Analysis of the Impact and Mechanism of Financial Technology Levels on Green Productivity

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Abstract. This paper selects the data of A-share listed companies in Shanghai and Shenzhen from 2013 to 2023, and explores the impact and mechanism of enterprise financial technology level on green productivity based on the perspective of green technology innovation. It was found that improving enterprise financial technology levels significantly promotes enterprise green technology innovation, and this conclusion is still based on the discussion of endogeneity issues and a series of robustness tests. In terms of the mechanism of action, the increase in the level of enterprise financial technology increases the investment in scientific and technological innovation, which in turn effectively promotes the green technological innovation of enterprises. At the same time, the strengthening of market competition in the industry further enhances the green innovation effect. Heterogeneity analysis reveals that both the property rights and the industry have a significant impact on the improvement of the financial technology level to promote enterprise green technology innovation. This paper reveals the key role of financial technology in enterprise innovation strategy. It provides empirical evidence for the promotion of financial technology innovation and the optimization of green productivity development path.

Keywords: Fintech, Green Technology Innovation, Green Productivity.

1. Introduction

General Secretary Xi Jinping pointed out in the eleventh collective study of the Political Bureau of the Central Committee of the Communist Party of China that "green development is the background color of high-quality development, and the new quality productivity itself is green productivity." With the circular economy as the development model, sustainable development as the goal, and "green" as the core value, green productivity aims to improve resource utilization, reduce carbon emissions and ecological pollution, and achieve economic, social, and ecological benefits with the same growth (Hongchun Zhou, 2024)[1] has become an important engine for promoting high-quality economic and social development in China. Although China's energy consumption per unit of GDP has dropped significantly and the proportion of non-fossil energy has steadily increased, compared with developed countries, there is still a gap in resource and energy efficiency, and the proportion of fossil energy and traditional industries is still high. Therefore, it has become crucial to accelerate green science and technology innovation and the popularization and application of advanced green technologies. In recent years, China has attached great importance to the development of financial science and technology, and financial science and technology by cloud computing, blockchain, artificial intelligence, and other modern technical means is significantly improving the efficiency and role of the financial system in serving the real economy. The role of financial technology in promoting green technological innovation of enterprises is also becoming more and more prominent and has received extensive attention from both academic and practical circles. However, the existing literature mostly studies the development of financial technology and enterprise green technology innovation from the macro-regional level and rarely pays attention to the impact of enterprises' financial technology level on green technology innovation. Based on this, this paper selects the data of A-share listed companies in Shanghai and Shenzhen to empirically test the impact of the level of enterprise financial technology on green technological innovation, and to explore the intermediary role of scientific and technological innovation investment mechanism, the moderating effect of the industry market competition, as well as the differences in the impact of the

level of enterprise financial technology on green technological innovation of different types of enterprises and industries, to provide policy thinking for the use of financial technology to promote enterprise green innovation, and then promote the development of China's green productivity.

2. Theoretical Analysis and Research Hypothesis

2.1. Enterprise financial technology development and green technology innovation

Enterprise green technology innovation is affected by both internal and external pressures. From the perspective of internal pressure, enterprises expect to reduce environmental pollution through green technological innovation to improve enterprise reputation, avoid environmental penalties, and obtain corresponding economic benefits; due to the short-sightedness of enterprise decision-makers and risk aversion strategies, enterprises may also reduce green technological innovation. From the perspective of external pressure, government environmental regulations, mandatory environmental policies and regulations, and consumers' green consumption concepts force enterprises to carry out green technological innovation to gain a sustainable competitive advantage; external audits and public media attention, investors' and consumers' expectations also affect firms' green innovation (Zhao X et al., 2024)[2]. At the same time, green innovation activities are prone to expose firms to severe external financing constraints due to the uncertainty of returns and information asymmetry (Jia Xu et al., 2020)[3]. Financial technology, which includes Internet and mobile payment, network financing, intelligent financial management services, and blockchain technology, can promote the comprehensive transformation of enterprises to digitalization and intelligence, optimize management and business processes, and improve the level of information sharing and knowledge integration ability of enterprises, thus providing technical support for green innovation activities (Deyong Song et al., 2022)[4].

