisition of commercial credit and commercial credit provision. The fixed effect for the year, λ_y, and industry fixed effects, λ_{ind}, are considered as well. Control variables include firm size (SIZE), return on assets (ROA), asset–liability ratio (LEV), firm age (AGE), Current Ratio (LIQ), and revenue growth (GROW).

4. Empirical Results

4.1. Summary Statistics

Among the 36,051 firms selected as the sample in this study, 9337 firms have no innovation, 26% of the total sample. The average number of patent applications is about 44, and the average number of invention patents is 20. Tables 2 and 3 show descriptive statistics for the total sample and the grouping categories PYBL and RCVB. Regarding property rights separation, statistics on the average number of patents in SOE and non-SOE were made through property rights SOE's dummy variable. Among them, the number of innovation patents and invention patents of SOEs is higher than that of other enterprises, indicating

the non-SOE. Private enterprises show more design over SOE, which shows that non-SOE has strong potential for technological innovation. Patent industry statistics indicate that the innovation indicators of the construction industry, mining, manufacturing, information transmission, software, information technology, scientific research, and technical service industries are the highest among the other sectors. Moreover, Table 4 indicates the average number of patents and commercial credits based on industry levels.

Table 2. Descriptive statistics of the sample.

Variable	Average	Standard Error	Maximum	Minimum	Observations
PTNT	1.977	1.752	9.909	0	31,194
PTNTI	1.311	1.478	9.108	0	31,194
PTNTNI	1.546	1.619	9.323	0	31,194
GRNT	2.811	1.423	9.503	0	12,717
GRNTI	1.664	1.300	8.177	0	10,306
GRNTNI	2.620	1.429	9.211	0	11,522
RCVB	0.146	0.124	0.977	0	36,051
PYBL	0.178	0.131	0.997	0	36,051
SIZE	21.623	1.323	28.509	10.842	36,048
ROA	0.034	0.067	0.202	−0.309	36,048
LEV	0.458	0.229	1.326	0.051	36,048
AGE	2.076	0.708	3.367	0.693	36,051
LIQ	2.23	2.459	16.287	0.201	36,047
R&D	0.021	0.018	0.095	0	14,946
BANK	0.0006	0.002	0.032	0	15,124
SBSDY	0.0063	0.01	0.337	0	15,124
GROW	0.224	0.618	4.453	−0.729	32,915
SOE	0.654	1.024	1	0	36,030

Note: The sample consists of 36,051 firms listed on the Shanghai Stock Exchange and Shenzhen Stock Exchange from 1996 to 2019. PTNT denotes the total amount of enterprise patent applications; PTNTI denotes invention patent applications; PTNTNI denotes non-invention patent applications; GRNT denotes the total number of patents granted; GRNTI denotes the number of invention patents granted; GRNTNI denotes the number of non-invention patents granted; RCVB denotes commercial credit provision; PYBL denotes the acquisition of commercial credit; SIZE denotes firm size; ROA denotes return on assets; LEV denotes asset–liability ratio; AGE denotes the history of the firm from its incorporation; LIQ is the Current Ratio; R&D denotes the Research and Development investment of the company; BANK denotes the bank loans payable to asset ratio; SBSDY denotes the government subsidies to assets ratio; GROW denotes the company's growth status; and SOE denotes state ownership. Descriptive statistics for the industry level obtained are available from the authors upon request. The detailed definitions of variables are reported in Table 1.

Table 3. Descriptive statistics of main variables by grouping.

	Variables	PYBL Grouping					RCVB Grouping				
		Average	Standard Error	Maximum	Minimum	Observations	Average	Standard Error	Maximum	Minimum	Observations
Control group	PTNT	1.425	1.582	8.959	0	9152	1.526	1.512	8.959	0	9838
	PTNTI	0.899	1.276	8.748	0	9152	1.017	1.251	8.748	0	9838
	PTNTNI	1.077	1.414	7.546	0	9152	1.083	1.334	7.546	0	9838
	RCVB	0.108	0.113	0.977	0	12,010	0.037	0.028	0.094	0	12,010
	PYBL	0.052	0.039	0.194	0	12,010	0.13	0.119	0.997	0	12,010
	SIZE	21.836	1.506	28.509	10.842	12,007	21.39	1.332	27.377	10.842	12,007
	ROA	0.036	0.069	0.202	−0.309	12,007	0.041	0.071	0.202	−0.309	12,007
	LEV	0.462	0.244	1.326	0.051	12,007	0.362	0.234	1.326	0.051	12,007
	AGE	2.216	0.724	3.367	0.693	12,010	2.016	0.743	3.367	0.693	12,010
	LIQ	2.184	2.814	16.287	0.201	12,006	3.32	3.698	16.287	0.201	12,006
	GROW	0.211	0.659	4.453	−0.729	11,024	0.193	0.637	4.453	−0.729	10,700
	SOE	0.569	1.042	1	0	11,999	0.695	1.07	1	0	12,006

Table 3. *Cont.*

	Variables	PYBL Grouping					RCVB Grouping				
		Average	Standard Error	Maximum	Minimum	Observations	Average	Standard Error	Maximum	Minimum	Observations
Experimental group	PTNT	2.339	1.809	9.016	0	11,184	2.354	1.934	9.909	0	10,600
	PTNTI	1.581	1.577	8.788	0	11,184	1.556	1.671	9.108	0	10,600
	PTNTNI	1.879	1.696	8.611	0	11,184	1.960	1.807	9.232	0	10,600
	RCVB	0.194	0.135	0.962	0	12,018	0.283	0.111	0.977	0.107	12,018
	PYBL	0.323	0.103	0.997	0.173	12,018	0.226	0.14	0.975	0	12,018
	SIZE	21.449	1.197	27.462	11.348	12,018	21.897	1.364	28.098	15.715	12,018
	ROA	0.03	0.07	0.202	−0.309	12,018	0.027	0.064	0.202	−0.309	12,018
	LEV	0.478	0.22	1.326	0.051	12,018	0.572	0.194	1.326	0.135	12,018
	AGE	1.982	0.676	3.367	0.693	12,018	2.156	0.687	3.367	0.693	12,018
	LIQ	2.133	1.87	16.287	0.201	12,018	1.415	0.652	6.54	0.201	12,018
	GROW	0.242	0.629	4.453	−0.729	10,977	0.267	0.654	4.453	−0.729	11,178
	SOE	0.706	0.989	1	0	12,012	0.587	0.987	1	0	12,008

Note: The sample consists of 36,051 firms listed on the Shanghai Stock Exchange and Shenzhen Stock Exchange from 1996 to 2019. PTNT denotes the total amount of enterprise patent applications; PTNTI denotes invention patent applications; PTNTNI denotes non-invention patent applications; RCVB denotes commercial credit provision; PYBL denotes the acquisition of commercial credit; SIZE denotes firm size; ROA denotes return on assets; LEV denotes the asset–liability ratio; AGE denotes the history of the firm from its incorporation; LIQ is the Current Ratio; GROW denotes the company's growth status, and SOE denotes state ownership. The detailed definitions of variables are reported in Table 1.

Table 4. The average number of patents and amount of commercial credit by industry.

