

Does the level of corporate finance affect corporate technological innovation?

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Abstract:

As the main way for enterprises to obtain funds, the level of financing directly determines the amount of resources available for technological innovation. In this paper, we conduct an empirical research method based on the data of Chinese listed companies from 2009-2023 to explore in depth the impact of the level of corporate financing on the technological innovation activities of enterprises. It is found that there is a significant positive correlation between the level of corporate financing and its technological innovation capability. The empirical findings of this paper provide strong evidence for understanding the impact of the level of corporate finance on technological innovation, and provide useful references for enterprises to formulate scientific financing strategies and technological innovation planning.

Keywords: Level of Financing; Technological Innovation; Enterprise Innovation

1. Introduction

In the context of China's market economy development, technological innovation of enterprises has become an important means to promote economic transformation and enhance international competitiveness. The level of financing, as an important financial basis for the operation of enterprises, directly determines their ability and efficiency of technological innovation. Studying the impact of enterprise financing level on technological innovation is of great practical significance, which not only helps to improve the competitive advantage of enterprises in the market, but also can provide important support for the national innovation-driven development strategy.

Technological innovation is the core driving force for enterprises to achieve sustainable development, especially in the current context of globalization and the rapid development of digital economy, the ability to innovate has become the key for enterprises to enhance their competitiveness and enter the high-end market. In China, the manufacturing industry is transforming from "quantity" to "quality", and innovative enterprises are leading the upgrade of the industry^[1]. The Chinese government has also taken technological innovation as a national strategy, and introduced a series of policies to promote independent innovation among enterprises, with a view to breaking through technological bottlenecks and promoting industrial upgrading.

For enterprises, technological innovation can not only

help them stand out in the fierce market competition, but also open up new market areas and form unique competitive barriers^[2]. For example, Huawei has successfully become one of the world's leading technology companies with its continuous innovation in 5G technology. Alibaba has rapidly captured domestic and international markets through its innovation in cloud computing and big data technology. As a result, technological innovation has become a core way for enterprises to gain long-term competitive advantage and enhance their market position.

However, technological innovation is often accompanied by high cost, high risk, long cycle and other characteristics, which makes enterprises face great financial pressure when carrying out technological innovation. Technological innovation requires a large amount of financial support, especially in the research and development stage, the experimental stage and the technology promotion stage, enterprises need to continue to carry out high-intensity capital investment. Adequate financial support enables enterprises to maintain R&D personnel, purchase experimental equipment, carry out technical cooperation and other innovative activities. Therefore, studying the relationship between the level of enterprise financing and the level of technological innovation can help enterprises realize the importance of financing for innovation, so as to achieve benign development.

By studying the relationship between enterprise financing constraint indicators and patent data from 2009 to 2023, this paper finds that the lower the enterprise financing

constraint indicators, the more patent inventions. This indicates that the higher the level of enterprise financing, the stronger the technological innovation ability. Enterprises may face huge financial losses in the process of innovation due to changes in market demand and immature technology. Enterprises with a higher level of financing have a stronger risk-resistant ability to withstand failures in innovation and continue to push forward technological upgrades and innovation iterations. Many high-tech companies in China, such as Xiaomi and BYD, have been able to withstand failures in the early stages of innovation by virtue of their strong financing capabilities, and have been able to continue to make technological improvements and ultimately succeed in launching market-competitive products. On the other hand, enterprises with low levels of financing are often forced to interrupt their innovation projects and miss market opportunities due to lack of funds when facing innovation risks.

2. Literature Review and Theoretical Analysis

2.1 Literature Review

Enterprise technological innovation is a key factor in promoting economic growth and industrial upgrading. In the fierce market competition, enterprise technological innovation has become the key to enhancing its competitiveness and realizing sustainable development. However, technological innovation often requires a large amount of capital investment, and it is often difficult for enterprises to meet this demand with their own funds. Therefore, the level of enterprise financing directly affects the ability and effect of enterprise technological innovation. Financing is an important source of funds for enterprise technological innovation, if enterprises can enhance their own value through technological innovation, it will be easier to obtain the favor of the capital market, thus enhancing the financing ability and providing more adequate financial support for technological innovation^[3].