On the one hand, the development of enterprise financial technology has enhanced the incentives for enterprises to engage in green innovation. First, financial technology can collate financial data from enterprise financial statements, financing records, and investment activities that can reflect the inputs and outputs of enterprises in green innovation, and evaluate the level of green innovation of enterprises by mining the correlations and trends in the data. This will further increase enterprises' attention to green technology innovation and discipline their green innovation behavior. Secondly, Financial technology can simplify the declaration and review of green bond issuance by enterprises, and at the same time, continuously supervise the use of fund-raising and the management of special accounts during the life of the bonds, and disclose the progress of green innovation projects promptly. In addition, from the perspective of cost reduction, financial technology optimizes the efficiency of enterprise supply chain management by improving the flexibility of enterprise production strategy adjustment and the precision of resource allocation, which in turn reduces operating costs (Annosi M C et al., 2021, Ma J et al., 2024)[5][6]; by improving the efficiency of market information processing, formulating accurate financial planning and financial supervision, reducing financial costs and creating good conditions for enterprise green project investment (Xuefeng Shao et al., 2022)[7].

On the other hand, the development of enterprise financial technology improves the ability of enterprises to carry out green innovation. First, from the perspective of raising funds, the application of enterprise financial technology can reduce the risk of enterprise financing constraints and capital chain breaks. Schumpeter's innovation theory suggests that the availability of funds affects the scale and speed of technological innovation and that enterprises with sufficient funds are more likely to engage in large-scale innovation activities, while those with a lack of funds may face constraints on their innovation activities. Enterprises tend to postpone or reduce green innovation projects due to external financing constraints, preferring to reduce energy consumption and pollution by updating environmentally friendly equipment (Cui X et al., 2023)[8]. In contrast, financial technology enriches the financing channels for enterprises' green innovation by reducing the asymmetry of information between banks and enterprises, making it easier for enterprises to obtain financial support. Secondly, the development of enterprise financial technology promotes the digitalization and intelligent

transformation of supply chain financing methods (Han S et al., 2024)[9], through the technical means of big data and blockchain, it has improved the risk management ability of supply chain finance, which can effectively prevent the risk of enterprise capital chain breakage (Minfeng Lu, 2020)[10]. In addition, from the perspective of project foresight, financial technology can help enterprises rapidly obtain market frontier information, track the evolution of frontier technology in real time, and assist enterprises in establishing green innovation positioning (H Chen et al., 2024)[11]. Based on this, this paper proposes the hypothesis:

H1: Enterprise financial technology applications can significantly promote enterprise green technology innovation.

2.2. Mechanisms based on the role of STI inputs

Investment in science, technology, and innovation (STI) is an important driver of enterprises' green technology innovation. A large number of existing empirical studies show that the development of financial technology inspires enterprises to increase investment in science and technology innovation. On the one hand, intelligent transactions in enterprise financial technology improve residents' willingness to consume by simplifying the transaction process, leading to a rise in market demand for products and quality requirements, which in turn prompts enterprises to increase their investment in innovation (Falk T et al., 2016)[12]. On the other hand, enterprise financial technology alleviates the problems of difficult and expensive financing by improving information transparency and expanding the coverage of financial services, which provides financial security for enterprise innovation investment. In addition, financial technology effectively alleviates the crowding effect of enterprise financial investment behavior on enterprise innovation investment (Yong He, 2023)[13]. Therefore, the application of enterprise financial science and technology will prompt enterprises to continuously improve their investment in scientific and technological innovation, purchase advanced research and development equipment and experimental equipment, and introduce and cultivate high-end talents, to enhance the efficiency and level of enterprise green technology innovation. Based on this, this paper proposes the hypothesis:

H2: Enterprise financial technology applications can promote green technology innovation by increasing STI investment.

2.3. The moderating role of competition in industrial markets

Market competition in the industry can expose firms to the risk of losing market share or even delisting, and firms take various precautions to avoid bankruptcy and liquidation. On the one hand, firms tend to develop clean energy and expand technological innovation assets as a hedge against market uncertainty (Mohammed K S et al., 2024)[14]. On the other hand, based on signaling theory, under the condition of information asymmetry, firms can influence investors' decisions by transmitting signals about internal value and development prospects. The higher the degree of market competition, the more companies tend to disclose social responsibility information as a way of signaling (Yu H C et al., 2017)[15] that establishes a positive and responsible enterprise image to gain the favor of customers and investors. As false disclosure of social responsibility information found by the market will have a bad impact on enterprise reputation, enterprises must adopt substantial green innovation behaviors and achieve real and effective green innovation results. Therefore, enterprises will more actively utilize financial and technological means to carry out green technological innovation, to give them an advantage in competition.