Industry	The Average Number of Patent Applications by Industry				The Average Number of Commercial Credits by Industry	
	Total Patent Applications	Invention Patents	Utility Model Patents	Design Patents	Obtained Commercial Credit	Provided Commercial Credit
1. Agriculture, Forestry, Animal Husbandry and Fisheries	7.956	3.455	2.815	1.686	0.081	0.117
2. Mining industry category	98.905	57.300	41.271	0.334	0.120	0.160
3. Manufacturing category	57.475	25.929	24.768	6.779	0.149	0.195
4. Electricity, heat, gas and water production and supply	12.388	4.017	8.150	0.221	0.083	0.106
5. Construction	113.686	42.235	69.933	1.518	0.271	0.238
6. wholesale and retail	7.033	2.530	2.532	1.971	0.215	0.170
7. Transportation, warehousing and postal services	6.645	2.065	4.220	0.361	0.062	0.094
8. Accommodation and Catering	0.308	0.063	0.107	0.138	0.084	0.098
9. Information transmission, software and information technology services	28.572	19.432	6.429	2.712	0.128	0.189
10. Real Estate	3.079	1.052	1.370	0.657	0.154	0.130
11. Leasing and Business Services	4.381	1.325	1.728	1.328	0.150	0.175
12. Scientific Research and Technical Service Industry	22.101	9.776	12.083	0.241	0.144	0.260
13. Water Conservancy, Environment and Public Facilities Management	13.455	5.085	7.981	0.389	0.099	0.127
14. Education	5.000	2.486	2.314	0.200	0.068	0.123
15. Health and social work	7.070	3.169	3.690	0.211	0.057	0.157
16. Culture, Sports and Entertainment	6.556	2.429	2.306	1.822	0.127	0.176
17. Comprehensive	12.288	6.437	5.008	0.843	0.122	0.163
Total	43.520	19.874	19.165	4.481	0.146	0.178

Data source: CSMRCVB & TONG patent database.

4.2. Benchmark Regression

As this study involves multiple variables, it is necessary to consider multicollinearity between the variables. The VIF test results are shown in Table 5. By inspection, the results show that the average between the variable VIF was 1.35, much less than 10, described between the variables and the absence of co-linearity. The Hausman test compares a significant difference between the random effect and the fixed effect models. The test results in Table 6 show that the fixed effect is more appropriate for the sample.

Table 5. VIF test results.

Variable	VIF	1/VIF
RCVB	1.42	0.702474
PYBL	1.2	0.834123
SIZE	1.27	0.785232
ROA	1.4	0.713358
LEV	2.24	0.446997
AGE	1.25	0.798557
LIQ	1.6	0.626799
GROW	1.06	0.941948
SOE	1.02	0.980534
IND	1.03	0.969886
VIF average	1.35	

Note: The sample consists of 36,051 firms listed on the Shanghai Stock Exchange and Shenzhen Stock Exchange from 1996 to 2019. RCVB denotes the commercial credit provision; PYBL denotes the acquisition of commercial credit; SIZE denotes firm size; ROA denotes return on assets; LEV denotes the asset–liability ratio; AGE denotes the history of the firm from its incorporation; LIQ is the Current Ratio; GROW denotes the company's growth status; SOE denotes state ownership, and IND is the dummy variable for the industry. The detailed definitions of variables are reported in Table 1.

Table 6. Hausman test results.

Model/Numerical	PTNT	PTNTI	PTNTNI
R(CHI2)	2153.35	2258.80	1939.04
R(P)	0.00	0.00	0.00

Note: The sample consists of 36,051 firms listed on the Shanghai Stock Exchange and Shenzhen Stock Exchange from 1996 to 2019. PTNT denotes the total amount of enterprise patent applications, PTNTI denotes invention patent applications, and PTNTNI denotes non-invention patent applications.

4.3. Fixed Effect Model

Table 7 reports the impact of commercial credit on innovation and the quality of innovation under fixed effects. The regression results for the total number of patent applications, invention patents, and non-invention patents show that the three patent variables have a significant positive correlation in the provision (RCVB) and acquisition (PYBL) of commercial credit, which is consistent with previous studies [24,39]. Among the three different types of patent applications, there are differences in application difficulty and technological content. It is easy to apply for utility model and design patents, and the R&D cycle is usually shorter; it takes about six months to one year to obtain a patent on average. For invention patents, which represent a higher degree of innovation, it is necessary to propose substantial improvements or new improvements to products or methods. The R&D cycle is relatively long and usually requires more than two years of proceedings. Therefore, this study conducted a regression analysis based on the current period and lag effect of patent applications for the first, second and third periods. The empirical results show that the provision and acquisition of commercial credit is significantly positive in the first, second and third lag periods.

Among the influencing factors at the enterprise level, the SIZE of the enterprise plays a positive role in promoting the number of innovation applications, possibly because enterprises with a more extensive scale tend to have more funds and R&D personnel, which play a positive role in the innovation of the enterprise. Similar results in previous studies [40,41] showed the existence of a positive relationship between SIZE and innovation. ROA coefficient is positive though not significant, reflecting that net profit accounted for relatively large businesses with a high number of patent applications. Thus, this outcome for ROA is consistent with previous studies [42,43]. The LEV coefficient is significantly negatively correlated, and the results are in line with previous studies [43,44], indicating that companies with more debt are less active in technological innovation. In the age category, enterprise innovation shows a relatively small negative correlation, indicating that Chinese growth-oriented enterprises have a stronger incentive to innovate than mature

enterprises, in line with the findings of [45,46]. The LIQ sign changes slightly, except for the second column (PTNTI); other values exhibit negative correlations with innovation, which illustrates a large proportion of liquid assets. Based on previous studies, a higher the liquidity ratio is correlated with fewer innovation opportunities, and vice versa [47]. However, Pham, Van, Le and Le [48] found a positive relationship between liquidity ratio issue size and innovation. Nevertheless, a small number of applications are shared by companies with small current liabilities. On the other hand, the patent disclosure number accounted for a relatively high proportion of these, reflecting the high quality of such enterprises' innovation.

Table 7. Fixed effect regression results.

Variable	Current Period			1-Year Lagged Period			2-Year Lagged Period		
	PTNT	PTNTI	PTNTNI	PTNT_1	PTNTI_1	PTNTNI_1	PTNT_2	PTNTI_2	PTNTNI_2
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
RCVB	1.636 *	0.784 *	2.009 *	1.474 *	0.626 *	1.876 *	1.242 *	0.462 *	1.623 *
	(0.071)	(0.065)	(0.074)	(0.070)	(0.063)	(0.072)	(0.072)	(0.063)	(0.074)
PYBL	1.657 *	1.467 *	1.447 *	1.663 *	1.428 *	1.413 *	1.758 *	1.453 *	1.498 *
	(0.061)	(0.056)	(0.064)	(0.061)	(0.055)	(0.063)	(0.064)	(0.056)	(0.065)
SIZE	0.466 ***	0.418 ***	0.409 ***	0.442 ***	0.391 ***	0.385 ***	0.413 ***	0.359 ***	0.357 ***
	(0.006)	(0.006)	(0.007)	(0.006)	(0.006)	(0.007)	(0.007)	(0.006)	(0.007)
ROA	0.791	0.666	0.315	0.383	0.384	0.011	0.151	0.273	−0.158
	(0.122)	(0.112)	(0.127)	(0.120)	(0.108)	(0.123)	(0.123)	(0.108)	(0.126)
LEV	−0.572 **	−0.303 **	−0.569 **	−0.552 **	−0.272 **	−0.537 **	−0.515 **	−0.245 **	−0.491 **
	(0.047)	(0.043)	(0.049)	(0.047)	(0.042)	(0.048)	(0.048)	(0.042)	(0.049)
AGE	−0.075 **	−0.054 **	−0.059 **	−0.076 **	−0.047 **	−0.060 **	−0.069 **	−0.041 **	−0.038 **
	(0.014)	(0.013)	(0.014)	(0.014)	(0.013)	(0.015)	(0.017)	(0.015)	(0.017)
LIQ	−0.004 ***	0.008 ***	−0.018 ***	0.001 ***	0.009 ***	−0.011 ***	−0.001 ***	0.008 ***	−0.011 ***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)	(0.004)	(0.005)
GROW	−0.048 **	−0.037 **	−0.041 **	−0.148 **	−0.105 **	−0.135 **	−0.160 ***	−0.104 **	−0.150 **
	(0.012)	(0.011)	(0.013)	(0.012)	(0.011)	(0.013)	(0.012)	(0.011)	(0.023)
Constant	−9.844 ***	−9.015 ***	−8.687 ***	−9.339 ***	−8.412 ***	−8.153 ***	−8.724 ***	−7.746 ***	−7.60 ***
	(0.001)	(0.009)	(0.007)	(0.009)	(0.004)	(0.004)	(0.005)	(0.006)	(0.008)
Industry effect	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year effect	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	28,446	28,446	28,446	28,279	28,279	28,279	25,821	25,821	25,821
R^2	0.569	0.498	0.460	0.562	0.494	0.452	0.542	0.479	0.431

Note: The sample consists of 36,051 firms listed on the Shanghai Stock Exchange and Shenzhen Stock Exchange from 1996 to 2019. PTNT denotes the total amount of enterprise patent applications; PTNTI denotes invention patent applications; PTNTNI denotes non-invention patent applications; RCVB denotes commercial credit provision; PYBL denotes the acquisition of commercial credit; SIZE denotes firm size; ROA denotes return on assets; LEV denotes the asset–liability ratio; AGE denotes the history of the firm from its incorporation; LIQ is the Current Ratio; and GROW denotes the company's growth status. The detailed definitions of variables are reported in Table 1. The p-values are recorded in parentheses. ***, **, * denote significance at the 1%, 5%, and 10% level, respectively. Test results obtained for the three lag periods are available from the authors upon request.