As an important source of capital for technological innovation, equity financing has the advantage of attracting investors with a long-term vision to bear the risk of innovation and share the future benefits^[4]. With the continuous development and improvement of the capital market, the channels of equity financing are becoming more and more diversified, including IPO, venture capital, private equity and so on. These financing methods not only provide enterprises with large amount of capital support, but also bring valuable resources such as management experience and market resources. Meanwhile, although debt financing still occupies an important position in enterprise operation, its limitations gradually appear when facing techno-

logical innovation projects. As a result, more and more enterprises have begun to explore new financing methods, such as crowdfunding, P2P lending, supply chain finance, etc., which provide new ways for SMEs to finance with their flexibility, efficiency and low cost. With the rapid development of financial technology, the application of blockchain, big data, artificial intelligence and other technologies is profoundly changing the ecology of the financial industry. The application of these technologies not only improves the financing efficiency and reduces the cost of financing, but also enhances the transparency and credibility of information, providing investors with more diversified investment options and more accurate risk assessment tools.

Financing can provide enterprises with the necessary financial support to ensure the smooth progress of technological innovation activities^[5]. Innovative activities are often accompanied by high risks, and adequate financing can reduce such risks and give enterprises more confidence in conducting long-term technological research and development. The development of financial technology promotes technological innovation by alleviating the financing constraints of enterprises and reducing financing costs. Small and medium-sized high-tech enterprises have the problem of narrow channels and high costs in financing. It is often difficult for these enterprises to obtain sufficient financial support through traditional bank credit channels, resulting in a shortage of funds in their technological innovation process^[6]. In addition, excessive financing may also have a negative impact on enterprise technological innovation, such as reducing innovation efficiency and increasing financial risks. With the development of fintech, it shows great potential in alleviating enterprise financing constraints and promoting enterprise technological innovation. It is found that the development of FinTech can significantly reduce the financing cost of enterprises and improve the efficiency of financing, thus alleviating the problem of capital shortage in the process of enterprise technological innovation. By lowering the market threshold, expanding the range of sources of capital supply and demand, and reducing the degree of information asymmetry by utilizing advanced technologies such as big data and blockchain, FinTech provides enterprises with more diversified financing channels and more convenient financing services. This not only helps enterprises obtain more financial support, but also improves their risk management ability and provides a more stable financial environment for technological innovation.

2.2 theoretical analysis

The level of enterprise financing, i.e. the scale and ability of an enterprise to potentially finance capital, is an import-

ant support for an enterprise's technological innovation activities. Technological innovation, as the fundamental driving force of enterprise development, requires sustained capital investment to support research and development activities, purchase advanced equipment, attract and train talents, etc. Therefore, the level of financing directly affects the breadth and depth of technological innovation. First of all, a higher level of financing can provide enterprises with sufficient financial security, so that enterprises can increase their investment in R&D, thus promoting the quantity and quality of technological innovation^[7]. This positive effect is reflected in two aspects: firstly, it directly increases the number of R&D projects and expands the coverage of technological innovation; secondly, it improves the quality and depth of R&D projects, prompting enterprises to develop more competitive new products, technologies and services.

However, the impact of the level of financing on technological innovation is not entirely positive. As the scale of financing increases, firms may face stricter social monitoring and disclosure requirements, as well as market expectations of short-term performance^[8]. These factors may lead firms to be more conservative in their technological innovation decisions, abandoning high-risk, high-yield but long-cycle innovation projects in favor of more prudent "growth" innovations. In addition, over-reliance on external financing may also weaken the independent innovation ability of enterprises, making them more inclined to acquire external technological resources through mergers and acquisitions rather than accumulating core technologies through internal research and development. In addition, the nature of the enterprise and the industry in which it operates may also have a moderating effect on the mechanism by which the level of financing affects technological innovation^[9]. Compared with state-owned enterprises, private enterprises may face more constraints and restrictions in the financing process, so their technological innovation activities are more sensitive to the level of financing. At the same time, there are also differences in the characteristics of technological innovation and financial needs of different industries, which further complicates the mechanism of the impact of the level of financing on technological innovation^[10].

In summary, the impact of enterprise financing level on enterprise technological innovation is a complex and dynamic process. A higher level of financing can provide financial support for enterprises and promote technological innovation activities; however, it may also bring a series of negative impacts, such as the decline of innovation quality and the weakening of innovation capability. Therefore, enterprises need to weigh the pros and cons in the financing process and formulate a reasonable financing

strategy and technological innovation planning in order to realize sustainable development. At the same time, the government and all sectors of society should also strengthen their support for enterprise financing and technological innovation to create a more favorable external environment for enterprises.

3. Research Design

3.1 Data sources and sample selection

The data source and sample selection process of this paper are as follows: firstly, the unbalanced panel data of Shanghai and Shenzhen A-share listed firms from 2009-2023 are obtained from CSMAR database as the research object, and the data are processed in the following ways: (1) the samples of the financial industry and the samples with missing data of important variables are excluded; (2) the ST and PT firms are excluded; (3) the observations with the negative degree of competition of the firms are excluded; and (4) the observations with the negative degree of competition of the firms are excluded.) In order to exclude the effect of extreme values, continuous variables are shrink-tailed by 1% up and down, finally obtaining 35,098 sample observations for 4,215 firms. The variable data come from the CSMAR database.