The predatory effect caused by market competition in the industry affects the cash flow risk of enterprises by influencing their business activities and capital financing (Zhibin Chen et al., 2015)[16]. Specifically, in an environment with a large degree of market competition, enterprises will intentionally accelerate capital turnover and increase precautionary cash reserves, and the extent of the impact of the predation effect is smaller due to the constraints imposed by the response of other competitors in the industry; in an environment with a small degree of market competition, enterprises adopt aggressive business strategies that may lead to greater fluctuations in working capital advances and recoveries, and the predation effect will expose enterprises to greater cash flow risk. Therefore,

the industry market competition will weaken the enterprise's cash flow risk, which in turn affects the effect of the enterprise's financial technology development on green technology innovation. Based on this, this paper proposes the hypothesis:

H3: Industry market competition can enhance the contribution of enterprise financial technology applications to green technology innovation.

3. Research Design

3.1. Sample selection

This paper selects the data of A-share listed enterprises in Shanghai and Shenzhen from 2013 to 2023 as the initial research sample, and implements the following treatments on the data to ensure the accuracy of the research: firstly, exclude the companies in the financial industry and the real estate industry, to avoid the interference of the results of the research due to the special characteristics of the financial industry and the status quo of the real estate market downturn; secondly, eliminate the samples listed as ST and PT in the current year; thirdly, exclude the samples with missing relevant variables; thirdly, eliminate the samples with missing relevant variables. Status in the current year; third, excluding samples with missing relevant variables. To eliminate the interference of extreme values, this paper shrinks all continuous variables at the 1% and 99% levels. After the above processing, 33,867 observations are finally obtained. The green technology innovation data used in this paper is from the CNRDS database, the financial technology data is taken from annual reports of listed companies and hand processed; the enterprise-level related data is from the Cathay Pacific database; the macro level data is from the National Statistical Yearbook.

3.2. Main variables

3.2.1. Enterprise Green Technology Innovation

Following Zhang D et al. (2019)[17] study, this paper adopts the number of green patent applications to assess the green innovation capability of enterprises. Specifically, this paper takes the natural logarithmic value of the number of green inventions and green utility models independently filed by an enterprise in the same year as a measure of the enterprise's green technological innovation (Green_patent).

3.2.2. Enterprise Financial Technology Levels

Following Lei Huang et al. (2023)[18], we utilize Python to conduct statistical analysis on the frequency of keywords related to financial technology levels in annual enterprise reports. The natural logarithm is taken by adding one to the results obtained as a measure of the financial technology level of each listed enterprise in each year (Fintech).

3.2.3. Control variables

Following Jia Xu et al. (2020)[3], The control variables selected in this paper include: enterprise size (Size), financial leverage (Lev), return on assets (ROA), equity checks and balances (Balance), ownership concentration (Top5), board size (Board), age of the enterprise (ListAge), accounts receivable ratio (Rec), and inventory ratio (Inv). Specific variables are described in Table 1.

3.3. Model design

The research model of this study is presented below:

$$\text{Green\_patent}_{i,t} = \alpha_0 + \alpha_1 \text{Fintech}_{i,t} + \sum \mu \text{Controls}_i + \text{Ind}_t + \text{Year}_i + \varepsilon_{i.t} \quad (1)$$

Where, $\text{Green\_patent}_{i,t}$ is the explanatory variable, $\text{Fintech}_{i,t}$ is the core explanatory variable, α_1 is the coefficient of main interest in this study. If α_1 is significantly greater than 0, it indicates that the improvement of enterprise Fintech level has a significant positive driving effect on enterprise

green technology innovation. $Controls_i$ represent the set of control variables. Fixed effects for year and industry are employed to eliminate the impact of unobservable factors. $\varepsilon_{i.t}$ is the random error term. In addition, this paper mitigates the effect of heteroskedasticity by using robust standard errors in the regression analysis.

