Research on the Impact of Fintech on the Radical innovation Capacity of Enterprises

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Abstract

This paper, based on the context of financial technology, selects a sample of Chinese listed companies from 2011 to 2022 as the research dataset to explore the relationship between financial technology and firms' radical innovation capabilities. The results show that financial technology significantly promotes the improvement of firms' radical innovation capabilities, and this conclusion remains valid after a series of robustness tests. In terms of mechanisms, reducing financing costs, alleviating liquidity constraints, and lowering leverage are effective channels through which financial technology enhances firms' radical innovation capabilities. Further research reveals that the enabling effect of financial technology is more pronounced for firms located in central and western regions, non-state-owned enterprises, and those in high-tech industries in the process of enhancing radical innovation capabilities. The findings of this paper have practical significance for further advancing the innovation-driven development strategy, exploring new fields and tracks for development, and leveraging financial services to support the real economy.

Keywords

Radical innovation Capability, Financing Cost, Digital Economy, Financial Technology.

1. Introduction

Since entering the 21st century, China's scientific and technological development has advanced by leaps and bounds, and the ability of independent innovation has been greatly improved, which has injected strong impetus into economic and social development. However, with the continuous increase of scientific and technological achievements, technology and industrial system is increasingly perfect, the difficulty of innovation is gradually increasing.Secondly, today's world science and technology competition is becoming increasingly fierce, and China is more dependent on imports in core technology, key materials, high-end equipment and other aspects, the bottleneck of these technologies to a certain extent, limited the development speed and innovation ability of China's related industries. Therefore, China must vigorously develop enterprise radical innovation, encourage more enterprises to implement radical innovation strategy, strictly guard against and effectively resolve various risks and challenges, and firmly grasp the initiative of technology and development in their own hands.

Compared with traditional innovation, radical innovation can break through the original value chain structure, form a new value network, and then reconstruct and recreate new technology competition nodes, supply chain networks, market patterns and industrial structures. Investing heavily in the research and development of breakthrough technologies and products is not only a realistic choice for China to achieve economic transformation and upgrading and cultivate innovative advantages, but also an inevitable path for Chinese enterprises to break through the technological blockade and build international competitiveness. However, radical innovation not only needs a lot of human and material resources, but also puts forward higher

requirements for researchers' innovation ability and innovation ability, so there are great difficulties in its practical application. Some scholars have pointed out that the project of radical innovation by enterprises has a large capital demand and high uncertaintyHall,2002)^{0[1]},and the inherent information asymmetry will induce adverse selection, moral hazard and other problems(Berger and Udell,1990)^[2],and the innovation activities of enterprises are faced with serious external financing problems (Ju Xiaosheng et al., 2013)^[3], which greatly limits the innovation ability of enterprises.

With the deepening application of emerging digital technologies such as big data, block chain, ting, Internet of Things and artificial intelligence in the financial field, Fintech has achieved rapid development. By injecting digital elements into the whole process of financial services, Fintech reduces the operating costs of financial markets, improves the efficiency of financial resource allocation, creates new financial products, gives birth to new financial service models, broadens the financing channels of enterprises, and effectively alleviates financing difficulties. But is the development of Fintech conducive to enhancing the radical innovation capability of Chinese enterprises? Through what channels can Fintech promote Chinese enterprises to carry out radical innovation? Strengthening the research on the above issues has great theoretical and practical value for driving the high-quality development of China's economy through innovation and improving the ability of financial services to serve the real economy.

2. Literature review

2.1. Research on financial technology

Fintech has an important impact on improving the digitalization level of enterprises, promoting the digital transformation and upgrading of enterprises, improving the total factor productivity of enterprises, reducing the financing cost of enterprises, easing the financing constraints of enterprises, and improving bank behavior.

Fintech can significantly improve the digital level of enterprises and promote the digital transformation and upgrading of enterprises. Tang Song et al. (2022) explored the impact of Fintech on the digital transformation of enterprises and the internal mechanism from the perspective of life cycle. Studies have shown that Fintech plays a positive role in promoting the digital transformation of enterprises, among which the effect of growth and maturity is more significant, while the effect of decline is not obvious^{0[4]}.Sumei Luo et al. (2022) studied the impact of financial technology on the transformation and upgrading of enterprises, and the empirical research results showed that financial technology promoted the transformation and upgrading of enterprises mainly by reducing the information asymmetry of enterprises and improving the efficiency of resource allocation of enterprises ^[5].

Fintech plays a significant role in promoting total factor productivity of enterprises. Song Min et al. (2021) used the number of Fintech companies to construct regional Fintech development indicators, and used the data of A-share listed companies to investigate the impact of Fintech development on the total factor productivity of enterprises and its mechanism. It is found that through the "empowerment" of financial technology, the information asymmetry between financial institutions and enterprises can be reduced, the financing constraints of enterprises can be reduced quantitatively, and the allocation efficiency of credit resources can be improved qualitatively, thus improving the total factor productivity of enterprises^[6].