4.4. Analysis of Different Property Rights

Numerous studies [49–51] have shown that companies with different ownership structures have different access to financial resources. Due to the small number of foreign and collective enterprises, only SOE and non-SOE firms are considered in the empirical analysis. The CCER final controller index is used to separate SOE and non-SOE companies.

Table 8 reports the impact of commercial credit on the total number of patents with different property rights (SOE, non-SOE), invention patents, non-invention patents in the current period, two and lag periods. The provision and acquisition of commercial credit plays a significant role in promoting corporate technological innovation during the current period and lag periods. The impact of commercial credit acquisition on SOEs is more significant than that on private enterprises. Similarly, Gou, Huang and Xu [52] found that SOEs have more commercial credit than non-SOEs do, and that SOEs have state credibility as an endorsement. The two lag results show that the impact on commercial credit provision exceeds the impact on SOEs. The acquisition of commercial credit in the second lag period showed a different result than in the current period. The impact of

commercial credit acquisition on the total number of patents lagging in the second phase is almost the same for SOEs and private enterprises.

Furthermore, results show that larger enterprises may have better innovation strength. Regardless of the current or lagging period, the enterprise's scale always has positive effects. The ROA always shows a positive effect on non-SOEs, while it has a negative effect on SOEs. The age of an enterprise has a positive impact on SOEs, while for private enterprises it has a negative effect. Private enterprises that have been established for a long time may face more innovation difficulties with the current ratio seeking to promote the technological innovation performance of SOEs, which indicates that the high liquidity and current liabilities of SOEs are rarely conducive to technological innovation.

Table 8. Different ownership of firms and patents analysis in the current period and two-year lag period.

Variables	Current Period						2-Year Lagged Period					
	PTNT		PTNTI		PTNTNI		PTNT_2		PTNTI_2		PTNTNI_2	
	SOE	Non-SOE	SOE	Non-SOE	SOE	Non-SOE	SOE	Non-SOE	SOE	Non-SOE	SOE	Non-SOE
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
RCVB	1.557 ***	1.511 ***	0.896 ***	0.432 ***	1.718 ***	2.243 ***	1.149 ***	1.148 ***	0.534 ***	0.168 *	1.379 ***	1.826 ***
	(0.009)	(0.007)	(0.009)	(0.001)	(0.001)	(0.006)	(0.006)	(0.009)	(0.005)	(0.008)	(0.009)	(0.007)
PYBL	2.138 **	1.173 **	1.807 **	1.040 **	1.931 **	1.001 **	2.189 **	1.300 **	1.738 **	1.061 **	1.919 **	1.094 **
	(0.045)	(0.041)	(0.035)	(0.046)	(0.035)	(0.048)	(0.027)	(0.035)	(0.033)	(0.036)	(0.046)	(0.041)
SIZE	0.475 ***	0.445 **	0.418 ***	0.398 **	0.441 ***	0.359 **	0.423 ***	0.383 **	0.358 ***	0.333 **	0.390 ***	0.295 **
	(0.009)	(0.011)	(0.008)	(0.010)	(0.009)	(0.012)	(0.009)	(0.011)	(0.008)	(0.010)	(0.009)	(0.012)
ROA	0.185	1.220	−0.125	1.358	0.061	0.441	−0.526	0.684	−0.370	0.882	−0.604	0.167
	(0.187)	(0.162)	(0.167)	(0.152)	(0.187)	(0.176)	(0.188)	(0.162)	(0.161)	(0.146)	(0.186)	(0.174)
LEV	−0.653 *	−0.514 *	−0.587 *	−0.091 *	−0.560 *	−0.570 *	−0.628 *	−0.425 *	−0.474 *	−0.100 *	−0.553 *	−0.439 *
	(0.073)	(0.065)	(0.065)	(0.061)	(0.073)	(0.071)	(0.073)	(0.065)	(0.062)	(0.058)	(0.072)	(0.070)
AGE	0.009 **	−0.178 **	−0.068 **	−0.108 **	0.021 **	−0.138 **	0.050 **	−0.250 **	−0.069 **	−0.127 **	0.073 **	−0.189 **
	(0.023)	(0.019)	(0.021)	(0.018)	(0.023)	(0.021)	(0.028)	(0.024)	(0.024)	(0.022)	(0.027)	(0.026)
LIQ	0.013 ***	−0.018 ***	0.020 ***	−0.001 ***	0.010 ***	−0.032 ***	0.011 ***	−0.015 ***	0.018 ***	−0.004 ***	0.013 ***	−0.027 ***
	(0.009)	(0.005)	(0.008)	(0.004)	(0.009)	(0.005)	(0.009)	(0.006)	(0.008)	(0.005)	(0.009)	(0.006)
GROW	−0.062 **	−0.037 **	−0.034 **	−0.035 **	−0.065 **	−0.019 **	−0.175 **	−0.146 **	−0.111 **	−0.089 **	−0.166 **	−0.134 **
	(0.019)	(0.016)	(0.017)	(0.015)	(0.030)	(0.025)	(0.019)	(0.016)	(0.016)	(0.014)	(0.018)	(0.017)
Constant	−10.425 ***	−8.944 ***	−9.158 ***	−8.284 ***	−9.781 ***	−7.209 ***	−9.308 ***	−7.593 ***	−7.814 ***	−6.863 ***	−8.672 ***	−5.855 ***
	(0.005)	(0.003)	(0.002)	(0.008)	(0.005)	(0.005)	(0.000)	(0.001)	(0.008)	(0.003)	(0.007)	(0.007)
Observations	14,310	13,239	14,310	13,239	14,310	13,239	13,553	11,446	13,553	11,446	13,553	11,446
R^2	0.577	0.563	0.528	0.461	0.491	0.426	0.542	0.549	0.503	0.452	0.455	0.406

Note: The sample consists of 36,051 firms listed on the Shanghai Stock Exchange and Shenzhen Stock Exchange from 1996 to 2019. PTNT denotes the total amount of enterprise patent applications; PTNTI denotes invention patent applications; PTNTNI denotes non-invention patent applications; RCVB denotes commercial credit provision; PYBL denotes the acquisition of commercial credit; SIZE denotes firm size; ROA denotes return on assets; LEV denotes the asset–liability ratio; AGE denotes the history of the firm from its incorporation; LIQ is the Current Ratio; and GROW denotes the company's growth status. The detailed definitions of variables are reported in Table 1. The p-values are recorded in parentheses. ***, **, * denote significance at the 1%, 5%, and 10% level, respectively. Test results obtained for the one-year lag period and the three lag phases are available from the authors upon request.

