Research on the Impact of Supply Chain Finance Based on Blockchain Technology on Enterprise Innovation Performance

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Abstract. This study aims to explore the impact mechanism of supply chain finance on enterprise innovation performance through the chain mediating effect of financing constraints and green technological innovation. Using data from 2014 to 2023 as the research sample, this paper employs a two-way fixed-effect model and mediating effect test method, combined with the background of blockchain technology empowering supply chain finance, to analyze the direct impact of supply chain finance development level on enterprise innovation performance and its indirect action paths. The research results show that supply chain finance can significantly improve enterprise innovation performance, and achieve a significant positive impact through two paths: alleviating financing constraints and improving the level of green technological innovation. Heterogeneity analysis indicates that the benefits are more significant for non-state-owned enterprises, non-heavy pollution industries, and enterprises in eastern regions. This study provides a theoretical basis and practical reference for optimizing supply chain financial services and promoting the construction of enterprise innovation ecosystems.

Keywords: Supply Chain Finance, Financing Constraints, Green Technological Innovation, Enterprise Innovation Performance, Blockchain Technology.

1. Introduction

Against the backdrop of the rapid development of financial technology and the deep integration of global industrial chains, supply chain finance, an innovative model that integrates business flow, logistics, capital flow, and information flow, has become a core engine driving the sustainable development of enterprises.Looking back at its development process, supply chain finance emerged in China in the early 20th century, gradually evolving from the traditional chattel mortgage model to a new stage of digitalization and intelligence. Among these advancements, the introduction of blockchain technology is particularly crucial - it has successfully overcome industry challenges such as information asymmetry and transaction fraud, laying a solid foundation for building a more transparent and reliable supply chain financial ecosystem.In recent years, the national government has continued to make efforts, with policies such as the "Opinions on Regulating the Development of Supply Chain Finance to Support the Stable Circulation and Optimization and Upgrading of Supply Chain Industries" being intensively implemented, further promoting a deeper integration and symbiosis between supply chain finance and the real economy.

In the context of the "dual carbon" strategy and high-quality development, corporate innovation, particularly green technological innovation, has undoubtedly become a core driver for breaking through resource and environmental constraints and fostering new productive forces. However, it is undeniable that small and medium-sized enterprises generally face or have long been plagued by the "Macmillan gap". Traditional financing models, constrained by collateral bias and information barriers, struggle to support the high investment required for innovative activities.Supply chain finance, on the other hand, by building a "supply chain collective credit" system, upgrades the credit of individual enterprises to the overall credit of the industrial chain. This institutional innovation provides a new perspective and feasible path for solving the dilemma of innovative financing.

Current research on supply chain finance mainly focuses on its impact on corporate financing constraints, capital structure, and other aspects, while paying relatively little attention to its

connection with corporate innovation performance.Scholars Yang Yi and Shi Shuhe believe that supply chain finance can promote enterprises to increase R&D investment by alleviating financing constraints, and this promoting effect is more prominent in enterprises with high financing constraints and private enterprises [1]. Scholars Yang Yalin and Wu Qiang also indicate that supply chain finance can improve the innovation level of retail enterprises by reducing financing constraints, and this effect is more obvious in regions with a higher level of financial development [2].

Based on the supply chain finance model empowered by blockchain technology, this study constructs a dual intermediary model of financing constraints and green technological innovation, with the core goal of clarifying the mechanism through which supply chain finance exerts an impact on enterprise innovation performance.Specifically, the research will focus on exploring three issues: first, whether supply chain finance can directly promote enterprise innovation performance; second, what kind of roles financing constraints and green technological innovation play in this process; third, whether the impact effect will show differences when enterprises are under different property rights, industry attributes and regional economic development levels.

