

How does supply chain finance reshape total factor productivity of enterprises

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ABSTRACT

This study uses a large sample, including 27,205 company-year data of A-share manufacturing enterprises in China from 2005 to 2024, to examine the impact of supply chain finance (SCF) on total factor productivity (TFP). Methodologically, we quantify the development level of SCF by analyzing the text content of the company's annual report, and calculate TFP by OP method. In order to deal with the possible endogenous problems, we use two-way fixed effect model and two-stage least squares (2SLS) tool variable method. The empirical results show that SCF can obviously improve TFP. From the economic point of view, TFP can increase by 0.4% on average for every standard deviation of SCF. Mechanism tests tells us that SCF mainly helps TFP growth by making better use of the company's working capital, such as reducing the occupied working capital and making inventory turnover faster. However, the operating expense ratio will greatly weaken this good effect, which is an important restrictive condition. Heterogeneity tests also found that this effect of improving production efficiency is more obvious in non-high-tech companies, polluting companies and non-state-owned enterprises. This study provides solid evidence and accurate suggestions for us to optimize resource allocation and guide the strategic development of supply chain finance.

Keywords: Supply Chain Finance; Total Factor Productivity; Working Capital Efficiency; Operating Expense Ratio.

1. INTRODUCTION

The report of the 20th CPC National Congress says that “we must really focus on building up the real economy” and that financial work needs to fully, accurately, and completely follow the new development philosophy. It stresses the need to “create new growth engines in areas like information technology, artificial intelligence, biotechnology, new energy, new materials, high-end equipment, and green environmental protection.” As a financial tool that helps industrial chains grow, supply chain finance has become a key way to make this strategy happen. In April 2025, a document called “Notice on Regulating Supply Chain Finance Operations and Guiding Supply Chain Information Service Providers to Better Serve SME Financing” said we must “fully, accurately, and completely implement the new development philosophy, deeply understand that financial work is about politics and serving the people, and make serving the real economy, people's livelihoods, and national strategies our main goal.” In order to reduce the financing cost of the whole industry and supply chain. As the first year of the 15th Five-Year Plan, in 2026, supply chain finance, an important financial innovation to optimize the allocation of supply chain resources, is set as a key part of the plan. Under the macro background of the deep integration of digital economy and real economy, improving the total factor productivity (tfp) of manufacturing industry has become a key task for us to promote high-quality economic development.

Based on this, this paper uses the data of China A-share listed companies from 2005 to 2024 to study the impact of supply chain finance on the total factor productivity of companies. The results show that supply chain finance can promote the company's total factor productivity, and this effect is more obvious in non-high-tech, non-polluting and non-state-owned enterprises. According to the resource arrangement theory (Lu Yi et al., 2025; Zhang and Hua, 2020) ^{[15][28]} and transaction cost theory (Williamson, 2010) ^[21], we found that supply chain finance significantly reduced the company's asset solidification and accelerated the capital turnover by integrating the “three streams” (capital flow, logistics and information flow). This dual path of “improving asset turnover” and “optimizing inventory turnover” has released the productivity dividend. However, the operating expense ratio will inhibit the significant positive impact of supply chain finance on total factor productivity. The research results of this paper have important practical significance for clarifying the development direction of supply chain finance.

The literature mentioned in this paper mainly has two directions:

The first study is about corporate supply chain finance. We want to see how supply chain finance can make the whole company more capable by changing the efficiency of using money. Previous studies mainly said that supply chain finance can help companies to make green inventions better, solve the problem of lack of money, and promote something called new-quality productive forces (Li et al., 2026; Lin, 2025; Han and Zhao, 2025) ^{[6] [10] [11]}. Although some people have studied the influence of supply chain finance on tfp (Xiao Chunmei, 2025), no one has talked about how supply chain finance changes tfp by affecting the efficiency of the company's usual turnover of money.

The second aspect is the research on the total factor productivity (tfp) of enterprises. Some existing studies examine tfp--from a macro perspective, such as industrial structure, GDP and tax reform (Cui and Ye et al., 2025; Islam and Dai, 2006; Sun et al., 2026) ^{[4] [7] [20]}, and some studies from the micro perspective, including traditional financing function, technological innovation and digital transformation (Shi and Jing, 2025; Chen, Hua, et al., 2026; Cheng et al., 2023) ^{[2] [3] [18]}. However, most existing literatures look at the influence of tfp from the perspective of internal resource allocation or macro-policy environment, and lack the path and mechanism to improve tfp from the micro level.