5. Robustness Analysis

5.1. Additional Control Variables

In order to strengthen the robustness of the regression results, three control variables that are closely related to the enterprise's technological innovation behavior are added here, namely, enterprise R&D investment, bank loans, and government subsidies. The business R&D investment data are available from 2007 onwards, and the analysis sample period considered is 2007–2017. After adding the control variables, the VIF test results show no multicollinearity between the variables. Table 9 reports the regression results after adding new control variables. The acquisition and provision of commercial credit have a significant role in promoting innovation. The acquisition of commercial credit

has a significant effect on promoting non-invention patents. Commercial credit provision has a greater role in promoting invention patents, which shows that enterprises' use of commercial credit promotes their enthusiasm and the quality of their innovation. Enterprise R&D investment is the most direct fund for enterprise innovation behavior among the new control variables, and has promoted the number of patents granted by enterprises. Our results on this topic are supported by several previous studies [53,54]. Bank loans, however, have an insignificant role in promoting the total number of patents and are not conducive to enterprise innovation quality in our study, which is similar to several previous findings [55,56]. Government subsidies maintain a certain degree of consistency with the role of patent applications, significantly promoting the number of patent grants and having the most substantial role in promoting invention patents. Previously, based on their empirical study of Chinese manufacturing firms, Lin and Luan [57] and Jiang, Zhang, Bu and Liu [58] showed that technological innovation significantly improves with funding support from the government.

Table 9. Regression results with additional control variables.

Variables	Current Period			2-Year Lagged Period		
	PTNT	PTNTI	PTNTNI	PTNT_2	PTNTI_2	PTNTNI_2
	(1)	(2)	(3)	(4)	(5)	(6)
RCVB	2.081 ***	1.048 ***	2.917 ***	1.926 ***	0.773 ***	2.858 ***
	(0.004)	(0.007)	(0.003)	(0.008)	(0.001)	(0.003)
PYBL	1.228 **	1.442 **	1.130 **	1.204 **	1.492 **	1.057 **
	(0.046)	(0.039)	(0.032)	(0.018)	(0.020)	(0.038)
SIZE	0.649 **	0.677 **	0.588 **	0.625 **	0.656 **	0.559 **
	(0.011)	(0.011)	(0.013)	(0.014)	(0.014)	(0.016)
ROA	0.371	0.229	−0.310	−0.591	−0.356	−1.244
	(0.215)	(0.221)	(0.251)	(0.254)	(0.259)	(0.298)
LEV	−1.042 *	−0.854 *	−1.122 *	−1.116	−0.922	−1.134
	(0.088)	(0.091)	(0.073)	(0.107)	(0.109)	(0.125)
AGE	−0.089 **	−0.036 **	−0.131 **	−0.082 **	0.003 **	−0.141 **
	(0.018)	(0.019)	(0.021)	(0.026)	(0.027)	(0.031)
LIQ	−0.014 ***	0.004 ***	−0.029 ***	−0.020 ***	−0.002 ***	−0.029 ***
	(0.005)	(0.005)	(0.006)	(0.007)	(0.007)	(0.008)
GROW	0.014 **	0.015 **	0.017 **	−0.198 **	−0.156 **	−0.209 **
	(0.021)	(0.022)	(0.024)	(0.026)	(0.026)	(0.031)
R&D	10.243 ***	12.333 ***	6.216 ***	8.647 ***	10.618 ***	5.053 ***
	(0.003)	(0.001)	(0.009)	(0.004)	(0.002)	(0.009)
BANK	4.821	−0.008	7.969	9.908	7.898	9.073
	(0.379)	(0.540)	(0.276)	(0.781)	(0.919)	(0.977)
SBSDY	10.579 **	12.689 **	8.940 **	9.586 *	10.812 **	7.927 *
	(0.043)	(0.030)	(0.048)	(0.067)	(0.040)	(0.072)
Industry effect	YES	YES	YES	YES	YES	YES
Year effect	YES	YES	YES	YES	YES	YES
Constant	−12.454 ***	−13.742 ***	−11.767 ***	−11.920 ***	−13.405 ***	−10.974 ***
	(0.005)	(0.002)	(0.007)	(0.009)	(0.006)	(0.009)
Observations	12,292	12,292	12,292	8342	8342	8342
R^2	0.385	0.363	0.314	0.351	0.339	0.279

Note: The sample consists of 36,051 firms listed on the Shanghai Stock Exchange and Shenzhen Stock Exchange from 1996 to 2019. PTNT denotes the total amount of enterprise patent applications; PTNTI denotes the invention patent applications; PTNTNI denotes the non-invention patent applications; RCVB denotes the commercial credit provision; PYBL denotes the acquisition of commercial credit; SIZE denotes the firm size; ROA denotes the return on assets; LEV denotes the asset-liability ratio; AGE denotes the history of the firm from its incorporation; LIQ is the Current Ratio; R&D denotes the Research and Development investment of the company; BANK denotes the bank loans payable to asset ratio; SBSDY denotes the Government subsidies to assets ratio and GROW denotes the company's growth status. The detailed definitions of variables are reported in Table 1. The p-values are recorded in parenthesis. ***, **, * denote significance at the 1%, 5%, and 10% level, respectively.

5.2. Replacement of Patent Applications with Patent Authorizations

This section replaces the number of patent applications with the number of patent authorizations. Columns (1)–(3) of Table 10 show the regression results for the number of patent authorizations, invention patent authorizations, and non-invention patent authorizations by enterprises. Overall, the acquisition and provision of commercial credit has a significant positive effect on the number of patents granted. Commercial credit acquisition has a greater promotional effect on non-invention patents, and the provision of commercial credit has the most significant promotional effect on enterprise invention patents. The SIZE, R&D and SBSDY coefficients have a significant positive relationship with patent grants, while LEV, AGE and GROW variables and the dependent variable have a significant negative relationship. The LIQ sign changes slightly, and relationships are significant with the dependent variables. Other variables are not statistically related to patent grants. These results are identical with the previous fixed effect results (Table 7) and conclusions. Therefore, we conclude that our results are robust.

Table 10. Logistic regression results for patent licensing.

	GRNT	**GRNTI**	**GRNTNI**
Variables	**(1)**	**(2)**	**(3)**
RCVB	2.168 ***	0.756 ***	2.882 ***
	(0.001)	(0.009)	(0.003)
PYBL	1.104 ***	1.297 ***	0.985 ***
	(0.004)	(0.002)	(0.003)
SIZE	0.608 **	0.595 **	0.570 **
	(0.012)	(0.011)	(0.013)
ROA	−0.499	−0.561	−0.781
	(0.212)	(0.208)	(0.255)
LEV	−1.110 *	−0.886 *	−1.148
	(0.087)	(0.085)	(0.104)
AGE	−0.088 **	0.009 **	−0.135 **
	(0.018)	(0.017)	(0.021)
LIQ	−0.019 ***	0.006 ***	−0.029 ***
	(0.005)	(0.005)	(0.007)
GROW	−0.041 **	−0.063 **	−0.019 **
	(0.021)	(0.020)	(0.025)
R&D	8.040 ***	9.583 ***	5.481 ***
	(0.009)	(0.009)	(0.007)
BANK	2.380	−5.682	5.981
	(0.295)	(0.179)	(0.357)
SBSDY	9.032 ***	10.70 ***	8.139 ***
	(0.004)	(0.002)	(0.007)
Industry effect	YES	YES	YES
Year effect	YES	YES	YES
Constant	−11.50 ***	−12.61 ***	−10.99 ***
	(0.000)	(0.000)	(0.002)
Observations	11,555	11,555	11,555
R^2	0.372	0.354	0.291

Note: The sample consists of 36,051 firms listed on the Shanghai Stock Exchange and Shenzhen Stock Exchange from 1996 to 2019. PTNT denotes the total amount of enterprise patent applications; GRNT denotes the total number of patents granted; GRNTI denotes the number of invention patents granted; GRNTNI denotes the number of non-invention patents granted; RCVB denotes commercial credit provision; PYBL denotes the acquisition of commercial credit; SIZE denotes firm size; ROA denotes return on assets; LEV denotes the asset–liability ratio; AGE denotes the history of the firm from its incorporation; LIQ is the Current Ratio; R&D denotes the Research and Development investment of the company; BANK denotes the ratio of bank loans payable to assets; SBSDY denotes the ratio of Government subsidies to assets; and GROW denotes the company's growth status. The detailed definitions of variables are reported in Table 1. The p-values are recorded in parentheses. ***, **, * denote significance at the 1%, 5%, and 10% level, respectively.