Table 1. Variable definitions

Variable Name	Variable Symbol	Definitions of Variables
Green technology innovation	Green_patent	The natural logarithm of the number of green inventions and green utility models filed in the year plus 1.
Level of financial technology	Fintech	The natural logarithm of the word frequency of Fintech plus 1.
Enterprise size	Size	The natural logarithm of enterprise total assets at the end of the period.
Financial leverage	Lev	Enterprise total liabilities / total assets.
Return on assets	ROA	Year-end net profit / total assets.
Shareholding checks and balances	Balance	The shareholding ratio of the second largest shareholder/shareholding ratio of the first largest shareholder
Ownership concentration	Top5	Number of top five shareholders / total number of shares
Board size	Board	The natural logarithm of the number of directors plus 1.
Enterprise age	ListAge	The natural logarithm of enterprise listed years plus 1.
Accounts receivable ratio	Rec	Net accounts receivable/ total assets
Inventory ratio	Inv	Net inventory/ total assets

4. Empirical Test and Analysis

4.1. Descriptive Statistics

Table 2 reports the descriptive statistics of the variables involved in this paper. Specifically, the mean value of Green_patent of the sample enterprises is 0.380, with a standard deviation of 0.786, indicating that the overall level of green innovation of the current enterprises has a greater room for improvement and that there is a certain degree of difference in the level of green innovation between different enterprises; the mean value of the level of Fintech is 3.566, with a standard deviation of 1.352, indicating that most enterprises have a higher degree of utilization of Fintech and hold an attitude of attaching importance to the development of Fintech, but there is a large difference in the level of Fintech among different enterprises.

Table 2. Descriptive statistics

Variable	N	Mean	S.D	Min	Max
Green patent	33867	0.380	0.786	0	3.611
Fintech	33867	3.566	1.352	0	6.410
Size	33867	22.20	1.269	19.87	26.14
Lev	33867	0.399	0.198	0.0540	0.875
ROA	33867	0.0420	0.0660	-0.234	0.227
Balance	33867	0.380	0.285	0.00100	1
Top5	33867	0.537	0.154	0.199	0.888
Board	33867	2.106	0.195	1.609	2.639
ListAge	33867	2.001	0.960	0	3.367
Rec	33867	0.129	0.101	0.00100	0.461
Inv	33867	0.121	0.0930	0	0.472

4.2. Regression analysis.

Table 3 reports the results of the benchmark regression of the impact of firms' level of financial technology on green technology innovation. Column (1) is the regression result with only core

explanatory variables and controlling for industry and year-fixed effects, while column (2) adds control variables on this basis and controls for industry and year-fixed effects as well, and the results show that the regression coefficients of the level of enterprise financial technology and green technological innovation are both significantly positive at the 1% level, indicating that the enhancement of the level of enterprise financial technology promotes the green technological innovation of the corporations. Thus, the hypothesis H1 proposed in the previous section is verified.

Table 3. Regression analysis

	(1)	(2)
	Green_patent	Green_patent
Fintech	0.083***	0.043***
	(0.000)	(0.000)
Size		0.152***
		(0.000)
Lev		0.221***
		(0.000)
ROA		0.407***
		(0.000)
Balance		-0.047***
		(0.001)
Top5		-0.132***
		(0.000)
Board		0.097***
		(0.000)
ListAge		-0.062***
		(0.000)
Rec		0.142***
		(0.003)
Inv		-0.132***
		(0.004)
Constant	0.085***	-3.242***
	(0.000)	(0.000)
Year	Yes	Yes
Ind	Yes	Yes
Observations	33867	33867
R-squared	0.137	0.187

***p<0.01,**p<0.05,*p<0.10

4.3. Robustness test

4.3.1. Replacement of explanatory variables

In this paper, the original explanatory variables are replaced by the green acquisitions(GA) of enterprises in the following year for the regression, using the sum of the number of green inventions and the number of green utility models independently acquired by enterprises in the following year plus one to take the natural logarithm of the value obtained to measure the green acquisitions of enterprises The results shown in column (1) of Table 4 exhibit no significant differences compared to the baseline regression.