The highlights of this paper are mainly in three aspects:

1. Innovation in the mechanism path: it breaks through the perspective of "financing constraint". Most of the existing researches regard supply chain finance as a financing tool, such as Zhang, Wei-Bin and Liu, Ke (2012) ^[29] mainly focus on how it can alleviate the financing problem. We have made use of the important findings on the effects of "asset turnover" and "inventory turnover", and put forward a new research angle on the level of "working capital efficiency" for the first time. It reveals how supply chain finance can improve the micro-mechanism of tfp by accelerating asset circulation and reducing resource mismatch.
2. Accuracy of heterogeneity analysis: reveal the asymmetric effect of "technology polarization rights". The empirical results show that supply chain finance has a more obvious "corrective effect" on non-high-tech enterprises, polluting enterprises and non-state-owned enterprises. This challenges the traditional view that only high-tech enterprises can benefit from financial intervention, and proves the unique advantages of supply chain finance in helping traditional manufacturing industries make up for shortcomings.
3. Enriching the existing literature: This study investigates the influence mechanism of supply chain finance on total factor productivity (tfp) of manufacturing enterprises from the micro-enterprise level through working capital efficiency. This method supplements and deepens the existing research on the relationship between scf and tfp.

The structure of this paper is arranged as follows: Part II will talk about theoretical analysis and research hypotheses; Part III introduces the research design, including models, data and variables; Part IV shows empirical results and analysis, including benchmark estimates, robustness tests and heterogeneity analysis; Part V is extended analysis; Finally, we will give the conclusion and policy recommendations.

2. THEORETICAL ANALYSIS AND RESEARCH HYPOTHESES

2.1 Supply Chain Finance and Total Factor Productivity: A Resource Orchestration Perspective

The resource arrangement theory (Williamson, 2010) ^[21] talks about three steps of managing resources: combining resources, packaging resources to form capabilities, and then creating value with these capabilities. From this theory, supply chain finance is an important tool for enterprise resource arrangement, which enables enterprises to create value by obtaining high-quality resources and efficiently integrating and utilizing existing resources. This method can help solve the problems that traditional manufacturing enterprises often encounter, such as rigid asset structure and serious inventory backlog, which will hinder the improvement of total factor productivity.

Zhou (2025) ^[35] analyzed in detail how supply chain finance breaks the information island between upstream and downstream companies through the credit endorsement and information sharing of core enterprises. This can not only reduce the transaction cost of our external financing, but more importantly, it changes the asset structure of the enterprise. Through the tools of accounts receivable financing and inventory pledge, the funds originally pressed on accounts receivable and inventory are released and become highly liquid working capital. This redistribution of resources directly enhances the flexibility of production and the speed of response to market changes, which is manifested in a substantial increase in total factor productivity in macroeconomics. This leads to the first hypothesis, as follows:

H1: Supply chain finance has significantly boosted the total factor productivity of manufacturing enterprises.

2.2 Mechanisms and Mediating Effects of Working Capital Efficiency: Mobilizing Existing Assets to Reduce Resource Misallocation

This paper uses two indicators-Asset Turnover Ratio and Inventory Turnover Ratio-to measure the working capital efficiency of a company. Zhou Lan and Wu Huijun (2022) ^[33] found that supply chain finance directly affects the company's asset turnover efficiency through its functions of “destocking” and “activating assets”, thus avoiding the high fixed asset management cost that manufacturing enterprises usually have to bear. Specifically, the supply chain financial platform uses IoT and blockchain technologies to turn static inventory and accounts receivable into dynamic credit assets. This change reduces the idle cost of assets and increases the frequency of asset use. As pointed out by Zhang Yajuan and Zhang Xuehui (2025) ^[31], improved asset turnover rate means more output per unit asset, which is a key driving force for total factor productivity growth. Inventory turnover (ttm) reflects the accuracy of supply chain management. According to the research of Zhang Xiaotao (2026) ^[30], supply chain finance reduces the precautionary saving motivation of enterprises by providing liquidity support based on real trade transactions. Enterprises can use the synergistic effect of supply chain platform to achieve more accurate “zero inventory” or “low inventory” management. The improvement of inventory turnover rate means that enterprises can achieve the same output scale with less resources, which directly reduces the marginal production cost. This improvement in operational efficiency is the key path for supply chain finance to empower the real economy and promote tfp growth.

H2: Supply chain finance significantly reduces the capital occupation and idle assets (Cap) of enterprises, thus promoting the growth of total factor productivity.

H3: Supply chain finance can improve the total factor productivity by significantly improving the inventory turnover rate (Ttm) of enterprises and reducing resource mismatch.