5.3. DiD Model Regression

This section introduces the Property Law as a quasi-natural experiment and uses the double-difference method to analyze the cause and effect relationship between commercial credit and enterprise technological innovation, following Pippel and Seefeld [59] and Fang, Gao and Lai [60]. Specifically, this article divides enterprises' commercial credit acquisition and commercial credit provision before and after promulgation of the Property Law into three groups: high, medium and low. The highest proportion is defined as the experimental group, and the lowest is defined as the control group. Furthermore, the two-way fixed effect of the year and the individual are used to conduct an empirical test of the double difference. The specific model is as follows:

$$Innovation_{it} = \beta_{it} + \delta\ (TREAT_{it} * TIME_{it}) + RCVB_{it} + TREAT_{it} + TIME_{it} + \lambda_y + \lambda_{\text{ind}} + Control_{it} + \varepsilon_{it} \quad (3)$$

$$Innovation_{it} = \beta_{it} + \delta\ (TREAT_{it} * TIME_{it}) + PYBL_{it} + TREAT_{it} + TIME_{it} + \lambda_y + \lambda_{\text{ind}} + Control_{it} + \varepsilon_{it} \quad (4)$$

The explained variables are divided into the total number of enterprise patent applications (PTNT), invention patent applications (PTNTI), and non-invention patent applications (PTNTNI). The coefficients in Equations (3) and (4) describe the impact of commercial credit on technological innovation before and after introduction of the Property Law. Companies with more access to commercial credit have better technological innovation performance than other companies. This study uses data from two groups and two time periods; the DiD estimate of policy impact can be written as follows:

$$\delta = \left(\overline{Y}_{s=treat,t=after} - \overline{Y}_{s=treat,t=before}\right) - \left(\overline{Y}_{s=control,t=after} - \overline{Y}_{s=control,t=before}\right) \quad (5)$$

where δ represents the average value (averaged over individuals, typically indexed by *i*), each group is *s*, and *t* is time. The data are divided into four groups, before and after data are used for treatment and control, and the above double difference is calculated. TREAT* TIME reflects the treatment effect and determines the corresponding change. The independent variables PYBL and RCVB mainly refer to the acquisition and provision of commercial credit. TREAT is a dummy variable if taken in the experimental group 1 if the control group were 0. TIME is a dummy variable of time; if *t* is before 2007, it will be 0, and if *t* is after 2007, it will be 1. Fixed effect for the year, λ_y, and industry fixed effects, λ_{ind}, are considered as well. In addition, the control variables described in the previous chapter are applied, including enterprise size (SIZE), return on assets (ROA), asset–liability ratio (LEV), company age (AGE), current ratio (LIQ), and operating income annual growth rate (GROW).

An important hypothesis for whether double-difference estimation is effective is that the explanatory variables must meet the common trend hypothesis. Before an external policy shock occurs, the processing group's explanatory variables and the control group of enterprises follow the same trend variety. Therefore, we conducted a parallel trend test on the total number of patent applications, invention patents, and non-invention patents using Stata software. We found that the data before the policy all conform to the hypothesis of parallel trends. This article relates to using patent term analysis in lag terms, parallel trend test results show that the annual values prior to policy impact were around 0, and the 95% confidence zone coefficients are insignificant. After 2007, the volatility was relatively large, and the coefficient was significant.

In order to more comprehensively and accurately identify the impact of commercial credit on technological innovation before and after the introduction of the Property Law, we conducted a differential test on the level of obtaining commercial credit and a group differential test on the provision of commercial credit. The empirical research on double difference was carried out on the aspects of providing and obtaining commercial credit. Then, we considered three indicators (PTNT, PTNTI, PTNTNI) to measure enterprise tech-

nological innovation. Furthermore, PTNTI applications can reflect enterprise innovation quality and efficiency. We used the double-difference model under the fixed effect in our empirical research.

Table 11 reports the regression results for the experimental and control groups on the impact of commercial credit acquisition on enterprise technological innovation before and after the introduction of the Property Law. The results show that the DiD coefficients are significantly positive after introduction of the Property Law. After adding a series of control variables, the results show that the DiD coefficients remain significantly positive. This further confirms that the acquisition of commercial credit has a positive role in promoting technological innovation. The results show that the DiD difference term is significantly positive even after considering the lag effect; thus, companies with more commercial credit have better innovation performance. The DiD item positively affects PTNTNI. Among the control variables, the SIZE coefficient has a significant positive relationship, while the LEV, AGE and GROW variables have a significant negative relationship with the dependent variable of patent rights. Other variables are not statistically related to patent grants. The results are identical with the previous fixed effect results (Table 7), and the conclusions, with very few exceptions (the sign of the LIQ coefficient varies very slightly). Thus, we conclude that our results are robust.

Table 11. Regression of patent applications in the current period and one-year lag periods in the RCVB group.

Variables	Current Year Period						One-Year Lagged Period					
	PTNT		PTNTI		PTNTNI		PTNT_1		PTNTI_1		PTNTNI_1	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
DiD	0.478 **	0.308 **	0.509 **	0.382 **	0.576 **	0.427 **	0.450 **	0.330 **	0.506 **	0.371 **	0.558 **	0.439 **
	(0.043)	(0.037)	(0.038)	(0.034)	(0.038)	(0.038)	(0.040)	(0.037)	(0.043)	(0.090)	(0.040)	(0.037)
TIME	1.731 **	1.946 **	1.278 **	1.354 **	1.824 **	1.400 **	2.506 **	2.054**	1.731 **	1.336 **	1.896 *	1.494 *
	(0.031)	(0.048)	(0.027)	(0.043)	(0.040)	(0.040)	(0.032)	(0.038)	(0.046)	(0.042)	(0.071)	(0.070)
TREAT	0.466 **	0.212 **	0.170 **	−0.075 **	0.395 **	0.231 **	0.336 **	0.166 **	0.051 *	−0.204 *	0.353 *	0.196 **
	(0.035)	(0.032)	(0.030)	(0.029)	(0.031)	(0.033)	(0.033)	(0.032)	(0.099)	(0.087)	(0.058)	(0.032)
PYBL		1.656 *		1.490 *		1.429 *		1.598 *		1.822 *		1.333 *
		(0.072)		(0.066)		(0.074)		(0.072)		(0.062)		(0.073)
SIZE		0.462 ***		0.411 ***		0.408 ***		0.437 ***		0.581 **		0.384 ***
		(0.008)		(0.007)		(0.008)		(0.008)		(0.012)		(0.008)
ROA		1.067		0.758		0.734		0.660		−0.139		0.346 **
		(0.149)		(0.137)		(0.154)		(0.146)		(0.247)		(0.149)
LEV		−0.281 *		−0.096 *		−0.257 *		−0.288 *		−0.580 *		−0.271 *
		(0.056)		(0.051)		(0.057)		(0.055)		(0.097)		(0.056)
AGE		−0.069 **		−0.057 **		−0.058 **		−0.062 **		−0.012 **		−0.049 **
		(0.017)		(0.016)		(0.017)		(0.018)		(0.027)		(0.018)
LIQ		0.009 ***		0.020 ***		−0.006 ***		0.012 ***		0.009 ***		−0.003 ***
		(0.005)		(0.004)		(0.005)		(0.005)		(0.007)		(0.005)
GROW		−0.048 **		−0.038 **		−0.043 **		−0.153 **		−0.174 **		−0.139 **
		(0.015)		(0.013)		(0.015)		(0.014)		(0.025)		(0.015)
Constant	0.424 ***	−9.844 ***	0.202 ***	−8.808 ***	−0.328 ***	−8.730 ***	−0.270 ***	−9.298 ***	−0.027	−12.155 ***	−0.287 ***	−8.176 ***
	(0.005)	(0.000)	(0.002)	(0.005)	(0.006)	(0.005)	(0.008)	(0.008)	(0.006)	(0.007)	(0.008)	(0.002)
Industry effect	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year effect	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	20,449	18,586	20,450	18,592	20,452	18,592	18,527	18,467	8573	8568	18,527	18,467
R^2	0.333	0.586	0.275	0.511	0.405	0.488	0.490	0.579	0.177	0.380	0.400	0.481

Note: The sample consists of 36,051 firms listed on the Shanghai Stock Exchange and Shenzhen Stock Exchange from 1996 to 2019. PTNT denotes the total amount of enterprise patent applications; PTNTI denotes invention patent applications; PTNTNI denotes non-invention patent applications; DiD is an estimate of policy impact; TREAT is a dummy variable if taken in the experimental group 1; TIME is a dummy variable of time with a value of 0 before 2007; RCVB denotes commercial credit provision; PYBL denotes the acquisition of commercial credit; SIZE denotes firm size; ROA denotes return on assets; LEV denotes the asset–liability ratio; AGE denotes the history of the firm from its incorporation; LIQ is the Current Ratio; and GROW denotes the company's growth status. The detailed definitions of variables are reported in Table 1. The p-values are recorded in parentheses. ***, **, * denote significance at the 1%, 5%, and 10% level, respectively.