Fintech can help enterprises ease financing constraints and improve their ability to obtain financing. By reducing transaction costs and capital costs of enterprises in financing, Fintech can help enterprises create credit, reduce complicated processes, enrich financing models, and provide enterprises with more flexible guarantee methods to improve their ability to obtain financing. Ma Qiang et al. (2020) believe that Fintech can improve the efficiency of financial

services to the real economy through various factors, such as accelerating the process of credit capitalization, improving financial risk control capabilities, and reducing financial costs [7].

Fintech can have a clear impact on bank behavior. Song Min et al. (2024) constructed a banklevel Fintech development index for the strategic cooperation between commercial banks and Fintech companies, analyzed the impact of the development of Fintech on the innovation ability of commercial banks, and showed that the development of Fintech can effectively promote the innovation of commercial banks. This is mainly achieved by reducing the difficulty of personal access to information and promoting industrial competition^[8]; Yan Jingrui and Zhu Shivi (2024). starting from the perspectives of bank deposits and loans, respectively, build a deposit and loan return model theory to explore how Fintech can alleviate the problems of "difficulty in obtaining customers" at the deposit end and "difficulty in risk control" at the loan end by enabling commercial banks. The research shows that the development of Fintech by commercial banks can significantly reduce their risk bearing level. And mainly through reducing the "import" cost of capital and improving the "export" structure of capital^[9].

2.2. **Research on the radical innovation capability of enterprises**

As for the definition of Radical innovation, foreign scholar Tidd believes that radical innovation is a combination of a series of activities such as exploring new marketing, new management models and new technologies (Tidd, 2001)^[18].March believes that radical innovation activities are opportunities to explore, discover, create and experiment (March, 1991)^{0[19]}.Colberg (1987) gave a quantitative definition: if the functional index of an innovation is increased by 5 times and the product cost is reduced by at least 30%, it can be called a radical innovation^[20].

The research practice of radical innovation in China is mainly concentrated in the following levels. First, at the national level, Xu Zhaoyi et al. (2024) evaluated the level of radical innovation of 140 million patents worldwide by using the dynamic complex network method, and investigated the impact of industrial robots on the development of radical innovation in 27 industries out of 41 countries of the United Nations Industrial Development Organization. It is also found that promoting the transformation of digital automation, attracting foreign direct investment and enhancing industrial competitiveness are the three key mechanisms for industrial robots to promote the improvement of the level of radical innovation in various industries in various countries^[22];Based on the theory of evolution and transformation, Jin Wenwan et al. (2024) constructed innovation breakthrough indicators to measure countries' geospatial and technological path dimensions respectively, discussed the global spatial distribution, dynamic evolution and influencing factors of radical innovation activities, and found that the scale of global innovation activities expanded rapidly, but the geographical concentration declined as a whole. At the same time, innovation activities in emerging countries are mainly due to the introduction of non-local knowledge and technology, which is relatively insufficient in terms of technological path breakthrough, and the concentration of radical innovation activities is comprehensively affected by internal and external factors^[23].

Secondly, at the urban level, Xu Jie (2023) constructs indicators of technology-related density and technology-unrelated density, and explores how technology-related, technology-unrelated, selective industrial policies and their interactions affect the development of urban breakthrough technologies in combination with local government policy planning texts ^[24].

Moreover, at the organizational level, Su Zhendong et al. (2024) regard the establishment of the pilot free trade Zone as a quasi-natural event, and adopt the multi-stage differential method to explore the effect of the establishment of the free trade zone on the breakthrough technological innovation of registered listed companies in the zone. The research finds that the breakthrough institutional innovation after the establishment of the free trade zone can significantly promote the breakthrough technological innovation of registered listed companies in the zone. In addition, its main functions are to alleviate the financing constraints faced by enterprises in the

region, promote industry-university-research cooperation, and promote the agglomeration of innovative human capital to promote enterprises to achieve breakthrough technological innovation^[25];Hu Shan et al. (2022) studied the causal relationship and influence mechanism between digital economy and enterprise innovation, and the results show that digital economy can significantly promote the radical innovation of enterprises, but the impact on the progressive innovation of enterprises is not significant. At the same time, the digital economy has a greater promotion effect on the radical innovation of non-state-owned enterprises, large enterprises and enterprises with a high proportion of executive ownership^[21].