2.3 The Regulatory Role of Operating Expense Ratio: The Boundaries of Efficiency

Although supply chain finance can optimize the asset structure, its effect is limited by the internal management efficiency of enterprises. Operating expense ratio (ofee) reflects a company's cost control ability. According to contingency theory (Li Jinhao, 2024) ^[9], the capital inflow brought by supply chain finance can be effectively transformed into productivity improvement only when enterprises have a strong cost control mechanism. For “lean-type” enterprises with low operating expenses, the funds injected by supply chain finance can quickly become R&D and production inputs, which can amplify productivity gains. On the contrary, enterprises with high operating expenses may be consumed by inefficient administrative expenses, which will weaken the effect of financial instruments to improve productivity. Therefore, the cost control ability of enterprises is the key condition for supply chain finance to play its role effectively.

H4: The proportion of operating expenses will weaken the relationship between supply chain finance and total factor productivity, that is, the higher the proportion of expenses, the less obvious the effect of supply chain finance on improving productivity.

3. RESEARCH DESIGN

3.1 Sample and Data Sources

This study uses the data of manufacturing companies listed in Shanghai, China and Shenzhen A-share markets from 2005 to 2024. We deal with the sample data like this: First, we remove the samples of companies that are marked as ST, ST or delisted during this period. Secondly, samples with missing key data or abnormal financial status were removed. Finally, we got the annual observation data of 27,205 companies. In order to reduce the influence of extreme values, we truncated the related variables at 1% and 99% levels. The data sources are: China Urban Statistical Yearbook, Guotai An database (CSMAR), financial data from Wind database, word frequency data obtained through text analysis of A-share annual report, and company annual report from China Securities Information Co., Ltd.

3.2 Variable Definition

3.2.1 dependent variable

Total Factor Productivity (tfp). According to the method of Lu Xiaodong et al. (2012), we used the total factor productivity (tfp) calculated by op method as the dependent variable in this study. We choose the logarithm of capital stock plus one as the proxy variable to estimate the tfp of listed manufacturing companies, so that we can capture those invisible productivity

shocks and make the results more convincing. In addition, because the capital investment of listed companies is basically positive every year, this method can minimize the risk of a large number of samples being lost.

3.2.2 Core explanatory variable

Supply Chain Finance (SCF). We refer to the keyword set of supply chain finance in the research of Zhang Lina et al. (2021) ^[27], and divide these keywords into four categories: inventory-related, accounts receivable-related, prepayment-related and financing-related. Please see Table 1 for the specific classification. This study uses the method of word frequency quantitative analysis to measure the financial level of supply chain of enterprises. Word frequency analysis can accurately measure the development trend and changes of supply chain finance. This method is very useful in describing the unique characteristics of different enterprises, and its analytical advantages are obvious.

Table 1. Key word Classification A

Type	Keyword
Inventory	Movable property pledge financing inventory pledge financing inventory financing inventory financing spot pledge financing warehouse receipt financing
Accounts receivable	Accounts receivable financing, accounts receivable assignment, factoring financing, reverse factoring agreement
Prepaid category	Accounts payable financing, future goods financing, goods pledge financing, confirmed warehouse financing
Financing-related	Supply chain finance, supply chain fund, supply chain investment, supply chain loan, supply chain management, supply chain financial services platform, supply chain finance platform, supply chain finance strategic alliance

3.2.3 Control variables

Following existing literature, this study selects the following control variables to enhance research precision, including firm size (size)、Asset-Liability Ratio (lev)、Equity Multiplier (em)、Return on Total Assets (roa)、Cash Flow Ratio (CashFlow), Shareholding Concentration of Top 10 Shareholders (Top10), Natural Logarithm of Employee Count (Employee2), Board Size (Board), Proportion of Independent Directors (Indep). The specific definitions of all variables are summarized in Table 2.

Table 2. Key Variable Definitions

Variable type	Variable name	Variable symbol	Variable declaration
Dependent variable	Supply chain finance	Small craft fair weather	Total frequency count of “supply chain finance” in corporate annual reports
Independent variable	Total factor productivity	Total fixed production cost	Total factor productivity of companies calculated using the op method
Control variables	Enterprise scale	Size	The natural logarithm of the company’s total assets at year-end
	Debt-to-asset ratio	Lev	Total liabilities to total assets ratio

Table 2. (continued) Key Variable Definitions

Variable type	Variable name	Variable symbol	Variable declaration
	Equity multiplier	Em	Ratio of total assets to total owners' equity
	Return on total assets	Roa	Net profit to total assets ratio
	Cash flow ratio	Cash flow	Net cash flow from operating activities as a percentage of total assets
	Shareholding ratios of the top ten shareholders before equity concentration	Top10	Top ten shareholders' shareholding ratios
	The natural logarithm of the number of employees	Employee2	The natural logarithm of the company's employee count at year-end
	Board size	Board	Take the logarithm of the total number of board members
	Percentage of independent directors	Indep	The ratio of independent directors to the total number of board members