Table 12 reports the regression results for the experimental and control groups on the impact of by commercial credit provision before and after the Property Law on enterprise technological innovation. There is a significant positive dependent correlation between the DiD coefficients and patent applications. This shows that initially, companies with more commercial credit had better innovation performance after the introduction of the Property Law. After adding certain control variables, the DiD remains significantly positive. Furthermore, the control variable coefficients and one-year lag results are consistent with the direction of access to commercial credit.

Table 12. Regression of patent applications in the current period and one-year lag period for the PYBL group.

Variables	Current Year Period						One-Year Lagged Period					
	PTNT		PTNTI		PTNTNI		PTNT_1		PTNTI_1		PTNTNI_1	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
DiD	0.491 **	0.452 **	0.537 **	0.534 **	0.449 **	0.421 **	0.552 **	0.495 **	0.316 *	0.269 *	0.493 **	0.444 **
	(0.038)	(0.037)	(0.034)	(0.034)	(0.038)	(0.038)	(0.040)	(0.036)	(0.087)	(0.091)	(0.040)	(0.037)
TIME	2.420 ***	1.555 **	1.740 **	1.008 **	1.874 **	1.096 **	2.439 **	1.635 *	1.819	1.301	1.895*	1.174 *
	(0.007)	(0.037)	(0.033)	(0.042)	(0.051)	(0.039)	(0.041)	(0.067)	(0.342)	(0.296)	(0.071)	(0.068)
TREAT	0.193 **	0.353 ***	0.044 **	0.180 **	0.198 **	0.309 **	0.162 **	0.307 **	0.127 *	0.402 *	0.167 **	0.263 **
	(0.031)	(0.003)	(0.028)	(0.028)	(0.031)	(0.031)	(0.032)	(0.030)	(0.099)	(0.087)	(0.032)	(0.030)
RCVB		0.958 **		0.531 **		1.159 **		0.852 **		0.330 **		1.072 **
		(0.027)		(0.022)		(0.029)		(0.026)		(0.024)		(0.027)
SIZE		0.477 ***		0.418 ***		0.421 ***		0.454 ***		0.585 ***		0.396 ***
		(0.008)		(0.007)		(0.008)		(0.007)		(0.002)		(0.008)
ROA		0.903		0.587		0.525		0.453		0.026		0.175
		(0.143)		(0.131)		(0.147)		(0.139)		(0.245)		(0.142)
LEV		−0.251 *		−0.090 *		−0.209 *		−0.257 *		−0.403		−0.222 *
		(0.055)		(0.051)		(0.057)		(0.054)		(0.100)		(0.055)
AGE		−0.026 **		−0.014 **		−0.0129 **		−0.019 **		0.017 **		−0.009 **
		(0.017)		(0.016)		(0.017)		(0.017)		(0.027)		(0.018)
LIQ		0.005 ***		0.018 ***		−0.009 ***		0.010 ***		0.025 ***		−0.005 ***
		(0.005)		(0.005)		(0.005)		(0.005)		(0.008)		(0.005)
GROW		−0.037 **		−0.04 **		−0.023 **		−0.129 **		−0.139 **		−0.111 **
		(0.015)		(0.013)		(0.015)		(0.014)		(0.027)		(0.015)
Constant	−0.167 *	−9.73 ***	−0.134 *	−8.60 ***	−0.253 *	−8.682 ***	−0.135 *	−9.222 ***	−0.036 *	−12.322 ***	−0.213 *	−8.120 ***
	(0.087)	(0.007)	(0.078)	(0.003)	(0.097)	(0.002)	(0.060)	(0.004)	(0.072)	(0.005)	(0.099)	(0.007)
Year effect	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Industry effect	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	20,343	18,569	20,343	18,569	20,343	18,569	18,563	18,506	8459	8454	18,563	18,506
R^2	0.481	0.591	0.401	0.515	0.378	0.491	0.482	0.586	0.151	0.368	0.382	0.485

Note: The sample consists of 36,051 firms listed on the Shanghai Stock Exchange and Shenzhen Stock Exchange from 1996 to 2019. PTNT denotes the total amount of enterprise patent applications; PTNTI denotes invention patent applications; PTNTNI denotes non-invention patent applications; DiD is an estimate of policy impact; TREAT is a dummy variable if taken in the experimental group 1; TIME is a dummy variable of time with a value of 0 before 2007; RCVB denotes commercial credit provision; PYBL denotes the acquisition of commercial credit; SIZE denotes firm size; ROA denotes return on assets; LEV denotes the asset–liability ratio; AGE denotes the history of the firm from its incorporation; LIQ is the Current Ratio; and GROW denotes the company's growth status. The detailed definitions of variables are reported in Table 1. The p-values are recorded in parentheses. ***, **, * denote significance at the 1%, 5%, and 10% level, respectively.

In order to strengthen the robustness of the regression results, this article replaces the measurement indicators of commercial credit. It uses the acquisition of commercial credit (accounts payable + bills payable + advance receipts)/operating cost measurement and the provision of commercial credit (accounts receivable + notes receivable + prepaid accounts)/operating income. The regression results are the same and remain significant; the obtained test results are available from the authors upon request.

Following Fang [34], we considered time policies before and after the Property Law was introduced. First, before enacting the Property Law, the external events for 2005 and 2006 are considered. Specifically, the time when the event variable occurred was adjusted to 2006. The test results (Table 13) show that neither the acquisition of commercial credit nor the estimated coefficients for the explained variables are significant. Thus, the

policies had not affected results before promulgation of the Property Law. Second, this study narrows the data time window to post-2008 in order to eliminate any interference from the "four trillion policy" (in November 2008, a Chinese economic stimulus plan of CNY 4 trillion (USD 586 billion) was announced by the State Council of the People's Republic of China in an attempt to minimize the impact of the global financial crisis on the economy). Critics of China's stimulus package have blamed it for causing a surge in Chinese debt after 2009, particularly among local governments and state-owned enterprises (Bradsher, Keith, "China's Central Bank Is Short of Capital", The New York Times, https://www.nytimes.com/2008/09/05/business/worldbusiness/05yuan.html (accessed on 22 May 2021)). Our results show that the differential explanatory variables had a significant positive effect following introduction of the Property Law on the accounts receivable of enterprises. This protection improved enterprises' commercial credit, thereby promoting their innovative power and efficiency. Based on this analysis (Table 14), it is clear that other macroeconomic policies in China have not affected the recognition of innovation by enterprises, and thus the regression results are robust.

Table 13. Regression results for time policy prior to promulgation of the Property Law.