3.2 Variable Selection and Measurement

(1) Explained Variables

The explanatory variables in this paper are patent application data, taking logarithms in terms of patent application data plus one. Take the logarithm of the patent acquisition data plus one.

(2) Explanatory variables

The explanatory variable of this paper is the enterprise financing level. Financing level (SA_index and FC_index) are chosen as proxies.

(3) Control variables

The selection of control variables for this study encompasses several key aspects of enterprise characteristics. Specifically, it has chosen:

Enterprise Size (Size), quantified through the natural logarithm of the total assets of the enterprise. This metric captures the scale of the company and its potential influence on resource allocation and innovation capabilities.

Enterprise Age (Age), defined as the number of years since the enterprise's initial listing. This factor accounts for the maturity and experience of the company, which could impact its access to financing and strategic decision-making.

Ownership Nature (Soe), a binary variable where Soe = 1 signifies state-owned enterprise status, and Soe = 0 otherwise. Given that state-owned enterprises often enjoy

preferential access to credit resources and government policies, this variable aims to capture the potential influence of ownership structure on inter-firm competition and resource allocation.

Return on Assets (Roa), calculated as the ratio of operating profit to total assets for the current year. This metric reflects the operational performance and profitability of the enterprise, which is often positively associated with its productivity and innovation capacity.

Fixed Assets Ratio (Fit), expressed as the proportion of total fixed assets to total assets. This ratio provides insights into the capital intensity and asset structure of the company, which may influence its investment decisions and technological advancements.

Debt Ratio (Debt), quantified by the ratio of total liabilities to total assets. The balance sheet structure, as indicated by this ratio, affects the financing costs and investment strategies of the enterprise, ultimately impacting its productivity and innovation outcomes.

Tobin's Q (TobinQ), measured as the ratio of the firm's market value to its replacement cost. This variable captures the market's perception of the company's growth potential and future profitability, which can influence its

access to capital and investment decisions.

By incorporating these control variables into our analysis, it aims to provide a more nuanced understanding of the relationship between enterprise financing levels and technological innovation, while accounting for the potential confounding effects of enterprise characteristics.

3.3 Descriptive statistics

Table 1 shows the descriptive statistics of the variables, and the number of sample observations is statistically obtained according to the main regression results. It can be found that: the minimum value of the logarithmic value of patent applications (lnPatents1) is 0, the maximum value is 9.737, and the standard deviation is 1.824, indicating that there are large differences in the level of innovation between different enterprises; using patent acquisition as a robustness test indicator, the difference between the maximum and minimum values is also large; the standard deviation of the level of enterprise financing (SA_index and FC_index) is 0.26, indicating that the differences between enterprises are small; the mean value of the nature of enterprise ownership (Soe) is 0.268, indicating that the proportion of state-owned enterprises in the sample is 26.8%.

Table 1. Descriptive Statistics of Variables

VarName	Obs	Mean	SD	Min	Max
lnPatents1	13464	1.149	1.824	0.000	9.737
lnPatents2	13464	0.519	1.258	0.000	7.892
SA_index	13464	-3.768	0.256	-5.646	-2.109
FC_index	13464	0.558	0.263	0.000	0.986
Size	13464	21.991	1.149	19.204	28.502
Age	13464	1.904	0.745	0.693	3.466
Soe	13464	0.268	0.443	0.000	1.000
Roa	13464	0.049	0.054	-0.680	0.277
Fit	13464	0.206	0.135	0.001	0.876
Debt	13464	0.387	0.188	0.030	0.975
TobinQ	13464	2.151	1.308	0.817	13.527

3.4 Empirical Model Setting

As mentioned earlier, this paper focuses on the impact of the level of corporate finance on corporate innovation, and this part constructs the following benchmark econometric regression model:

$$\ln Patents_{it} = \beta_0 + \beta_1 _index_{it} + \beta_{it} X + \epsilon_i + \epsilon_t + \mu_{it} \quad (1)$$

where the following tables i and t represent firms and

years, respectively, $\ln Patents_{it}$ is the firm's level of innovation, X is a set of control variables, ϵ_i is an unobserved factor that does not vary over time for firms to control for firms' individual fixed effects, ϵ_t is used to control for the time fixed effects, and μ_{it} is a random perturbation term.