3.3 Model Specifications

To examine the impact of supply chain finance on the total factor productivity of listed manufacturing enterprises, this paper constructs a model:

$$tfp_op_{i,t} = \alpha_0 + \alpha_1 scf_tnwa_{i,t} + \sum cv_{i,t} + \sum year + \sum firm + \varepsilon_{i,t} \quad (1)$$

Among these, the dependent variable is total factor productivity (tfp_op), the independent variable is supply chain finance (scf_tnwa), and cv represents the control variable. Additionally, year and firm denote annual and firm fixed effects, respectively. This study performs cluster-wise standardization of regression coefficients at the firm level.

4. EMPIRICAL FINDINGS AND ANALYSIS

4.1 Descriptive statistics

Table 3 shows the descriptive statistics of each variable. Specifically, the average value of Supply Chain Finance (scf_tnwa) is 1.54, the median value is 1, and the minimum and maximum values are 0 and 22, respectively. The average and median of the overall application level of Supply Chain Finance in the company are 6.61 and 6.5 respectively, the minimum and maximum values are 4.6 and 8.9, and the standard deviation is 2.61. This shows that the overall application level of Supply Chain Finance is relatively low, and there are great differences between different companies. The data distribution is to the right-a few companies have a very high level of Supply Chain Finance, but most companies have a relatively low level. The average of Total Factor Productivity (tfp_op) is 6.61, the median is 6.5, the smallest is 4.6, the largest is 8.9, and the standard deviation is 0.77. This shows that the overall production efficiency of our company is very high, and the efficiency gap between companies is not big, and the development is relatively balanced. This just meets the requirements of China for listed companies. They are all mature enterprises, have passed the test of the market, and their earning power is very stable.

Table 3. Descriptive statistics

Varname	Obs	Mean	Sd	Min	Median	Max
Tfp_op	27205	6.61	0.77	4.6	6.5	8.9
Scf_tnwa	27205	1.54	2.61	0	1	22
Size	27205	22.06	1.16	20	22	26
Lev	27205	0.39	0.18	0.028	0.38	0.87
Em	27205	1.83	0.73	1	1.6	6.90
Roa	27205	0.04	0.06	0.36	0.041	0.25
Cashflow	27205	0.05	0.06	0.17	0.051	0.31
Top10	27205	0.58	0.15	0.22	0.59	0.92
Employee2	27205	7.70	1.13	4.5	7.60	11
Board	27205	2.11	0.19	1.6	2.20	2.7
Indep	27205	0.38	0.05	0.20	0.36	0.57

4.2 Baseline Regression

Table 4 reports the regression results of supply chain finance on firm total factor productivity. Column (1) presents the regression of supply chain finance on firm total factor productivity alone, while columns (2), (3), and (4) sequentially incorporate control variables, year fixed effects, and firm fixed effects. The regression results indicate that regardless of whether control variables, year effects, or firm fixed effects are included, the regression coefficient for scf_tnwa remains statistically significant at the 5% level. This confirms that the development of supply chain finance significantly enhances firm tfp, thereby validating Hypothesis 1. Taking Column (4) as an example, the economic interpretation of the core explanatory variable's coefficient is as follows: for each one-standard-deviation increase or decrease in supply chain finance, tfp increases or decreases by 0.4% on average, explaining 0.16% of the variance in the sample mean.

Table4. Baseline Regression Results

	(1)	(2)	(3)	(4)
	Tfp_op	Tfp_op	Tfp_op	Tfp_op
Scf_tnwa	0.064*** (27.18)	0.009*** (6.21)	0.005*** (3.63)	0.004** (2.51)
Size	-	0.637*** (60.11)	0.572*** (41.93)	0.539*** (32.85)
Lev	-	0.641*** (10.79)	0.677*** (11.45)	0.582*** (9.22)
Em	-	-0.057*** (-4.49)	-0.053*** (-4.23)	-0.045*** (-3.48)
Roa	-	2.223*** (27.18)	2.221*** (28.03)	2.191*** (26.98)
Cashflow	-	0.585*** (13.15)	0.632*** (14.13)	0.624*** (13.62)

Table4. (continued) Baseline Regression Results

	(1)	(2)	(3)	(4)
	Tfp_op	Tfp_op	Tfp_op	Tfp_op
Top10	-	-0.162***	-0.072	-0.058
	-	(-3.76)	(-1.56)	(-1.07)
Employee2	-	-0.278***	-0.251***	-0.261***
	-	(-21.55)	(-17.45)	(-15.40)
Board	-	0.006	0.034	0.023
	-	(0.18)	(1.07)	(0.64)
Indep	-	0.044	-0.001	-0.022
	-	(0.48)	(-0.01)	(-0.23)
Cons	6.408***	-5.539***	-4.674***	-3.850***
	(531.01)	(-27.44)	(-21.16)	(-13.71)
Firm_Effect	No	No	No	Yes
Year_Effect	No	No	Yes	Yes
N	28834	27205	27205	27205
Adj. R ²	-	-	-	0.69

Note: ***, **, * and indicate significance at the 1%, 5%, and 10% levels, respectively. The values in parentheses are t-values. The same applies below.