2. Research Design

2.1. Sample Data Selection and Data Source

This study takes the ten-year consecutive data of A-share listed companies in Shanghai and Shenzhen from 2014 to 2023 as the sample basis, and conducts multi-dimensional data screening in combination with research needs: first, exclude companies with abnormal operations such as ST (companies with consecutive two-year losses), *ST (companies with consecutive three-year losses), and PT (companies suspended from listing due to consecutive three-year losses, etc.); second, eliminate samples of enterprises in the insurance and financial industry; third, filter out observations with missing variables; then, remove individual enterprises with only a single record during the research period; finally, perform 1%-99% quantile winsorization on all continuous variables.After the above series of data cleaning steps, 15,752 valid observation samples from 2,925 listed companies were finally obtained. The research data are all taken from the Wind database and the Guotai'an database (CSMAR), and the Stata 18 software is used to complete the regression analysis process.

2.2. Variable Setting

2.2.1 Dependent Variable

The dependent variable in this study is set as enterprise innovation performance. A review of existing literature shows that academic circles commonly use two types of indicators to measure this variable: one is the total number of patent applications or the total number of authorized patents, and the other is new product sales [3][4][5][6][7].In view of the problems such as uncertainty in examination, instability in annual fee payment in the patent authorization process, and the potential influence of administrative procedures, compared with the total number of authorized patents, patent application data can better reflect the stability, reliability and timeliness of the indicator [8]. Meanwhile, to avoid interference that may be caused by extreme values, this study draws on the practices of Zhong Fengying, Leng Bingjie (2022) and Zhang Yufei et al. (2023), and takes the natural logarithm of the total number of enterprise invention patent applications plus 1 as the quantitative form of the dependent variable [3][9].

2.2.2 Explanatory Variable

This study takes the development level of supply chain finance (SCF) as the explanatory variable. Given the diversity and complexity of operation modes in the field of supply chain finance, it refers to the research method of Liu Jingyi et al. (2019) and selects the ratio of the total amount of a company's short-term loans, accounts payable, and notes payable to the total year-end assets as an appropriate indicator to measure the development level of supply chain finance [10]. This ratio is

positively correlated with the development level of a company's supply chain finance [8]; that is, the larger the value, the higher the level of the company's supply chain financing.

2.2.3 Mediating Variables

The mediating variables selected in this paper are enterprise financing constraints and green technological innovation.

(1) Financing Constraints (SA). The SA index is used as a measure of enterprise financing constraints, and the calculation formula is as follows:

$$SA = -0.737 \times Size + 0.043 \times Size2 - 0.04 \times Age \quad (1)$$

In Equation 1, enterprise size (Size) represents the logarithm of the total assets of the enterprise, and Age is the age of the enterprise. A larger SA value indicates a more serious financing constraint problem;

(2) Enterprise Green Technological Innovation (GTI). It is measured by taking the natural logarithm of the sum of the number of green invention patents and green utility model patents applied by the enterprise plus 1 [11].

All variables and definitions selected in this paper are shown in Table 1.

Table.1. Variable Definition Table

Variable Type	Variable Name	Variable Symbol	Variable Definition
Dependent Variable	Enterprise Innovation Performance	Inv	Natural logarithm of the total number of enterprise invention patent applications plus 1
Explanatory Variable	Supply Chain Finance	SCF	(Short-term Loans + Notes Payable + Accounts Payable) / Total Year-end Assets
Mediating Variables	Financing Constraints	SA	SA =(- 0.737)× Size + 0.043 × $Size^2$ - 0.04×Age
	Green Technological Innovation	GTI	ln (Number of Green Invention Patent Applications + Number of Green Utility Model Applications + 1)
Control Variables	Return on Net Assets	ROE	Net Profit / Net Assets
	Company Size	Size	Natural logarithm of annual total assets
	Asset-Liability Ratio	Lev	Total Year-end Liabilities / Total Year-end Assets
	Proportion of Independent Shareholders	Inde	Independent Directors / Number of Board Members
	Shareholding Ratio of the Largest Shareholder	Top1	The proportion of the largest shareholder in the total share capital of the company
	Enterprise Age	Age	ln (Current Year - Enterprise Establishment Year)
	Industry	Ind	1 if belonging to a certain industry, 0 otherwise, industry classification refers to the CSRC industry classification (2012)

2.3. Model Construction

Based on the research content of this paper, the empirical analysis model is constructed as follows:

(1)Benchmark Regression Model

$$Inv_{i,t} = \alpha_0 + \alpha_1 SCF_{i,t} + \alpha_2 ROE_{i,t} + \alpha_3 Size_{i,t} + \alpha_4 Lev_{i,t} + \alpha_5 Inde_{i,t} + \alpha_6 GDP_{i,t} + \alpha_7 Top1_{i,t} + \alpha_8 Age_{i,t} + \lambda_i + year_t + \varepsilon_{i,t} \quad (2)$$

In Equation 2, i and t are the data of the i-th enterprise in the t-th year, α0 is the intercept, α1 to $\alpha_8$are the variable coefficients, λ_i is the individual fixed effect, yeart is the time fixed effect, and εit is the random disturbance term.