Variables	PTNT	PTNTI	PTNTNI	PTNT	PTNTI	PTNTNI
	1	2	3	4	5	6
DiD	0.031	0.032	0.062	−0.027	0.082	−0.042
	(0.113)	(0.184)	(0.105)	(0.113)	(0.187)	(0.104)
TIME	0.062	0.086	0.003	0.122	0.0667	0.0755
	(0.181)	(0.161)	(0.175)	(0.181)	(0.162)	(0.174)
TREAT	0.393 **	0.139 **	0.392 **	0.611 **	0.340 **	0.509 **
	(0.049)	(0.036)	(0.032)	(0.045)	(0.046)	(0.038)
PYBL	1.560 ***	1.129 ***	1.147 ***			
	(0.008)	(0.007)	(0.002)			
RCVB				0.725 ***	0.328 **	0.764 ***
				(0.003)	(0.004)	(0.007)
SIZE	0.362 **	0.254 **	0.300 **	0.426 **	0.327 **	0.340 **
	(0.028)	(0.021)	(0.026)	(0.027)	(0.021)	(0.025)
ROA	0.528	0.275	0.225	0.316	−0.086	0.132
	(0.450)	(0.335)	(0.418)	(0.436)	(0.337)	(0.400)
LEV	−0.371	−0.190	−0.295	−0.513	−0.277	−0.454
	(0.169)	(0.126)	(0.157)	(0.169)	(0.131)	(0.155)
AGE	0.006 *	−0.066 *	0.109 *	0.011 *	−0.037 *	0.095 *
	(0.070)	(0.052)	(0.065)	(0.072)	(0.056)	(0.066)
LIQ	0.031 **	0.031 **	0.020 **	0.018 **	0.025 **	0.015 **
	(0.021)	(0.015)	(0.019)	(0.023)	(0.018)	(0.021)
GROW	−0.045 *	−0.055 **	−0.022 **	−0.032 *	−0.036 **	−0.009 **
	(0.054)	(0.040)	(0.050)	(0.053)	(0.041)	(0.049)
Industry effect	YES	YES	YES	YES	YES	YES
Year effect	YES	YES	YES	YES	YES	YES
Constant	−7.546 ***	−5.236 ***	−6.476 ***	−8.537 ***	−6.593 ***	−7.023 ***
	(0.003)	(0.006)	(0.006)	(0.008)	(0.004)	(0.006)
Observations	1703	1703	1703	1706	1706	1706
R^2	0.274	0.199	0.230	0.296	0.241	0.239

Note: The sample consists of 36,051 firms listed on the Shanghai Stock Exchange and Shenzhen Stock Exchange from 1996 to 2019. PTNT denotes the total amount of enterprise patent applications; PTNTI denotes invention patent applications; PTNTNI denotes non-invention patent applications; DiD is an estimate of policy impact; TREAT is a dummy variable if taken in the experimental group 1; TIME is a dummy variable of time with a value of 0 before 2007; RCVB denotes commercial credit provision; PYBL denotes the acquisition of commercial credit; SIZE denotes firm size; ROA denotes return on assets; LEV denotes the asset–liability ratio; AGE denotes the history of the firm from its incorporation; LIQ is the Current Ratio; and GROW denotes the company's growth status. The detailed definitions of variables are reported in Table 1. The p-values are recorded in parentheses. ***, **, * denote significance at the 1%, 5%, and 10% level, respectively.

Table 14. Regression results when narrowing the time window.

Variables	PTNT	PTNTI	PTNTNI	PTNT	PTNTI	PTNTNI
	1	2	3	4	5	6
DiD	0.412 **	0.137 **	0.474 **	0.677 **	0.442 **	0.522 **
	(0.045)	(0.051)	(0.042)	(0.048)	(0.046)	(0.045)
PYBL	2.120 ***	1.603 ***	1.585 ***			
	(0.000)	(0.000)	(0.000)			
RCVB				0.674 ***	0.407 ***	0.647 ***
				(0.001)	(0.001)	(0.002)
SIZE	0.356 ***	0.280 ***	0.307 ***	0.387 ***	0.309 ***	0.323 ***
	(0.003)	(0.009)	(0.002)	(0.003)	(0.008)	(0.001)
ROA	1.069	0.642	0.850	0.900	0.552	0.704
	(0.409)	(0.330)	(0.390)	(0.390)	(0.317)	(0.369)
LEV	−0.149	−0.062	−0.106	−0.236	−0.028	−0.147
	(0.158)	(0.128)	(0.151)	(0.155)	(0.126)	(0.147)
AGE	−0.172 **	−0.182 **	−0.016 *	−0.339 **	−0.252 **	−0.198 **
	(0.045)	(0.043)	(0.062)	(0.047)	(0.045)	(0.043)
LIQ	0.015 **	0.028 **	0.011 **	0.004 **	0.023 **	0.022 **
	(0.022)	(0.018)	(0.021)	(0.024)	(0.019)	(0.022)
GROW	−0.141 **	−0.072 **	−0.125 **	−0.107 **	−0.056 **	−0.086 **
	(0.043)	(0.035)	(0.041)	(0.042)	(0.034)	(0.039)
Year effect	YES	YES	YES	YES	YES	YES
Industry effect	YES	YES	YES	YES	YES	YES
Constant	−6.534 ***	−5.214 ***	−6.085 ***	−6.681 ***	−5.618 ***	−5.889 ***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	1835	1835	1835	1833	1833	1833
R^2	0.358	0.283	0.293	0.373	0.307	0.300

Note: The sample consists of 36,051 firms listed on the Shanghai Stock Exchange and Shenzhen Stock Exchange from 1996 to 2019. PTNT denotes the total amount of enterprise patent applications; PTNTI denotes invention patent applications; PTNTNI denotes non-invention patent applications; DiD is an estimate of policy impact; RCVB denotes commercial credit provision; PYBL denotes the acquisition of commercial credit; SIZE denotes firm size; ROA denotes return on assets; LEV denotes the asset–liability ratio; AGE denotes the history of the firm from its incorporation; LIQ is the Current Ratio; and GROW denotes the company's growth status. The detailed definitions of variables are reported in Table 1. The p-values are recorded in parentheses. ***, **, * denote significance at the 1%, 5%, and 10% level, respectively.

5.4. Regression of Sub-Groups with Different Financial Constraints

For further analysis, we considered the data for 2007–2017 separately and conducted a regression analysis to measure the impact of corporate financing regulations on commercial credit. First, corporate financing regulations were divided into two groups, namely, high and low. Considering the highest third as having a high degree of financing constraints and the lowest third as having a low degree of financial constraints, these two groups were compared. The results in Table 15 show that commercial credit acquisition positively affected both companies with high financial constraints and those with fewer financial constraints. Property Law implementation increased companies' probability of obtaining commercial credit, and has promoted technological innovation. The impact of commercial credit on invention patents in the highly constrained group is more significant than in the low financing constraint group. The provision of commercial credit mainly has a significant impact on the highly constrained group. Remarkably, the leverage ratio and the ratio of bank loans to assets are not significant. Government subsidies show a significant relationship with technological innovation.

Table 15. Regression results for different financial constraint sub-groups.