4.3 Robustness Test

In order to ensure the reliability of the benchmark regression results, this paper conducted a series of robustness tests:

Replace the interpreted variable. Referring to Zhou Lan et al.'s (2022) ^[33] supply chain finance word frequency statistics, we replaced and added some keywords, constructed a revised supply chain finance word frequency data set B(scf_tnwb) (see Table 5 for the specific keyword classification), and then made a regression analysis with the total factor productivity (tfp_op). The results show that the conclusion of this paper is still valid after replacing the explained variables.

Table 5. Key word Classification B

Type	Keyword
Inventory	Movable property pledge financing inventory pledge financing inventory financing stock financing spot pledge financing warehouse receipt financing
Accounts receivable	Accounts receivable financing, factoring financing, reverse factoring, dynamic discounting, accounts receivable securitization
Prepaid category	Accounts payable financing, future goods financing, goods pledge financing, confirmed warehouse financing
Financing-related	Supply chain finance, supply chain financing, supply chain fund, supply chain investment, supply chain loan, supply chain management, trade credit, financial supply chain, supplier financing, buyer financing, supplier-managed inventory, buyer investment, distributor financing, working capital management, logistics financing, unified credit financing, financial value chain, working capital optimization

We change the core explanatory variables into intermediate inputs as proxy variables, and add generalized moment estimation (GMM) in the estimation process, and then calculate the total factor productivity by LP method, taking the first-order lag term of current capital value and proxy variables as instrumental variables. After logarithm of the data, regression analysis shows that supply chain finance still has a significant positive correlation with total factor productivity, and the result is still stable.

Plus control variables. When we add the inventory ratio (inv) and big4 (if it is the audit of the big four accounting firms, it will be marked as 1, otherwise it will be marked as 0) to the regression model, it is found that adding more control variables will not affect the significant positive correlation between supply chain finance and total factor productivity.

Plus high-dimensional fixation effect. This paper also makes a cross-year and cross-industry joint fixed effect regression test on supply chain finance and total factor productivity. As can be seen from Table 6, the results show that supply chain finance is still positively correlated with total factor productivity at a significant level of 5%, which further confirms that supply chain finance can significantly improve the company's total factor productivity.

Table 6. Robustness Test Results

	(1)	(2)	(3)	(4)
	Tfp_op	Tfp_lp	Tfp_op	Tfp_op
Scf_tnwa	-	0.004**	0.004***	0.003**
	-	(2.39)	(2.95)	(2.08)
Scf_tnwb	0.003**	-	-	-
	(2.22)	-	-	-
Size	0.539***	0.509***	0.560***	0.535***
	(32.90)	(30.99)	(32.98)	(34.15)
Lev	0.584***	0.556***	0.440***	0.570***
	(9.24)	(8.71)	(7.25)	(9.14)
Em	-0.045***	-0.045***	-0.041***	-0.045***
	(-3.50)	(-3.42)	(-3.21)	(-3.49)
Roa	2.192***	2.249***	2.081***	2.131***
	(27.00)	(26.95)	(25.19)	(26.25)
Cashflow	0.623***	0.616***	0.736***	0.608***
	(13.60)	(13.01)	(15.05)	(13.60)
Top10	-0.057	-0.040	-0.040	-0.047
	(-1.06)	(-0.73)	(-0.76)	(-0.94)
Employee2	-0.261***	0.087***	-0.274***	-0.261***
	(-15.40)	(5.47)	(-16.22)	(-15.90)
Board	0.022	0.016	0.024	0.030
	(0.63)	(0.42)	(0.70)	(0.87)
Indep	-0.023	-0.026	-0.036	0.006
	(-0.24)	(-0.27)	(-0.41)	(0.07)

Table 6. (continued) Robustness Test Results

	(1)	(2)	(3)	(4)
	Tfp_op	Tfp_lp	Tfp_op	Tfp_op
Inv	-	-	1.110***	-
	-	-	(11.17)	-
Big4	-	-	-0.005	-
	-	-	(-0.21)	-
_Cons	-3.854***	-3.609***	-4.149***	-3.733***
	(-13.75)	(-12.64)	(-13.67)	(-11.73)
Firm_Effect	Yes	Yes	Yes	Yes
Year_Ffect	Yes	Yes	Yes	Yes
N	27205	27205	25862	27205
Adj. R ²	0.69	0.76	0.66	0.70