(2) Mediating Effect Model

$$SA_{i,t} = \alpha_0 + \alpha_1 SCF_{i,t} + \alpha_2 ROE_{i,t} + \alpha_3 Size_{i,t} + \alpha_4 Lev_{i,t} + \alpha_5 Inde_{i,t} + \alpha_6 GDP_{i,t} + \alpha_7 Top1_{i,t} + \alpha_8 Age_{i,t} + \lambda_i + year_t + \varepsilon_{i,t} \quad (3)$$

$$GTI_{i,t} = \alpha_0 + \alpha_1 SCF_{i,t} + \alpha_2 ROE_{i,t} + \alpha_3 Size_{i,t} + \alpha_4 Lev_{i,t} + \alpha_5 Inde_{i,t} + \alpha_6 GDP_{i,t} + \alpha_7 Top1_{i,t} + \alpha_8 Age_{i,t} + \lambda_i + year_t + \varepsilon_{i,t} \quad (4)$$

$$Inv_{i,t} = \alpha_0 + \alpha_1 SCF_{i,t} + \alpha_2 SA_{i,t} + \alpha_3 GTI_{i,t} + \alpha_4 ROE_{i,t} + \alpha_5 Size_{i,t} + \alpha_6 Lev_{i,t} + \alpha_7 Inde_{i,t} + \alpha_8 GDP_{i,t} + \alpha_9 Top1_{i,t} + \alpha_{10} Age_{i,t} + \lambda_i + year_t + \varepsilon_{i,t} \quad (5)$$

2.4. Research Hypotheses

Against the backdrop of fierce global industrial competition and China's pursuit of high-quality development, supply chain finance, as a financial innovation in the digital economy, alleviates capital flow bottlenecks, enhances fund efficiency, and boosts corporate competitiveness. It offers new financing approaches, facilitates resource utilization and achievement transformation, leading to the hypothesis: Supply chain finance significantly promotes corporate innovation performance.

Supply chain finance can directly improve corporate performance and indirectly enhance innovation performance by relieving financing constraints. Information asymmetry in traditional financing markets has posed financing difficulties for enterprises, while supply chain finance alleviates such constraints through building financial ecosystems and credit sharing mechanisms, injecting capital momentum into innovation. Thus, Hypothesis 2 is proposed: Supply chain finance can promote corporate innovation performance by relieving financing constraints.

Against the backdrop of growing global resource and environmental constraints, green and low-carbon development has become the mainstream. The 2025 Government Work Report emphasizes strengthening ecological protection. Green technological innovation is crucial for energy conservation and carbon reduction. As a bridge between industrial ecology and green development, supply chain finance provides funding, promotes information sharing, and incentivizes green innovation. Thus, Hypothesis 3 is proposed: Supply chain finance enhances innovation performance by promoting green technological innovation.

3. Empirical Analysis

3.1. Descriptive Statistical Analysis

Based on the selected variables in this paper, a descriptive statistical analysis is carried out for each variable, and the results are shown in Table 2.