4.3.2. Adding provincial-level fixed effects

Considering that enterprises located in the same province may be subject to the same macro factors, provincial fixed effects are added to eliminate this effect. Results shown in column (2) of Table 4 indicate the robustness of the baseline regression.

4.3.3. Lagging explanatory variables and control variables by 1 period

Considering that the impact of enterprise financial technology level on green technology innovation has a lagged effect, we lag both the core explanatory variables and control variables by 1

period. The results shown in column (3) of Table 4 exhibit no significant differences compared to the baseline regression.

Table 4. Robust test1-3

	(1)	(2)	(3)
VARIABLES	GA	Green_patent	Green_patent1
Fintech	0.027***	0.040***	0.041***
	(0.000)	(0.000)	(0.000)
Constant	-3.186***	-3.244***	-3.348***
	(0.000)	(0.000)	(0.000)
Controls	Yes	Yes	Yes
Year	Yes	Yes	Yes
Ind	Yes	Yes	Yes
Province	No	Yes	No
Observations	28368	33867	28368
R-squared	0.195	0.194	0.195

***p<0.01,**p<0.05,*p<0.10

5. Endogeneity Analysis

To alleviate the endogeneity problem, this paper chooses the level of financial technology development in the region where the firm is located as the instrumental variable (IV) and uses the cumulative number of financial technology firms registered in the region plus one to take the natural logarithmic value as a proxy for the level of financial technology development in the region. Table 5 reports the regression results of the instrumental variables. The Kleibergen-Paap rk Wald F value is greater than the Stock-Yogo 10% level critical value, which passes the weak instrumental variable test; the p-value of the Kleibergen-Paap rk LM test is 0.004, which satisfies the instrumental variable identifiability. The regression results show that the regression coefficients of enterprise financial technology level and green technology innovation are still significantly positive after considering the endogeneity problem, further proving hypothesis H1.

Table 5. Endogeneity analysis

	(1)	(2)
	First stage	Second stage
VARIABLES	Fintech	Green_patent
Fintech		0.248*
		(0.053)
IV	0.068***	
	(0.000)	
Constant	-3.519***	-2.882***
	(0.000)	(0.000)
Controls	Yes	Yes
Year	Yes	Yes
Ind	Yes	Yes
Kleibergen-Paap rk LM statistic	8.325(0.004)	Yes
Kleibergen-Paap rk Wald F statistic	32.206(16.38)	Yes
Observations	23897	23897
R-squared	0.013	0.010

***p<0.01,**p<0.05,*p<0.10

6. Further Analysis

6.1. Analysis of mediating effects

Based on Jiang's (2022)[19] approach, this paper establishes a regression model to test the role of the causal relationship between the level of enterprise financial technology and enterprise green technology innovation channels, the model is constructed as shown in the following (2).

$$\mathrm{RD}_{it} = \beta_0 + \beta_1 \mathrm{Fintech}_{it} + \sum \mu \mathrm{Controls}_i + \mathrm{Ind}_t + \mathrm{Year}_i + \varepsilon_{i.t} \quad (2)$$

Among them, science and technology innovation investment draws on Kim W S et al. (2018)[20] research results, the proportion of R&D investment in total assets is used as an alternative indicator to measure the firm's investment in science and technology innovation (RD). Table 6 demonstrates the test results of the STI input mechanism. The regression results show that the regression coefficient of financial technology is significantly positive at the 1% level, indicating that the increase in the level of enterprise financial technology can significantly increase the enterprise's investment in science and technology innovation.

There are numerous of literature on the impact of enterprise STI investment on enterprise green technology innovation. Hui Wang et al. (2016)[21] From the theoretical level, it is argued that increasing R&D investment can expand the stock of green innovation knowledge of enterprises, and the "knowledge spillover" effect accelerates the dissemination and application of green innovation knowledge, which helps to improve the efficiency of green innovation of enterprises. Lee K H et al (2015)[22] argued that R&D investment is closely related to the green technology innovation capability of enterprises, which in turn has a positive effect on green innovation performance. Guangpei Li et al (2018)[23] found that enterprise R&D expenditures for the purchase of software hardware and green process technology equipment, and the provision of training and learning resources for R&D personnel can help to enhance the enterprise's green product innovation capability and green process innovation capability. As a result, the mechanism of science and technology innovation investment is argued, and hypothesis H2 of this paper is valid.