Tool variable method. Considering that missing variables or reverse causality may lead to endogenous problems, this paper uses instrumental variable method to test and correct these problems. Referring to the methods of Bu Jun and Zhu Yue (2024) and Song Min et al. (2021) ^{[1] [19]}, this study groups the data by industry and city. Calculate the average value (scf_enwa_iv) of “supply chain finance” (scf_tnwa) indicators in each group, and assign the average value to each enterprise in the group. Scf_tnwa_iv also eliminates the industry spillover effect, thus separating the cross-industry and cross-regional common shocks.

The model is as follows:

$$scf_tnwa_{i,t} = \alpha_0 + \alpha_1 scf_tnwa_iv_{i,t} + \sum cv_{i,t} + \sum year + \sum firm + \varepsilon_{i,t} \quad (2)$$

$$tfp_op_{i,t} = \alpha_0 + \alpha_1 scf_tnwa_{i,t} + \sum cv_{i,t} + \sum year + \sum firm + \varepsilon_{i,t} \quad (3)$$

Therefore, we use scf_tnwa_iv as a tool variable to make a two-stage least squares regression analysis. The results are in columns (1) and (2) of Table 7. Column (2) of Table 7 shows that the regression coefficient of scf_tnwa_iv in the first stage is significantly positive at the level of 1%, which shows that the tool variables we selected have strong explanatory power and can well predict the development level of supply chain finance at the enterprise level. Moreover, the p value of 0.002 significantly rejects the hypothesis of “insufficient tool variable identification” and proves the statistical validity of scf_tnwa_iv in the model. In addition, scf_tnwa_iv has no weak identification problem, which makes the tool variables more robust and credible. Column (1) shows that after the second-stage adjustment, the regression coefficient of supply chain finance to total factor productivity at the enterprise level is still significantly positive at the level of 1%, which confirms that our findings are robust.

Table 7. Endogeneity Test Results

	(1)	(2)
	Tfp_op	Scf_tnwa
Scf_tnwa	0.032***	-
	(2.58)	-
Scf_tnwa_iv	-	0.540***
	-	(9.31)

Table 7. (continued) Endogeneity Test Results

	(1)	(2)
	tfp_op	scf_tnwa
Size	0.531*** (31.63)	0.239*** (3.14)
Lev	0.567*** (8.84)	0.428 (1.14)
Em	-0.046*** (-3.52)	0.051 (0.60)
Roa	2.194*** (26.52)	-0.170 (-0.42)
Cashflow	0.626*** (13.44)	-0.133 (-0.50)
Top10	-0.069 (-1.27)	0.279 (0.90)
Employee2	-0.262*** (-15.40)	0.052 (0.74)
Board	0.026 (0.73)	-0.167 (-0.80)
Indep	0.007 (0.07)	-1.038* (-1.84)
_Cons	-3.692*** (-12.64)	-5.683*** (-3.89)
N	27205	27205
Adj. R ²	-	0.24

4.4 Heterogeneity Test

In order to further study the asymmetric influence of supply chain finance on the total factor productivity of different manufacturing enterprises, this study further groups the samples:

Whether an enterprise belongs to high-tech enterprises can refer to Liu Haohua and Yu Zhongfa(2025) ^[13]. Non-high-tech enterprises usually have weak technology accumulation, and mainly rely on external funds to purchase environmental protection equipment or upgrade processes to achieve green transformation. Supply chain finance can reduce their financing costs and directly improve the allocation efficiency of production factors. In contrast, high-tech enterprises have core technological advantages and independent research and development capabilities, and their green transformation depends more on long-term research and development investment and technological breakthroughs, which is a long-term process. The short-term liquidity support provided by supply chain finance is difficult to translate into significant economic benefits or total factor productivity improvement in a short time.

Whether a company is a polluting enterprise will greatly affect the role of supply chain finance in total factor productivity, and there are great differences in different industries. This effect is particularly obvious in polluting industries, but it is not very important in non-polluting industries. According to the research of Mu Qingfen (2024) ^[17], Tian Feng and Yang

Ayang (2023) ^[22], this is mainly due to two reasons: First, polluting enterprises usually face more serious financing difficulties and higher asset specificity, so the improvement of production efficiency brought by scf's capital investment will be more obvious; Second, in the face of more and more stringent environmental regulations, polluting enterprises urgently need funds for green transformation. At this time, scf provides key liquidity support, thus significantly improving their productivity. On the contrary, non-polluting enterprises have relatively smooth financing channels and better asset liquidity, which limits the marginal improvement effect brought by scf.