2.3. Related research on the impact of Fintech on the radical innovation capability of enterprises

Some scholars have explored the path of financial technology (digital finance) to promote enterprises to achieve radical innovation from the perspective of theoretical mechanism. For example, Xu Zhaoyi et al. (2023) found that Fintech can significantly enhance the level of radical innovation of enterprises.In terms of the mechanism of action, financing optimization, knowledge accumulation, and digital transformation are effective channels for Fintech to enhance the level of radical innovation of enterprises. Further analysis found that Fintech is mainly through cross-border effect, that is, by guiding and promoting enterprises to carry out cross-border research and development, improve the level of radical innovation of enterprises. With the support and guidance of financial technology, digital patents generated by non-digital enterprises have a higher level of radical innovation. In addition, enterprises with relatively scarce financial technology enabling resources and relatively weak strength achieve "curve overtaking" and technological leapfrog in the development of radical innovation ^[14]; The study of Li Chuntao et al. (2022) shows that Fintech can promote enterprise innovation through two ways: one is to reduce the financing constraints of enterprises; the other is to improve the innovation effect of tax return^[16]; Liu Changgeng et al. (2022) found that Fintech can accurately identify high-quality innovative enterprises and play a certain role in the company's innovation system, including reducing financing costs, improving the company's commercial credit value and improving liquidity constraints^[12]; Tang Song et al. (2020) pointed out that the development of digital finance can effectively correct the problems of "attribute mismatch", "domain mismatch" and "stage mismatch" existing in traditional finance, and promote the increase of technological innovation output of enterprises through the four channels of easing financing constraints of enterprises, reducing the rate of financial expenses of enterprises, driving enterprises to deleverage and stabilizing their financial conditions^[15].

3. Influencing mechanism and research hypothesis

Fintech can reduce transaction costs to a large extent through economies of scale. Although the initial investment capital is huge, once the scale effect of open modular service and quantitative investment is formed, its marginal cost will tend to be zero (Liu Changgeng et al., 2022)^[12].First of all, Fintech uses big data, artificial intelligence and other technologies to more accurately evaluate the credit status and operating conditions of borrowing enterprises, reducing the information asymmetry between financial institutions and companies. Therefore, financial institutions are willing to lend to enterprises at lower interest rates, thereby reducing the financing costs of enterprises. Secondly, the innovative financial products and services developed by Fintech can not only lower the threshold of traditional financial services, but also improve the availability and convenience of financial services, so that more enterprises can easily obtain the required financial support: Finally, the development of Fintech promotes the diversification and competition of the financial market, which not only reduces the operating costs of financial institutions, but also improves the efficiency and quality of financial services, brings more financial services and choices to companies, helps companies choose the most

suitable financing methods according to their own needs, and makes the composition of capital more reasonable. Thus reducing the company's financing costs. Based on the above, this paper proposes the following research hypothesis:

Hypothesis 1: The development of Fintech can promote the improvement of enterprises' radical innovation ability by reducing the financing cost of enterprises.

Maintaining the liquidity of assets is the key to technological innovation and sustainable operation of enterprises. From the perspective of internal financing, under external shocks, enterprises' technological innovation may be suspended due to capital chain rupture and high adjustment costs (Ju Xiaosheng et al., 2013)^[3]. Therefore, how to maintain a healthy cash flow in the process of radical innovation is crucial. On the one hand, Fintech breaks the geographical and time constraints of traditional financial services by providing innovative financial products and services, making it easier for enterprises to obtain the funds they need. These new financial services enable more enterprises, especially small and medium-sized enterprises and start-ups, to obtain the necessary financial support and improve the liquidity of corporate assets; On the other hand, through the application of big data, artificial intelligence, blockchain and other technologies, Fintech has improved the accuracy and efficiency of risk assessment, thus reducing information asymmetry, reducing financing constraints of enterprises, and improving the liquidity restrictions of enterprises, thus helping enterprises to obtain funds at a lower cost for radical innovation activities. This will help to improve the ability of enterprise radical innovation. Based on the above, this paper proposes the following research hypothesis:

Hypothesis 2: The development of Fintech can promote the improvement of firms' radical innovation ability by improving their liquidity constraints.

After the development of digital finance improves the financing situation of enterprises, the need for enterprises to raise funds by increasing leverage will be reduced. In particular, new technologies such as big data, blockchain and cloud computing in digital finance can provide necessary supporting conditions for the development of enterprise technology projects, and will gradually reduce the initiative demand for leverage when the business strength of enterprises increases (Tang Song et al., 2020) ^[15].In addition, the application of financial technology can help enterprises reduce financing costs and optimize capital structure. Through financial technology, enterprises can more accurately evaluate the costs and risks of different financing methods, so as to make more intelligent financing decisions, thus reducing the demand for leverage, releasing innovation resources, and promoting the improvement of enterprises' radical innovation ability. Based on the above, this paper proposes the following research hypothesis:

Hypothesis 3: The development of Fintech can promote the improvement of enterprises' radical innovation ability by reducing enterprise leverage.