Table 6. Analysis of mediating effects

	(1)
VARIEBLES	RD
Fintech	0.002***
	(0.000)
Constant	0.026***
	(0.000)
Controls	Yes
Year	Yes
Ind	Yes
Observations	30954
R-squared	0.269

* p < 0.1, ** p < 0.05, *** p < 0.01

6.2. Analysis of moderating effects

This paper establishes a regression model to test the moderating role of industry market competition between the level of enterprise financial technology and enterprise green technology innovation, and the model is constructed as shown in the following (3) equation.

$$\mathrm{Green\_patent}_{it} = \gamma_0 + \gamma_1 \mathrm{Fintech}_{it} + \gamma_2 \mathrm{HHI}_{it} + \gamma_3 \mathrm{Fintech}_{it} \times \mathrm{HHI}_{it} + \sum \mu \mathrm{Controls}_i + \mathrm{Ind}_t + \mathrm{Year}_i + \varepsilon_{i.t} \quad (3)$$

In this case, the Herfindahl-Hirschman index is chosen to measure the degree of market competition (HHI), i.e., the square of the ratio of the total assets of each company in the industry to the total assets of the industry combined is cumulative, and the higher the value, the higher the degree of monopoly in the market is represented, i.e., the lower the degree of competition in the market. The results of the moderating effects are shown in Table 7, with the cross-multiplier term (HHI× Fintech) has a significantly negative regression coefficient, indicating that industry market competition positively moderates the role of enterprise financial technology level on green technology innovation, so hypothesis H3 of this paper is valid.

Table 7. Analysis of moderating effects

VARIEBLES	(1) Green_patent
Fintech	0.052***
	(0.000)
HHI	0.197*
	(0.050)
HHI×Fintech	-0.059***
	(0.006)
Constant	-3.287***
	(0.000)
Controls	Yes
Year	Yes
Ind	Yes
Observations	32771
R-squared	0.186

*p<0.1,**p<0.05,***p<0.01

6.3. Heterogeneity analysis

6.3.1. Analysis of industry heterogeneity

Due to the different innovation willingness, financing needs, and industry regulatory policies in different industries, there may be differences in the impact of enterprise financial technology level on green technology innovation. The regression results are shown in Table 8. The increase in the level of enterprise financial technology significantly promotes the green technology innovation of enterprises in the manufacturing, construction, and service industries, while this promotion is not obvious in the agriculture, mining, electricity, heat, gas, and water production and supply industries. The reasons may lie in the following: first, the traditional agriculture, mining and electricity, heat, gas, and water production and supply industries mainly rely on manpower and traditional mechanical equipment in the production and transportation process, and the degree of application of financial technology in these industries is relatively low, which affects the promotion effect of financial technology on green technological innovation. Secondly, for the mining industry, the construction of green mines often requires large initial investments and may not directly bring significant economic benefits to enterprises in the short term. Therefore, some enterprises may pursue short-term economic benefits too much and neglect the importance of green technological innovation, thus lacking the intrinsic motivation to carry out green technological innovation. Third, the electricity, heat, gas, and water production and supply industries also face some challenges in the promotion of new energy projects. Due to the prominent issue of renewable energy subsidy arrears, some enterprises' new energy projects were unable to obtain subsidies according to the original plan, resulting in serious losses for the projects. This not only affects the economic efficiency of enterprises but also slows down the research and development process of green projects.

Table 8. Analysis of industry heterogeneity

	(1) Agriculture	(2) Mining industry	(3) Manufacturing industry	(4) Production and supply of electricity, heat, gas, and water	(5) Construction industry	(6) Service industry
VARIABLES	Green_patent	Green_patent	Green_patent	Green_patent	Green_patent	Green_patent
Fintech	0.029	0.007	0.050***	0.031	0.116***	0.024***
	(0.264)	(0.785)	(0.000)	(0.123)	(0.001)	(0.001)
Constant	-3.862***	-4.838***	-3.938***	-2.342***	-0.208	-1.486***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.746)	(0.000)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
Ind	Yes	Yes	Yes	Yes	Yes	Yes
Observations	380	708	23649	1058	780	7292
R-squared	0.235	0.286	0.177	0.070	0.117	0.279