For the types of enterprise ownership, please refer to the research of Yu Tao (2025) ^[26]. According to the characteristics of enterprises, this paper divides them into state-owned and non-state-owned to study how supply chain finance affects the total factor productivity of enterprises differently. Non-state-owned enterprises face greater market competition pressure, it is more difficult to borrow money, and their organizational structure is relatively flat, making decisions faster. Therefore, the optimization of capital flow and information flow brought by supply chain finance can directly help them strengthen supply chain cooperation, quickly upgrade technology or adjust processes, and quickly turn money into innovation efficiency and operational efficiency. However, state-owned enterprises have low competitive pressure and inherent "implicit guarantee", and the channels for borrowing money are very smooth, but the efficiency of using money is not too high. Therefore, the promotion effect brought by scf to them is limited. Table 8 shows that for non-state-owned enterprises, the regression coefficient of supply chain finance is significantly positive (0.004) at the statistical level of 5%, while the coefficient of state-owned enterprises is much smaller and statistically insignificant (0.001). This shows that non-state-owned enterprises can make better use of supply chain finance to promote the upgrading of TFP.

Table 8. Heterogeneity Test Results

	(1)	(2)	(3)	(4)	(5)	(6)
	Nan Hightech	Hightech	No Pollute	Pollute	No Soe	Soe
Scf_tnwa	0.008*** (2.83)	0.003 (1.46)	0.002 (1.35)	0.007** (2.26)	0.004** (2.57)	0.001 (0.40)
Size	0.543*** (14.45)	0.536*** (29.22)	0.549*** (27.66)	0.488*** (17.91)	0.524*** (25.83)	0.544*** (19.16)
Lev	0.406*** (3.46)	0.622*** (8.61)	0.655*** (9.00)	0.418*** (3.82)	0.541*** (7.52)	0.641*** (4.60)
Em	-0.068*** (-3.09)	-0.039** (-2.57)	-0.038** (-2.50)	-0.067*** (-3.08)	-0.038** (-2.41)	-0.051** (-2.10)
Roa	1.952*** (12.28)	2.223*** (23.80)	2.246*** (22.90)	2.005*** (15.60)	2.117*** (23.16)	2.436*** (14.72)
Cashflow	0.627*** (7.39)	0.628*** (11.82)	0.629*** (11.30)	0.553*** (7.89)	0.670*** (12.30)	0.476*** (5.87)
Top10	0.176 (1.62)	-0.147** (-2.46)	-0.147** (-2.46)	0.116 (1.27)	-0.055 (-0.78)	-0.114 (-1.06)
Employee2	-0.275*** (-9.64)	-0.254*** (-12.58)	-0.259*** (-12.25)	-0.271*** (-11.23)	-0.250*** (-10.92)	-0.279*** (-10.91)
Board	0.093 (1.26)	0.012 (0.31)	0.044 (1.05)	-0.031 (-0.51)	0.011 (0.29)	0.032 (0.44)
Indep	0.112 (0.45)	-0.051 (-0.52)	-0.045 (-0.40)	-0.017 (-0.10)	-0.042 (-0.39)	0.089 (0.52)

Table 8. (continued) Heterogeneity Test Results

	(1)	(2)	(3)	(4)	(5)	(6)
	Nan Hightech	Hightech	No Pollute	Pollute	No Soe	Soe
_Cons	-4.108*** (-6.30)	-3.758*** (-12.07)	-4.114*** (-12.82)	-2.482*** (-5.10)	-3.631*** (-10.86)	-3.702*** (-7.92)
Firm_Effect	Yes	Yes	Yes	Yes	Yes	Yes
Year_Ffect	Yes	Yes	Yes	Yes	Yes	Yes
N	5599	21606	19829	7376	19823	7382
Adj. R ²	0.69	0.68	0.68	0.70	0.66	0.71

5. EXPANDED ANALYSIS

5.1 Mechanism Verification

Previously, we only discussed “supply chain finance-total factor productivity of enterprises”. This study mainly focuses on the benchmark regression and heterogeneity of supply chain finance, but it is not clear how they are related. According to the existing research, we set up an intermediary model to see how supply chain finance affects the total factor productivity(tfp) of enterprises, and use actual data to prove the influence path of supply chain finance on economic entities.

In this paper, two groups of mechanism variables are selected to test the mechanism.