4. Research design

4.1. Sample selection and data sources

Considering that the Peking University Digital Financial Inclusion Index has been compiled since 2011, this paper selects samples of Chinese listed companies from 2011 to 2022 as the research data set. The basic information of listed companies, such as financial and research and development data, patent application and citation data are from the CSMAR database, the WIND database and the State Intellectual Property Office; Regional variables, such as regional population size, level of financial development, level of economic development, level of foreign investment, level of science, technology and education expenditure, etc., are all derived from the China City Statistical Yearbook, the Statistical Yearbook of provinces and cities, and the China Regional Economic Statistical Yearbook.

According to the general practice, in order to make the sample data more representative, the sample data are processed as follows: (1) The samples of listed financial companies such as banks, securities and insurance are excluded; (2) Remove the samples with missing data in the main variables; (3) Samples of companies with negative carrying value of owners' equity are excluded; (4) A two-sided 1% Winsor was applied to continuous variables in order to eliminate the interference of outliers on the results of this paper. After the above processing, the final sample involves 31,338 observations from year 2011 to 2022.

4.2. Variable Selection

4.2.1. Explained variables

Using the method of Hu Shan (2022) as reference, this paper uses the natural logarithm of the number of Invention patents granted by an enterprise in the current year plus 1 to measure the invention capability of an enterprise. The amount of non-invention patents (including utility model patents and design patents) is added by 1 and the natural logarithm is taken to measure the enterprise's progressive innovation ability^[21].

4.2.2. Core explanatory variables

Based on the methods of Guo Feng et al. (2021) ^[10]and Xie Xuanli et al. (2018)^[11], this paper uses the logarithmic Peking University Digital Financial Inclusion Index as the proxy variable (FINT) of Fintech.

4.2.3. Control variables

According to the general literature practice, this paper selects the following control variables in the empirical model: Size is the size of the enterprise, expressed by the natural logarithm of the total assets at the end of the year; ROA is the return on assets, measured by the ratio of net profit to total assets at the end of the year; Cashflow is the cash flow ratio, which is measured by the ratio of net cash flows generated from operating activities to total assets. Growth is the growth rate of operating revenue (enterprise growth), measured by the ratio of operating revenue of the current year to that of the previous year minus 1; Indep is the proportion of independent directors, measured by the proportion of independent directors in the number of directors; Dual Indicates whether the chairman and general manager concurrently serve. If the chairman and general manager are the same, the value is 1. Otherwise, the value is 0. Top10 is the concentration of enterprise equity, measured by the proportion of the top 10 shareholders; ListAge is the listed years of the company, expressed by the natural logarithm of the listed years of the company; At the same time, in order to take into account the construction of explanatory variables, this paper further controls variables such as regional financial development degree Finc and economic development level Econ.

4.3. Model construction

Considering that the annual number of granted invention patents of many sample enterprises is 0, this paper takes the natural logarithm to measure the radical innovation after adding 1 to the number of granted patents of enterprises, and uses a typical "two-way fixed effect model" to control the time effect and industry effect. The model is as follows:

$$Invention_{i,t} = \beta_0 + \beta_1 FINT_{m,t} + \beta Controls + \delta_t + \gamma_j + \varepsilon_{i,t}$$
(1)

The subscripts i, t, and m represent the company, year, and city, respectively. The explained variable Invention represents the radical innovation capability of enterprise i in year t, which is measured by the natural logarithm of the number of authorized invention patents added by 1. Core explanatory variable FINT represents the development level of Fintech in the t year of m, the city where enterprise i is located, and Peking University Financial Inclusion Index is used as a proxy variable. Controls represent all kinds of control variables that affect a company's ability to break new ground. δ and γ represent the year fixed effect and industry fixed effect,

respectively, and ε represents the random error term. The symbol and significance of $\beta 1$ are the focus of this paper. If β_1 is greater than 0, it indicates that the more developed the Fintech, the stronger the radical innovation ability of the enterprise, and the weaker the vice versa.

5. Empirical results and analysis

5.1. Descriptive Statistics

The table1 shows that there are significant differences in Invention capability among different enterprises. The mean value is 0.729, the standard deviation is 1.054, the maximum value is 4.97, and the minimum value is 0. In addition, the highest value of FINT level is 5.889, and the lowest value is 3.563, with a large difference, which indicates that the development level of Fintech in different regions of China presents an obvious imbalance, and there are great regional differences in the application and development of Fintech. In addition, different companies also have great differences in such aspects as enterprise scale, return on assets, cash flow ratio, proportion of independent directors, and listed years of enterprises.