Table.2. Descriptive Statistical Analysis

VarName	Obs	Mean	SD	Min	Max
Inv	15752	3.218	1.356	0.693	7.279
SCF	15752	0.232	0.138	0.010	0.605
SA	15752	-3.859	0.271	-4.498	-2.939
GTI	15752	1.937	1.113	0.693	5.537
ROE	15752	6.951	12.386	-52.190	37.610
Size	15752	22.744	1.407	20.345	27.048
Lev	15752	0.445	0.190	0.075	0.883
Inde	15752	0.378	0.055	0.333	0.571
Top1	15752	33.465	15.128	8.000	74.570
Age	15752	21.460	6.233	4.000	69.000

It can be seen from Table 2 that the average value of Inv is 3.218, the standard deviation is 1.356, the minimum value is 0.693, and the maximum value is 7.279. The average value is greater than the standard deviation, reflecting that the overall dispersion degree of enterprise innovation performance of listed companies is low, and the overall difference is relatively small, but there is a large gap in extreme values, which also reflects that the performance level of some listed companies is high, while that of some listed companies is low. The average value of SCF is 0.232, the standard deviation is 0.138, the minimum value is 0.010, and the maximum value is 0.605. The average value is higher than the standard deviation, reflecting that the development level of supply chain finance of listed companies is significantly different, and there is a certain development difference among enterprises in this field.

3.2. Correlation Analysis

Based on the selected variables in this paper, a correlation analysis is carried out, and the results are shown in Table 3.

Table.3. Correlation Analysis

	Inv	SCF	SA	GTI	ROE	Size	Lev	Inde	GDP	Top1	Age
Inv	1										
SCF	0.162***	1									
SA	0.073***	-0.066***	1								
GTI	0.584***	0.176***	0.079***	1							
ROE	0.123***	-0.122***	0.099***	0.073***	1						
Size	0.416***	0.177***	-0.002	0.386***	0.105***	1					
Lev	0.169***	0.663***	-0.012	0.269***	-0.115***	0.526***	1				
Inde	0.029***	-0.025***	0.064***	0.014*	-0.004	-0.010	-0.018**	1			
Top1	0.043***	-0.021***	0.121***	0.072***	0.150***	0.196***	0.065***	0.039***	-0.041***	1	
Age	0.031***	0.020**	-0.757***	0.038***	-0.072***	0.243***	0.146***	-0.045***	0.083***	-0.077***	1

**p<0.1; **p<0.05; ***p<0.01*

It can be seen from the results of the correlation analysis that the explanatory variables and dependent variables selected in this paper show a significant positive correlation at the 1% level, and the correlation coefficient is 0.162, preliminarily verifying the first research hypothesis of this paper. At the same time, the explanatory variables, control variables, etc. selected in this paper all have significant correlations with the dependent variable at the 1% level, indicating that the variable selection in this paper is good, and further analysis can be carried out.

3.3. Multicollinearity Test

In this paper, a regression model is constructed for empirical analysis. Before the regression analysis, it is necessary to test the multicollinearity between variables. If there is a serious multicollinearity problem between variables, it may lead to the occurrence of spurious regression results, directly affecting the reliability of the regression results. Therefore, the variance inflation factor (VIF) test is used for the multicollinearity test. When VIF≧10, it indicates high collinearity, and the results are shown in Table 4.

Table.4. Multicollinearity Test

Variable	VIF	1/VIF
Lev	2.910	0.344
SA	2.340	0.428
Age	2.320	0.431
SCF	2.080	0.481
Size	2.040	0.489
ROE	1.130	0.888
Top1	1.100	0.910
SA	2.340	0.428
Age	2.320	0.431
SCF	2.080	0.481
Size	2.040	0.489
Inde	1.010	0.989
Mean VIF	1.770	

It can be seen from the results in Table 4 that the VIF test values of each variable selected in this paper are all less than 10, indicating that there is no serious multicollinearity problem between variables, and regression analysis can be carried out.

3.4. Model Test

Further careful testing is carried out on the selection of the model, and the F test, LM test, and Hausman test are used respectively to carefully evaluate the advantages and disadvantages of the fixed-effect model, random-effect model, and mixed cross-sectional model. The results are shown in Table 5.

Table.5. Model Test

Test Method	Test Value	P Value	Test Conclusion
F Test	13.47	0.000	Fixed-effect model is better than mixed cross-sectional model
LM Test	20194.22	0.000	Random-effect model is better than mixed cross-sectional model
Hausman Test	266.37	0.000	Fixed-effect model is better than random-effect model

According to the model test results presented in Table 5, it can be clearly observed that in the three groups of tests, the fixed-effect model shows better performance than the random-effect model and the mixed cross-sectional model. Therefore, this study decides to use the fixed-effect model for subsequent regression analysis.