Variables	PTNT		PTNTI		PTNTNI	
	High Constraint	Low Constraint	High Constraint	Low Constraint	High Constraint	Low Constraint
RCVB	2.194 ***	2.377 ***	1.304 ***	1.181 ***	2.718 ***	3.384 ***
	(0.002)	(0.008)	(0.008)	(0.003)	(0.004)	(0.000)
PYBL	2.242 ***	0.129 ***	2.358 ***	0.721 ***	2.044 ***	0.021 ***
	(0.002)	(0.009)	(0.004)	(0.002)	(0.005)	(0.008)
SIZE	0.640 ***	0.632 ***	0.669 ***	0.662 ***	0.574 ***	0.578 ***
	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.003)
ROA	0.662	1.011	0.199	0.749	0.290	0.437
	(0.357)	(0.430)	(0.373)	(0.439)	(0.404)	(0.505)
LEV	−1.203	−0.620	−1.102	−0.312	−1.146	−0.824
	(0.142)	(0.199)	(0.148)	(0.203)	(0.161)	(0.234)
AGE	−0.197 *	0.220 **	−0.256 *	0.223 **	−0.051 *	0.267 *
	(0.074)	(0.054)	(0.077)	(0.055)	(0.083)	(0.063)
LIQ	−0.024 **	−0.004 ***	−0.003 **	−0.024 ***	−0.045 **	−0.013 ***
	(0.014)	(0.008)	(0.015)	(0.008)	(0.016)	(0.009)
GROW	−0.053 **	0.026 **	−0.063 **	0.057 **	−0.032 **	0.002 *
	(0.032)	(0.049)	(0.033)	(0.050)	(0.036)	(0.058)
R&D	9.114 ***	10.672 ***	10.529 ***	14.394 ***	6.700 ***	8.229 ***
	(0.001)	(0.008)	(0.001)	(0.004)	(0.008)	(0.003)
BANK	2.606	3.326	−12.391	−3.053	12.441	10.608
	(0.498)	(0.198)	(0.184)	(0.254)	(0.256)	(0.342)
SBSDY	12.623 ***	17.113 ***	14.087 ***	22.468 ***	10.858 ***	10.528 ***
	(0.007)	(0.002)	(0.005)	(0.001)	(0.001)	(0.008)
Year effect	YES	YES	YES	YES	YES	YES
Industry effect	YES	YES	YES	YES	YES	YES
Constant	−12.181 ***	−12.283 ***	−13.161 ***	−13.448 ***	−11.824 ***	−11.956 ***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	4486	3456	4486	3456	4486	3456
R^2	0.360	0.480	0.323	0.445	0.292	0.422

Note: The sample consists of 36,051 firms listed on the Shanghai Stock Exchange and Shenzhen Stock Exchange from 1996 to 2019. PTNT denotes the total amount of enterprise patent applications; PTNTI denotes invention patent applications; PTNTNI denotes non-invention patent applications; RCVB denotes commercial credit provision; PYBL denotes the acquisition of commercial credit; SIZE denotes firm size; ROA denotes return on assets; LEV denotes the asset–liability ratio; AGE denotes the history of the firm from its incorporation; LIQ is the Current Ratio; GROW denotes the company's growth status; R&D denotes the Research and Development investment of the company; BANK denotes the ratio of bank loans payable to assets; and SBSDY denotes the ratio of government subsidies to assets. The detailed definitions of variables are reported in Table 1. The p-values are recorded in parentheses. ***, **, * denote significance at the 1%, 5%, and 10% level, respectively.

6. Discussion

This study focused on the impact of commercial credit provision on the innovative behavior and heterogeneity of enterprises with different ownership types. Several robustness tests support the validity of our results. The fixed effect results illustrate that the provision and acquisition of commercial credit promotes technological innovation [24,39], consistent with the H1 and H2 hypotheses. In practice, commercial credit will affect enterprise technological innovation. Moreover, technological innovation may affect enterprises' commercial credit. Cooperative enterprises trust higher technological innovation levels and gain more commercial credit. Simultaneously, growing companies are able to provide commercial credit in order to continue to occupy the market by improving their competitiveness and striving for further development space and technological innovation capabilities.

Furthermore, patent applications promoting invention are more common in private enterprises than in SOEs. The regression results show that the acquisition of commercial credit is particularly critical to private enterprises' technological innovation, which increases the total patent numbers of private enterprises and promotes substantial innovation, which is be conducive to the growth and development of private enterprise. Therefore, our results found that private enterprises face more difficulties in financing bank credit, similar to previous studies [61]. More efficient financing channels such as internal funds can help private companies to achieve their objectivities. Commercial credit has a direct effect on the research and development investment of listed companies. The more commercial credit a

listed company obtains, the more investment it is able to obtain. A higher level of financial development allows a greater role for investment in technological innovation in promoting enterprises to obtain commercial credit.

Among the control variables, firm size positively correlates with the dependent variable, meaning that it improves enterprises' technological innovation capabilities [40,41]. Large-scale enterprises have stronger innovation power and strength because when the enterprise is larger, there is a greater capacity to support technological innovation activities. ROA coefficient is positive as well, though not significantly, indicating that companies with better profits have better innovation performance. LEV is significantly negative, showing that companies with high debt ratios are not highly innovative. The relationship between bank financing and innovation is critically discussed [62,63], as the characteristics of innovation (low collateral, large uncertainties) may make bank financing difficult. Even though the famous direct problems are connected with external financing innovations, there may be an indirect relation between bank credit and innovation. Firms can obtain loans from banks that offer collateral for projects other than innovation. Government subsidies have shown a significant positive effect on enterprise innovation, and help enterprises increase the total number of patent rights [57,58].

Based on the empirical analysis results, commercial credit acquisition and provision positively affect enterprises' total number of patent applications and invention patent applications in the current period. Thus, commercial credit significantly promotes the enthusiasm of enterprise innovation and improves its quality. This supports hypothesis H3, namely, that following the implementing the Property Law, enterprises will increase their use of commercial credit, thereby promoting technological innovation. Therefore, hypothesis H3 is accepted, and the results are consistent with previous studies [27,28]. Furthermore, the results show that commercial credit acquisition has a positively effect on both companies with high financial constraints and those with fewer financial constraints. Property Law implementation has increased companies' probability of obtaining commercial credit and promoted technological innovation. This implies that commercial credit acquisition promotes the enthusiasm of enterprises' technological innovation and improves their innovation quality. The provision of commercial credit has a more significant impact on the highly constrained group. It is clear that the Property Law protects the company's accounts receivable and qualitatively pledges the provision of corporate commercial credit by significantly increasing the number of patents and improving the quality of research and development.

Finally, we suggest that the government should focus on promoting the marketization level of the commercial banking financial industry and diversifying the financing channels for research and development investment by enterprises when it is difficult to collect the internal resources of enterprises to provide capital support for these activities continuously. Furthermore, it is necessary to establish sound financial market development and to promote balance in the financial development of various regions. Financial development will affect the provision and acquisition of business credit. It is necessary to promote the reform of the financial system, promote the development of the financial market, improve the level of financial development, speed up the marketization of the financial industry, and make the financial market benign.

7. Conclusions

The existing literature lacks clear and unified policy conclusion implications concerning commercial credit and enterprise technological innovation. In particular, there may be endogenous problems in the benchmark regression of commercial credit and innovation. Therefore, it is very important to set up an appropriate model for empirical research. Based on the quasi-natural experiment enabled by the Property Law of the People's Republic of China of 2007, our study uses a double-difference method to systematically evaluate the causal relationship between commercial credit acquisition and the technological innovation provided by enterprises. There are several findings in this article based on its robust results.

The acquisition and provision of commercial credit help improve enterprises' enthusiasm for innovation and improve the quality of their innovation, mainly manifested in an increase in the number of patent applications and invention patents. In our analysis of the samples' heterogeneity, a positive effect on the innovation level of SOEs and private enterprises was found. The impact of commercial credit on enterprise technological innovation has a dose-dependent effect. When the gap in commercial credit between groups changes, the impact on corporate innovation fluctuates as well. The promulgation of the Property Law effectively protects the accounts receivable of enterprises, incentivizes enterprises to actively provide commercial credit, and plays a further positive role in enterprises' technological innovation. Commercial credit has an obvious positive effect on research and development by enterprises heavily constrained by financing, and significantly improves the quantity and quality of enterprises' technological innovation.

Finally, this article has important practical significance. Currently, in the face of global value chain development it is necessary to improve local enterprises' independent innovation capabilities in order to improve the status of China's industrial chains. We have found that corporate commercial credit is conducive to the development of corporate technological innovation. Therefore, companies can consider informal financing channels in order to develop technological innovation and promote corporate development, even under financial constraints. Furthermore, by comparing the experimental and control groups before and after introduction of the Property Law, we found that the protection extended to accounts receivable and intellectual property significantly promoted the number of patent applications. In other words, optimizing the legal environment is a key way to promote technological innovation by enterprises. Protection at the legal level is not limited to laws such as the "Intellectual Property Law of the People's Republic of China" that protect innovations; laws and policies such as the Property Law that help companies ease financing problems can promote technological innovation as well, as financing constraints remain the key hindrance to enterprises' technological innovation.

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