Table 1. Descriptive Statistics					
Variable	Observation	Mean	standard	minimum	maximum
			deviation	value	value
Invention	31338	0.729	1.054	0	4.970
NonInvention	31338	1.184	1.453	0	5.613
FINT	31338	5.428	0.414	3.563	5.889
Size	31338	22.257	1.316	19.585	26.452
ROA	31338	0.039	0.066	-0.373	0.247
Cashflow	31338	0.046	0.069	-0.199	0.267
Growth	31338	0.164	0.413	-0.658	4.024
Indep	31338	37.675	5.406	28.570	60.000
Dual	31338	0.283	0.451	0	1
Top10	31338	58.116	15.227	20.843	90.974
ListAge	31338	2.155	0.837	0	3.401
Econ	31338	11.492	0.516	8.773	13.056
Finc	31338	4.169	1.717	0.588	13.530

5.2. Benchmark regression

As can be seen from the benchmark regression, Fintech has a significant positive impact on the radical innovation ability of enterprises, with an impact coefficient of 0.354, while the impact coefficient on the progressive innovation ability is 0.815, which is greater than the former. This may be because radical innovation involves high technical complexity and innovation, and often requires a large amount of R&D investment and long-term exploration. Due to its frontier and uncertainty, it faces higher market risks and financing constraints, and the risk of failure is correspondingly higher. At the same time, due to the uncertainty of technology, its risk assessment is more difficult. Incremental innovation is usually improved and perfected on the basis of existing technology, the technical risk and market risk are relatively low, and it is easier to be accepted by the market. The input cost and time cost are relatively low, and the return cycle is short. Therefore, compared with radical innovation, progressive innovation is easier to obtain financial support from Fintech due to its lower risk, easier to be stimulated by Fintech, and easier to be widely accepted by the market.

In addition, the significance and symbols of the coefficients of other control variables are basically consistent with the existing literature. The influence coefficient of firm size is positive and significant at the statistical level of 1%. The larger an enterprise is, the stronger its radical innovation ability will be. This may be because a larger enterprise has a more rigorous

management system, a stronger talent team and a stronger external financing channel, so it is easier to raise the R&D funds required for radical innovation activities. The influence coefficients of ROA and Cashflow ratio are also positive and statistically significant at 1%, indicating that the stronger the profitability and the more abundant the cash flow, the stronger the radical innovation ability of enterprises, which may be because these enterprises have sufficient funds to engage in R&D innovation or efficient production activities. However, the influence of enterprise Growth and Listage is significantly negative, which may be because with the increase of enterprise growth and listing years, enterprises may gradually shift from the rapid expansion and innovation-driven stage in the initial stage to a more stable business strategy, and enterprises in this stage tend to pay more attention to maintaining market share and stabilizing profits. Therefore, enterprises with a longer listed age may have relatively weak investment and motivation in innovation, resulting in the weakening of their radical innovation ability. The estimated results of Dual and Top10 ownership concentration are significantly negative, which may be due to the fact that ownership concentration represents the controlling power of corporate executives or major shareholders. When ownership concentration is too high, corporate executives or major shareholders may disregard external supervision and illegally occupy the company's cash flow by relying on their own control advantages. Therefore, it is not conducive to the improvement of the enterprise's radical innovation ability, and the increase of the proportion of independent directors is conducive to preventing such behavior, so the coefficient is significantly positive.

Table 2. Benchmark regression		
	(1)	(2)
	Invention	NonInvention
FINT	0.354***	0.815***
	(4.21)	(7.26)
Size	0.238***	0.223***
	(39.95)	(30.89)
ROA	0.463***	0.950***
	(5.18)	(8.05)
Cashflow	0.261**	0.679***
	(3.20)	(6.25)
Growth	-0.070***	-0.110***
	(-6.11)	(-7.19)
Indep	0.003**	0.002
	(2.66)	(1.87)
Dual	-0.028*	-0.033*
	(-2.22)	(-2.02)
Top10	-0.004***	-0.002**
	(-10.39)	(-2.92)
ListAge	-0.161***	-0.232***
	(-19.26)	(-20.70)
Econ	0.045*	-0.070**
	(2.51)	(-2.82)
Finc	-0.018***	-0.084***
	(-4.61)	(-17.00)
_cons	-6.449***	-6.625***
	(-18.21)	(-14.27)
Ν	31337	31337
adj. R2	0.238	0.327

t statistics in parentheses

* *p* < 0.05, ** *p* < 0.01, *** *p* < 0.001

5.3. Endogeneity test

In order to solve the possible endogenous problem in the benchmark model, this paper selects the Internet penetration rate of various prefecture-level cities in China as an instrumental variable, and the results are shown in Table 3. From column (1) and column (2), it can be seen that there is a significant positive relationship between instrumental variables and explanatory variables, and the LM statistic is 1630.39, which is significant at the statistical level of 1%, indicating that there is no problem of insufficient recognition and the instrumental variables have a good correlation. The F statistic is 2523.36, significantly greater than 10, and is significant at the 1% statistical level, indicating that there is no weak instrumental variable problem.