3.5. Benchmark Regression

Based on the benchmark regression model constructed in this paper, regression analysis is carried out, and the results are shown in Table 6.

Table.6. Benchmark Regression

	(1) Inv	(2) Inv
SCF	0.237***	0.464***
	(2.63)	(4.12)
ROE		0.000648
		(1.14)
Size		0.463***
		(25.13)
Lev		-0.525***
		(-5.70)
Inde		0.137
		(0.80)
Top1		0.00350***
		(2.99)
_cons	3.163***	-7.476***
	(147.67)	(-17.71)
Company	Yes	Yes
Year	Yes	Yes
N	15752	15752
F	7***	99***
r2	0.821	0.830
r2_a	0.780	0.791

t statistics in parentheses , * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Column (1) of Table 6 shows the regression analysis results without adding control variables, and column (2) shows the regression results with all control variables added. The results of both columns show that supply chain finance has a significant positive impact on enterprise innovation performance, and research hypothesis 1 of this paper is verified.

3.6. Robustness Test

In order to ensure the accuracy of the regression results, this paper uses robust standard error correction, removes the 2020 epidemic sample, uses pre-epidemic data, and adds industry fixed effects to carry out robustness tests. First, robust standard error correction is used to deal with possible heteroscedasticity problems; second, the 2020 epidemic sample is removed because the epidemic has an impact on the operation of global enterprises; third, the data from 2014 to 2019 are used for regression analysis to consider the potential differences in enterprise development in the post-epidemic era; finally, industry fixed effects are added, and the results are shown in Table 7.

Table.7. Robustness Test

	(1)	(2)	(3)	(4)
	Robust Standard Error Inv	Excluding 2020 Inv	Using Pre-epidemic Sample Inv	Adding Industry Fixed Inv
SCF	0.464***	0.504***	0.595***	0.466***
	(3.60)	(4.10)	(3.42)	(4.14)
ROE	0.000648	0.000596	0.000309	0.000610
	(1.04)	(0.94)	(0.38)	(1.07)
Size	0.463***	0.460***	0.449***	0.464***
	(18.68)	(23.44)	(15.25)	(25.16)
Lev	-0.525***	-0.564***	-0.741***	-0.524***
	(-5.10)	(-5.60)	(-5.11)	(-5.69)
Inde	0.137	0.280	0.260	0
	(0.74)	(1.50)	(1.02)	(.)
Top1	0.00350**	0.00373***	0.00534***	0.00359***
	(2.30)	(2.97)	(2.99)	(3.06)
_cons	-7.476***	-7.479***	-7.411***	-7.453***
	(-13.09)	(-16.63)	(-11.07)	(-17.93)
Company	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Industry				Yes
N	15752	13628	6887	15752
F	55***	86***	39***	116***
p	0.000	0.000	0.000	0.000
r2	0.830	0.827	0.875	0.830
r2_a	0.791	0.782	0.833	0.791

t statistics in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

According to the regression analysis results in Table 7, it can be observed that in the four groups of robustness tests, the regression analysis results all show that SCF has a significant positive impact on Inv. This finding indicates that the robustness test of this paper is passed, and the reliability of the regression results is initially confirmed.

3.7. Mediating Effect Analysis

Based on the mediating effect model constructed in this paper, a mediating effect analysis is carried out, and the results are shown in Table 8.