***p<0.01,**p<0.05,*p<0.10

6.3.2. Analysis of firm heterogeneity

The promotion effect of enterprise financial technology level on green technology innovation may differ between SOEs and non-SOEs. The results in Table 9 show that the regression coefficients of Fintech are all significantly positive, but the regression coefficients of Fintech are significantly larger for non-state-owned enterprises compared to state-owned enterprises, and the empirical p-value of the difference in regression coefficients between the groups obtained by the Bootstrap method 1,000 times is 0.000, which confirms that the regression coefficients of Fintech are significantly different between state-owned enterprises and non-state-owned enterprises. The reason may lie in the fact that non-SOEs face greater financing constraints due to difficulty in assessing creditworthiness and discriminatory treatment, compared to SOEs, which usually have access to more financial support. Fintech plays a more important role in alleviating the financing constraints of non-SOEs by reducing information asymmetry and providing abundant financing channels. In addition, the relatively cumbersome decision-making process of SOEs and their lack of flexibility in the use of FinTech may hinder the promotion of their green innovation projects.

Table 9. Analysis of firm heterogeneity

	(1) State-owned enterprise	(2) Non-state enterprise
VARIABLES	Green_patent	Green_patent
Fintech	0.020***	0.058***
	(0.007)	(0.000)
Constant	-3.435***	-2.986***
	(0.000)	(0.000)
Controls	Yes	Yes
Year	Yes	Yes
Ind	Yes	Yes
Observations	11093	22774
R-squared	0.245	0.181
Experience P-value	0.000***	

***p<0.01,**p<0.05,*p<0.10

7. Conclusions

This paper empirically analyzes the impact of enterprise financial technology level on enterprise green technology innovation and its mechanism of action with the research samples of Shanghai and Shenzhen A-share listed companies from 2013 to 2023. The main conclusions are as follows: (1) The improvement of enterprise financial technology level significantly promotes enterprise green technology innovation, and this conclusion still holds after a series of robustness tests and consideration of endogeneity issues. (2) The results of the mechanism test based on the mediation effect model show that in the process of enterprise financial technology level affecting enterprise green technology innovation, there exists a conduction channel of "improving enterprise financial technology level → increasing enterprise scientific and technological innovation investment → improving enterprise green innovation level". The mechanism test results of the moderating effect model show that the industry market competition positively moderates the relationship between the level of enterprise financial technology and enterprise green technology innovation, i.e., the more intense the industry market competition, the stronger the green innovation effect of enterprise financial technology development. (3) Heterogeneity analysis shows that the improvement of enterprise financial technology level has a more significant effect on the enhancement of green innovation level of non-state-owned enterprises, manufacturing industry, construction industry, and service industry enterprises.

The following policy implications can be drawn from the findings of this paper:

First, the government should encourage the innovative development of the financial technology industry and increase support for the research and development of new financial technology innovations such as artificial intelligence, big data, and blockchain. This will lead to the introduction of more financial technology products and services with high practicality and security, further enhance the ability and efficiency of financial technology to serve the real economy, and help enterprises ease financing pressure and reduce business risks.

Secondly, enterprises should improve the level of financial technology and accelerate the matching of financial technology products with their green innovation projects, to provide better intelligent support and services. On the one hand, financial technology is utilized to manage enterprise resource allocation and asset operation, formulate accurate financial planning to reduce operating costs and financial risks, and enhance managers' willingness to engage in green innovation. On the other hand, modern communication technologies such as cloud computing are utilized to improve the internal and external communication efficiency of enterprises, reduce the degree of information asymmetry, alleviate the financing difficulties of enterprises, and promote their green innovation input.

Third, the relevant departments need to further improve the domestic market regulatory system, eliminate industry monopolies, improve the level of market competition in various industries, and give full play to the green innovation effect of enterprise financial technology development. In particular, the government should increase financial support and subsidies for green innovation projects and green technology research and development of enterprises in the agriculture, mining, electricity, heat, gas, and water production and supply industries, and establish a sound system of protection for patented technologies, to provide legal safeguards for enterprises' green innovation.

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