	Table 3. Endogeneity test	
	(1)	(2)
	FINT	Invention
IV	0.077***	
	(50.233)	
FINT		2.548***
		(9.910)
Controls	Yes	Yes
Fixed year effect	Yes	Yes
Fixed industry effect	Yes	Yes
Kleibergen-Paap rk LM statistic		1630.39***
Hansen J statistic		0.000
Kleibergen-Paap rk Wald F statistic		2523.36***
Ν	31334	31334
adj. R2	0.984	0.058

t statistics in parentheses

* p < 0.05, ** p < 0.01, *** p < 0.001

5.4. Robustness test

5.4.1. Replace the interpreted variable

Based on the practice of Hu Shan (2022), the weights of invention patents, utility model patents and design patents are respectively 0.5, 0.3 and 0.2 according to their scientific and technological innovation content, and they are logarithmic, so as to measure the radical innovation and progressive innovation of enterprises respectively according to the number of patent authorization and patent application^[21]. It can be seen from the results that after replacing the enterprise radical innovation index, the regression results are basically consistent with the benchmark regression results.

Table 4. Robustness test			
	(1)	(2)	
	Invention2	NonInvention2	
FINT	0.892***	0.675***	
	(5.62)	(4.22)	
Controls	Yes	Yes	
Fixed year effect	Yes	Yes	
Fixed industry effect	Yes	Yes	
N	18891	18460	
adj. R2	0.274	0.268	

t statistics in parentheses

* p < 0.05, ** p < 0.01, *** p < 0.001

5.4.2. Explanatory variable lag processing

Considering that Fintech and enterprise radical innovation are likely to have a time lag effect, this paper conducts a regression of explanatory variables and control variables with a lag of one stage. The results are basically consistent with the baseline regression. Table 5 Explanatory variable l

Tables	Sie S. Explanatory variable lag processing		
	(1)	(2)	
	Invention	NonInvention	
L.FINT	0.274**	0.615***	
	(3.03)	(5.14)	
Controls	Yes	Yes	
Fixed year effect	Yes	Yes	
Fixed industry effect	Yes	Yes	
Ν	26815	26815	
adj. R ²	0.248	0.336	

t statistics in parentheses

* p < 0.05, ** p < 0.01, *** p < 0.001

6. Mechanism analysis

In this part, the mediating variable Media is constructed, and the mediating effect model is mainly used to test the mechanism of the development of Fintech on the radical innovation ability of enterprises. Specific model Settings are as follows:

$$Invention_{i,t} = \alpha_0 + \alpha_1 FINT_{m,t} + \alpha Controls + \delta_t + \gamma_j + \varepsilon_{i,t}$$
(2)

$$Invention_{i,t} = \alpha_0 + \alpha_1 FINT_{m,t} + \alpha Controls + \delta_t + \gamma_j + \varepsilon_{i,t}$$
(2)
$$Media_{i,t} = \mu_0 + \mu_1 FINT_{m,t} + \mu Controls + \delta_t + \gamma_j + \varepsilon_{i,t}$$
(3)

$$Invention_{i,t} = \phi_0 + \phi_1 FINT_{m,t} + \phi_2 Media_{i,t} + \phi Controls + \delta_t + \gamma_j + \varepsilon_{i,t}$$
(4)

6.1. Reduce the financing cost

Financial expense ratio (Cost)¹ can comprehensively reflect corporate financing cost (Liu Changgeng, 2022)^[12].Therefore, in order to verify hypothesis 1, this paper uses the financial expense ratio to measure the enterprise financing cost, and tests the above transmission mechanism through models (2) - (4).The corresponding estimates are reported in Table 6: The development of Fintech can significantly reduce the financing cost of enterprises, and at the statistical level of 1%. And the reduction of financing cost is conducive to the radical innovation ability of enterprises.The reduction of financing cost is conducive to the improvement of enterprises' radical innovation ability. This shows that the reduction of financial expense rate plays a part of the intermediary role in the relationship between "Fintech and enterprises' radical innovation capability", that is, Fintech can alleviate the problem of high financing of enterprises by reducing the financing cost of enterprises, and thus improve the radical innovation capability of enterprises. Hypothesis 1 is true.

Table 6. The mechanism test of	financial technology to redu	ce enterprise financing cost
	(1)	(2)
	Cost	Invention
FINT	-0.028***	0.305***
	(-8.50)	(3.63)
Cost		-1.750***
		(-13.77)
Controls	Yes	Yes
Fixed year effect	Yes	Yes
Fixed industry effect	Yes	Yes
N	31337	31337
adj. R ²	0.285	0.241

t statistics in parentheses

* p < 0.05, ** p < 0.01, *** p < 0.001

6.2. Improve liquidity constraints

In order to verify hypothesis 2, the research method of Liu Changgeng et al. (2022) is used in this paper to measure Fluidity of corporate liquidity by using the proportion of current assets to total assets as an intermediary variable of the above-mentioned mechanism^[12].