Table.8. Mediating Effect

	(1) Inv	(2) SA	(3) Inv	(4) GTI
SCF	0.464***	-0.0533***	0.269***	0.342***
	(4.12)	(-6.63)	(2.86)	(3.15)
GTI			0.570***	
			(74.39)	
ROE	0.000648	-0.0000171	0.000917*	-0.000472
	(1.14)	(-0.42)	(1.92)	(-0.86)
Size	0.463***	0.0336***	0.267***	0.343***
	(25.13)	(25.53)	(17.12)	(19.33)
Lev	-0.525***	-0.0426***	-0.353***	-0.302***
	(-5.70)	(-6.49)	(-4.58)	(-3.40)
Inde	0.137	0.0243**	-0.152	0.509***
	(0.80)	(1.99)	(-1.07)	(3.09)
Top1	0.00350***	0.000873***	0.00334***	0.000283
	(2.99)	(10.44)	(3.41)	(0.25)
_cons	-7.476***	-4.638***	-4.013***	-6.081***
	(-17.71)	(-153.94)	(-11.28)	(-14.94)
Individual Effect	Yes	Yes	Yes	Yes
Time Effect	Yes	Yes	Yes	Yes
N	15752	15752	15752	15752
F	99***	133***	815***	58***
r2	0.830	0.978	0.881	0.765
r2_a	0.791	0.973	0.854	0.712

t statistics in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Column (1) of Table 8 shows that SCF has a significant positive impact on Inv, and improving the development level of enterprise supply chain finance can significantly improve enterprise innovation performance. Columns (2) and (3) show that SCF still has a significant positive impact on Inv, SA has a significant negative impact on Inv, and GTI has a significant positive impact on Inv. Data in columns (2) and (4) show that supply chain finance (SCF) is significantly negatively correlated with SA and significantly positively correlated with green technological innovation (GTI). This means that enterprise supply chain finance can exert a significant positive effect on enterprise innovation performance by alleviating financing constraints and improving the level of green technological innovation, thus verifying Hypotheses 2 and 3 of this study.

3.8. Heterogeneity Analysis

(1) Enterprise Property Right Heterogeneity

In the heterogeneity analysis, the focus is first placed on the differences in enterprise property rights. This study divides the sample enterprises into two groups: state-owned enterprises and non-state-owned enterprises, to conduct the heterogeneity analysis. The results are presented in Table 9.

Table.9. Analysis of Enterprise Property Right Heterogeneity

	(1)State-owned Inv	(2)Non-state-owned Inv
SCF	0.294*	0.699***
	(1.81)	(4.47)
ROE	0.00146*	-0.000537
	(1.65)	(-0.72)
Lev	-0.480***	-0.483***
	(-3.38)	(-3.97)
Size	0.473***	0.502***
	(16.19)	(20.61)
Inde	-0.149	0.423*
	(-0.63)	(1.72)
Top1	0.00137	0.00161
	(0.87)	(0.87)
_cons	-7.596***	-8.446***
	(-11.35)	(-15.06)
Company	Yes	Yes
Year	Yes	Yes
N	6392	9360
F	43***	65***
r2	0.856	0.802
r2_a	0.828	0.751

t statistics in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Based on the results in Table 9, it can be found that non-state-owned enterprises show stronger significance in the impact of supply chain finance on enterprise innovation performance, and the impact coefficient passes the 1% significance test, while the impact coefficient of state-owned enterprises is only significant at the 10% level. Empirical research shows that non-state-owned enterprises can more effectively break through the capital barriers of innovative investment through supply chain finance by virtue of their rapid response to market signals and efficient use of financing tools, while the innovation drive of state-owned enterprises more depends on the synergistic effect of supply chain finance and traditional policy resources.

(2) Industry Attributes

Table.10. Analysis of Industry Attribute Heterogeneity

	(1)Heavy Pollution Industry Inv	(2)Non-Heavy Pollution Industry Inv
SCF	0.0838	0.634***
	(0.42)	(4.64)
ROE	-0.00112	0.00120*
	(-1.05)	(1.76)
Lev	-0.373**	-0.542***
	(-2.20)	(-4.92)
Size	0.390***	0.484***
	(11.45)	(21.78)
Inde	0.250	0.122
	(0.75)	(0.61)
Top1	0.00628***	0.00239
	(3.14)	(1.63)
_cons	-5.866***	-7.980***
	(-7.57)	(-15.61)
Company	Yes	Yes
Year	Yes	Yes
N	4224	11528
F	25***	77***
r2	0.808	0.836
r2_a	0.765	0.798

t statistics in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

The heterogeneity analysis based on industry attributes in Table 10 shows that the impact of supply chain finance (SCF) on enterprise innovation performance varies significantly between heavy pollution industries and non-heavy pollution industries: the SCF coefficient of non-heavy pollution industries (such as electronic information and high-end equipment) is 0.634, which has a significant positive effect on innovation performance; while the coefficient of heavy pollution industries (such as steel and chemical industry) is only 0.0838 and is not significant.Restricted by factors such as the priority allocation of compliance funds under strict environmental protection policies and the high innovation risks caused by technological path dependence, the innovation empowerment effect of supply chain finance has not been released.