4. Empirical Analysis

4.1 Base Regression

Based on the empirical test of the basic relationship between the level of corporate finance and corporate innovation based on model (1), Table 2 reports the regression results of the impact of the level of corporate finance on corporate innovation. The results of the benchmark regression show that the effects of corporate financing constraints (SA_index and FC_index) on corporate innovation (lnPatents1) are both significant at the 1% level, indicating that the increase in the level of corporate financing significantly promotes corporate innovation. Columns (1) and (3) report the estimation results with the inclusion of con-

trol variables, the coefficient of the explanatory variable is -0.221, which is significantly negative at the 1% level; Columns (2) and (4) report the estimation results with the inclusion of the effect of the control variable financing constraints level on firms' innovations, the coefficient of the explanatory variable financing constraints level (FC_index) increases in absolute value, and the coefficient of the explanatory variable financing constraints level (FC_index) coefficient decreases in absolute value, suggesting that the presence of firm-level characteristics that do not change with individuals and time are omitted variables affecting firms' total factor productivity, and that not controlling for these variables overestimates the effect of reduced firm competitiveness.

Table 2: Baseline Regression

	(1)	(2)	(3)	(4)
	lnPatents1	lnPatents1	lnPatents1	lnPatents1
SA_index	-0.221***	-0.220***		
	(0.0614)	(0.0886)		
FC_index			-0.578***	-0.349***
			(0.070)	(0.135)
Size		0.250***		0.186***
		(0.023)		(0.034)
Age		-0.152***		-0.230***
		(0.027)		(0.032)
Soe		0.267***		0.306***
		(0.056)		(0.060)
Roa		0.099		0.127
		(0.290)		(0.311)
Fit		0.007		0.100
		(0.145)		(0.156)
Debt		-0.108		-0.186
		(0.119)		(0.133)
TobinQ		0.096***		0.100***
		(0.0124)		(0.013)
Constant	1.957***	-3.302***	1.443***	-2.639***
	(0.232)	(0.556)	(0.047)	(0.796)

4.2 Innovative Application Cases of Deep Learning in Artistic Creation

In order to exclude the influence of patent application measurement bias on the empirical results in this paper, the coefficients of the independent variables are significant under the conditions of patent acquisition measuring

the innovation effect of enterprises, which are consistent with the previous results. After calculating the coefficient of enterprise financing level under the replacement of the explanatory variables, the coefficient of enterprise financing level is not much different from that of the benchmark regression results, and changing the way of measuring the

explanatory variables will not affect the core conclusions of this paper, which confirms the robustness of the empirical results of this paper.

Table 3. Robustness test

	(1)	(2)	(3)	(4)
	lnPatents2	lnPatents2	lnPatents2	lnPatents2
SA_index	-0.277	-0.224***		
	(0.047)	(0.069)		
FC_index			-0.457***	-0.368***
			(0.070)	(0.135)
Size		0.110***		0.133***
		(0.018)		(0.025)
Age		-0.177***		-0.177***
		(0.020)		(0.024)
Soe		-0.108**		-0.086*
		(0.044)		(0.045)
Roa		-0.357		-0.422*
		(0.217)		(0.228)
Fit		-0.440***		-0.467***
		(0.112)		(0.117)
Debt		-0.085		-0.136
		(0.091)		(0.099)
TobinQ		0.085***		0.078***
		(0.009)		(0.010)
Constant	0.932***	-2.366***	0.545***	-2.083***
	(0.176)	(0.427)	(0.035)	(0.588)

5. Conclusion

In the rapidly changing global economic environment, technological innovation has become the core driving force for the sustainable development and competitiveness enhancement of enterprises. However, technological innovation activities often require a large amount of financial support, which makes financing an important way for enterprises to obtain innovation resources. The level of financing not only reflects the ability of enterprises to obtain external funds, but also directly determines the amount of resources available for technological innovation activities. Therefore, exploring the impact of the level of enterprise financing on technological innovation is of great significance for understanding the innovation mechanism of enterprises and optimizing their financing strategies.

Focusing on listed companies in China, this paper collects

and analyzes a large amount of data from 2009 to 2023, and empirically analyzes the intrinsic link between the level of corporate finance and their technological innovation activities. Through empirical analysis, it is found that an increase in the level of financing will provide a more solid financial guarantee for the technological innovation of enterprises, which will promote the enterprises to increase R&D investment, introduce high-end talents, and carry out cutting-edge technology research and development, and thus promote the enterprises to occupy a favorable position in the market competition.

The research in this paper not only has important theoretical value, which can enrich and expand the research results in the field of enterprise financing and technological innovation; at the same time, it also has important practical significance, which can provide useful references and lessons for enterprises to formulate scientific financing strategies and technological innovation planning.

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