In Table 7, it can be seen from column (1) that the development of financial technology can significantly improve the liquidity of enterprises, and column (2) can be seen that the improvement of corporate liquidity has a significant positive effect on the improvement of radical innovation ability at the statistical level of 1%, indicating that the improvement of corporate liquidity restriction does play a partial intermediary role in the relationship between financial technology and enterprises' radical innovation ability. Hypothesis 2 is true.

Table 7. The mechanism test of financial technology to improve corporate liquidity constraints

	<u> </u>	
	(1)	(2)
	Fluidity	Invention
FINT	0.053***	0.335***

¹ the proportion of corporate financial expense in operating income

Fluidity	(3.37)	(3.99) 0.365***
Controls	Yes	(11.62) Yes
Fixed year effect	Yes	Yes
Fixed industry effect	Yes	Yes
N	31337	31337
adj. R2	0.420	0.241

t statistics in parentheses

* p < 0.05, ** p < 0.01, *** p < 0.001

6.3. Deleveraging

Based on the research method of Tang Song et al. (2020), this paper adopts asset-liability ratio (Lev) as the measurement indicator of corporate leverage and as the intermediary variable of the above mechanism^[15].

As can be seen from column (1) in Table 8, the development of Fintech has a significant impact on reducing corporate leverage, which is statistically significant at 1%. (2) In the column, the reduction of enterprise leverage has a significant positive impact on the improvement of the radical innovation capability, indicating that the reduction of enterprise leverage indeed acts as a partial intermediary of the relationship between "Fintech and enterprise radical innovation capability". Hypothesis 3 is true.

Table of the meenanism test o maneiar teennology to reduce corporate reverage			
	(1)	(2)	
	Lev	Invention	
FINT	-0.065***	0.343***	
	(-4.23)	(4.09)	
Lev		-0.161***	
		(-4.88)	
Controls	Yes	Yes	
Fixed year effect	Yes	Yes	
Fixed industry effect	Yes	Yes	
N	31337	31337	
adj. <i>R</i> ²	0.480	0.238	

Table 8. The mechanism test o financial technology to reduce corporate leverage

t statistics in parentheses

* *p* < 0.05, ** *p* < 0.01, *** *p* < 0.001

7. Heterogeneity analysis

7.1. Heterogeneity analysis based on the geographical location of the enterprise

According to the geographical position of the region where the enterprise is located, it is divided into three groups: eastern region, western region and central region. Regional grouping regression shows that for the central and western regions, Fintech can significantly promote

the innovation output of enterprises, among which, the central region has the largest impact, with a coefficient of 1.41, which is statistically significant at 1%. In the eastern region, Fintech has a weak inhibitory effect on the radical innovation ability of enterprises.

This may be caused by the following factors: First, compared with the central and western regions, the infrastructure and business environment in the eastern region are more adequate, and Fintech may inhibit the radical innovation ability of enterprises due to issues such as excessive financialization; However, the development level of financial technology and economic development in the central and western regions is relatively low, which provides greater marginal development space for financial technology, that is, by providing diversified financing channels, financial technology can inject innovation funds for enterprises in the central and western regions, so as to significantly improve the radical innovation ability of enterprises in the central and western regions. Second, compared with the central and western regions, the fiercer market competition in the eastern region may make enterprises pay more attention to how to obtain short-term benefits and seize market share, while ignoring how to achieve long-term technological innovation. In recent years, the central and western governments have increased their support for local enterprises, and promoted the popularization and application of financial technology within enterprises through a series of fiscal measures. These policy measures have provided enterprises in the central and western regions with the funds and opportunities required for innovative activities, thus promoting the improvement of their radical innovation capabilities.

	(1)	(2)	(3)
	Eastern china	Western china	Central china
FINT	-0.192	0.641**	1.410***
	(-1.53)	(3.20)	(6.92)
Size	0.244***	0.239***	0.238***
	(33.83)	(15.73)	(14.69)
ROA	0.647***	0.103	-0.050
	(6.00)	(0.46)	(-0.21)
Cashflory	0 201***	0.200	0.070
Casillow	(2.02)	-0.200	0.079
	(3.93)	(-1.01)	(0.36)
Growth	-0.072***	-0.021	-0.097***
	(-5.04)	(-0.77)	(-3.82)
Indep	0.001	0.007**	0.006*
	(1.00)	(2.60)	(2.21)
Dual	-0.011	-0 103**	-0.076*
Dual	(-0.75)	(-3.10)	(-2, 22)
	(-0.73)	(-3.10)	(-2.22)
Top10	-0.005***	-0.002	-0.005***
	(-9.57)	(-1.95)	(-4.70)
ListAge	-0.155***	-0.178***	-0.209***
0	(-14.78)	(-8.66)	(-10.09)