(3)Regional Heterogeneity

Further, based on the provinces where the enterprises are located, the enterprises are divided into eastern region, central region, and western region enterprises to analyze the regional heterogeneity of the impact of supply chain finance development level on enterprise innovation performance, and the results are shown in Table 11.

Table.11. Analysis of Regional Heterogeneity

	(1) Eastern Inv	(2) Central Inv	(3) Western Inv
SCF	0.448***	0.191	0.437
	(3.39)	(0.68)	(1.22)
ROE	0.000334	0.00142	0.00154
	(0.49)	(1.01)	(0.84)
Lev	-0.638***	-0.305	-0.192
	(-5.95)	(-1.29)	(-0.64)
Size	0.467***	0.449***	0.361***
	(21.53)	(9.72)	(5.94)
Inde	0.0585	0.299	0.464
	(0.29)	(0.69)	(0.88)
Top1	0.00227	-0.00209	0.0235***
	(1.59)	(-0.77)	(6.22)
_cons	-7.443***	-7.281***	-6.383***
	(-14.69)	(-6.95)	(-4.80)
Company	Yes	Yes	Yes
Year	Yes	Yes	Yes
N	11393	2698	1430
F	71***	15***	19***
r2	0.841	0.805	0.801
r2_a	0.804	0.761	0.752

t statistics in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

It can be seen from the results in Table 11 that the impact of supply chain finance on enterprise innovation performance is significantly positive in eastern region enterprises, but the impact is not significant in central and western region enterprises.

4. Conclusions and Suggestions

4.1. Research Conclusions

This study empirically analyzes the impact of supply chain finance on enterprise innovation performance using data from A-share listed companies in Shanghai and Shenzhen from 2014 to 2023. Research results show that: supply chain finance significantly enhances enterprise innovation performance; it indirectly promotes enterprise innovation by alleviating financing constraints and facilitating green technological innovation; heterogeneity tests indicate that non-state-owned enterprises, non-heavy pollution industries, and enterprises in eastern regions can significantly improve innovation performance through supply chain finance.

The study has three limitations: first, the sample only includes A-share listed companies, so its applicability to non-listed small and medium-sized enterprises requires further verification; second, green technological innovation is measured solely by the number of patents, without addressing quality dimensions such as the efficiency of innovation achievement transformation; third, the quantitative analysis of the depth of blockchain technology application in supply chain finance is absent. Future research can be refined by incorporating technological maturity for detailed investigations.

4.2. Policy Suggestions

Based on the above research conclusions, this paper puts forward the following policy suggestions:

First, the government should actively guide supply chain financial business and provide policy support and regulatory systems. The government can implement differentiated policies, provide subsidies and tax incentives for non-state-owned enterprises and core enterprises in central and western regions, and at the same time promote the combination of green transformation of heavy pollution industries and supply chain finance to stimulate enterprise innovation. These measures will promote the positive and healthy development of supply chain finance.

Second, enterprises should integrate into the supply chain network of core enterprises, optimize management processes, and expand the application scenarios and scale of supply chain finance. Through financial technology and digital means, such as cloud computing, artificial intelligence, and blockchain technology, improve the real-time sharing, transparency, and accuracy of supply chain information, and lay a foundation for the smooth development of supply chain finance.

Third, financial institutions: Adopt market orientation, use big data/AI to identify financing needs via data integration, enhance data sharing with core enterprises/third parties, reduce costs through blockchain traceability, and improve risk management via information platforms.

Fourth, regional collaboration: Eastern regions integrate supply chain finance with green innovation via industrial clusters; central/western regions strengthen platforms and cultivate leaders. Cross-regional mechanisms match financial expertise with industrial needs to boost efficiency and achieve balanced supply chain finance empowerment.

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