Table 9. Heterogeneity analysis based on the geographical location of the enterprise

0.097*** Finc 0.185*** -0.263*** (4.31)(4.11)(-5.54)-0.048*** 0.000291 -0.012 Econ (0.05)(-0.84)(-6.35)-9.766*** -4.208*** -8.541*** _cons (-7.45)(-11.43)(-9.43) 22157 5031 Ν 4144 adj. R² 0.246 0.262 0.261

t statistics in parentheses

* p < 0.05, ** p < 0.01, *** p < 0.001

7.2. Heterogeneity analysis based on different property rights of enterprises

As can be seen from Table 10, Fintech plays a greater role in promoting the radical innovation ability of non-state-owned enterprises than that of state-owned enterprises. This may be because: First, non-state-owned enterprises, especially start-ups, usually face strong financing constraints. If they adopt traditional lending methods, it is difficult to obtain a large amount of financial support required for groundbreaking innovation activities. By providing diversified financing channels, Fintech can effectively alleviate the financing problems of non-state-owned enterprises and provide financial guarantee for their groundbreaking innovation activities. On the other hand, state-owned enterprises have the guarantee and support of national reputation in operation and financing, so it is easier for them to conduct external financing, and lenders are also willing to conduct transactions with state-owned enterprises in order to enhance the connection with the government. Therefore, the marginal improvement effect of Fintech on alleviating the financing constraints of state-owned enterprises is weak. Second, compared with non-state-owned enterprises, the decision-making process within state-owned enterprises is relatively complex, and whether an enterprise wants to carry out radical innovation is largely limited by the assessment mechanism within the system and the risk avoidance tendency. resulting in lower utilization efficiency of Fintech by state-owned enterprises. Third, in the fierce market competition, non-state-owned enterprises are more motivated to promote the improvement of radical innovation through Fintech, so as to develop new products and services, enhance their core competitiveness, and seize market share. However, due to the relatively stable market position of state-owned enterprises and less external competition pressure, the motivation for radical innovation may be insufficient.

	(1)	(2)
	Non state-owned enterprises	State-owned enterprises
FINT	0.980***	0.181
	(7.43)	(1.64)
Size	0.228***	0.228***
	(25.48)	(27.20)
ROA	0.619***	0.352***
	(3.38)	(3.39)
Cashflow	0.377**	0.304**
	(2.73)	(3.00)

Table 10. Heterogeneity analysis based on different property rights of enterprises

Growth	-0.069*** (-3.44)	-0.055*** (-3.90)
Indep	0.006** (3.25)	0.001 (0.76)
Dual	-0.028 (-0.94)	-0.008 (-0.59)
Top10	-0.005*** (-7.51)	-0.003*** (-5.87)
ListAge	-0.169*** (-10.45)	-0.189*** (-17.40)
Finc	-0.114*** (-3.77)	0.108*** (4.91)
Econ	-0.061*** (-9.33)	0.005 (1.07)
_cons	-7.731*** (-14.35)	-5.997*** (-12.58)
N adj. <i>R</i> ²	11245 0.3338	19383 0.1864

t statistics in parentheses

* p < 0.05, ** p < 0.01, *** p < 0.001

8. Conclusions and policy recommendations

At the national level: First of all, while strengthening the construction of Fintech infrastructure and improving the level of Fintech research and development and application, it is also necessary to establish and improve the Fintech regulatory framework, pay attention to preventing and resolving financial risks, and create a good external environment for enterprises to carry out radical innovation; Secondly, we should optimize the policy environment for Fintech, establish and improve tax, fiscal and other preferential policies conducive to the development of Fintech, and provide customized and differentiated financial services for the real economy, so as to promote the deep integration of Fintech and the real economy, and jointly promote the improvement of the radical innovation ability of enterprises. Finally, we should strengthen the construction and training of talent teams, encourage tripartite cooperation between universities, enterprises and scientific research institutions, and jointly cultivate compound talents in the field of financial technology, so as to help enterprises carry out radical innovation activities.

At the enterprise level, first of all, enterprises should base on their own development planning and stage, actively embrace the convenience brought by financial technology, and constantly improve the internal risk monitoring, risk identification, risk analysis and risk response mechanism, so as to reduce the operational risks of enterprises and create a good internal environment for groundbreaking innovation activities. Secondly, enterprises should establish and improve the internal Fintech application system, and actively promote the integration of Fintech and enterprise business, promote the digital transformation and intelligent upgrading

of business through Fintech means, and improve the market competitiveness of enterprises and radical innovation ability. Finally, enterprises should actively explore financial technology innovation models, such as supply chain finance and blockchain finance, to expand financing channels, reduce corporate financing costs and liquidity restrictions, and promote the improvement of radical innovation capabilities of enterprises through financial technology innovation.

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