The first group of mechanism variables is Capital Occupation (Cap), which measures the degree of asset occupation. The calculation method is accounts receivable plus inventory and then divided by total assets. As can be seen from Table 9, the regression coefficient of SCF to Cap is significantly negative (-0.010), indicating that the implementation of supply chain finance can effectively reduce the company’s capital occupation. By revitalizing static assets, supply chain finance reduces the unreasonable funds occupied in daily operations. Next, the negative coefficient of Cap to TFP (-0.306) shows that this reduction in asset occupation can minimize resource mismatch, thus significantly promoting the growth of total factor productivity (TFP). This proves that Cap is a key intermediary variable through which SCF influences TFP.

$$cap_{i,t} = \alpha_0 + \alpha_1 scf_tnwa_{i,t} + \sum cv_{i,t} + \sum year + \sum firm + \varepsilon_{i,t} \quad (4)$$

$$tfp_op_{i,t} = \alpha_0 + \alpha_1 cap_{i,t} + \sum cv_{i,t} + \sum year + \sum firm + \varepsilon_{i,t} \quad (5)$$

The second group includes inventory turnover (TTM). According to the research of Lu Liqi et al. (2025) and Yang Ruda et al. (2023)^{[11][25]}, and because inventory management is a core part of the company’s operation, we chose the inventory turnover rate to represent the management’s operational capability. Efficient inventory turnover can not only reduce the capital cost on inventory, but also reflect the company’s super management ability in production planning and supply chain coordination; These capabilities are usually positively correlated with higher total factor productivity.

$$ttm_{i,t} = \alpha_0 + \alpha_1 scf_tnwa_{i,t} + \sum cv_{i,t} + \sum year + \sum firm + \varepsilon_{i,t} \quad (6)$$

$$tfp_op_{i,t} = \alpha_0 + \alpha_1 ttm_{i,t} + \sum cv_{i,t} + \sum year + \sum firm + \varepsilon_{i,t} \quad (7)$$

Table 9. Mechanism Analysis

	(1)	(2)	(3)	(4)
	Cap	Tfp_op	Ttm	Tfp_op
Scf_tnwa	-0.010*** (-3.12)	-	0.050*** (2.67)	-

Table 9. (continued) Mechanism Analysis

	(1) Cap	(2) Tfp_op	(3) Ttm	(4) Tfp_op
Cap	-	-0.306*** (-49.58)	-	-
Ttm	-	-	-	0.046*** (16.38)
Size	0.775*** (18.71)	0.769*** (70.80)	0.116 (1.03)	0.534*** (31.92)
Lev	-1.576*** (-9.20)	0.118*** (2.74)	-0.287 (-0.67)	0.569*** (9.47)
Em	0.127*** (3.35)	-0.006 (-0.64)	-0.005 (-0.05)	-0.044*** (-3.41)
Roa	-5.501*** (-23.46)	0.650*** (14.54)	4.445*** (9.61)	1.984*** (25.19)
Cashflow	-1.325*** (-11.54)	0.193*** (7.31)	2.169*** (6.59)	0.498*** (11.64)
Top10	0.075 (0.70)	-0.030 (-0.92)	0.585 (1.31)	-0.091* (-1.77)
Employee2	-0.660*** (-15.47)	-0.459*** (-45.44)	-0.205* (-1.88)	-0.245*** (-14.32)
Board	-0.087 (-1.12)	-0.015 (-0.73)	-0.032 (-0.14)	0.038 (1.13)
Indep	-0.054 (-0.28)	-0.050 (-0.80)	0.166 (0.23)	0.031 (0.34)
_Cons	-8.414*** (-12.27)	-6.314*** (-35.74)	2.706 (1.30)	-3.930*** (-13.81)
Firm_Effect	Yes	Yes	Yes	Yes
Year_Ffect	Yes	Yes	Yes	Yes
N	30346	27205	28644	25706
Adj. R ²	0.25	0.89	0.03	0.70

5.2 Moderation Effect Test

Scf improves tfp by improving the company's financial structure, such as reducing debt ratios and increasing liquidity, and operating expense ratios directly affects the efficiency of this path. According to Zhou et al. (2023) ^[34], Li and Wang (2024) ^[8] found that companies with low expense ratios can quickly turn the financial optimization brought by scf into actual production inputs. After obtaining scf support, these companies will quickly spend money on production areas such as R&D and equipment upgrading, instead of filling inefficient expenses, so as to obtain more obvious tfp improvement.

Conversely, companies with high expense ratios may use money to pay high costs, thus weakening the positive impact of financial restructuring on tfp. The specific regulatory test results are given in Table 10.

Table 10. Moderation Effect Test Results

	(1)
	Tfp_op
Scf_tnwa	0.009*** (3.72)
Ofee	-1.754*** (-14.50)
C.Scf_Tnwa#C. Ofee	-0.038*** (-3.17)
Size	0.513*** (32.15)
Lev	0.473*** (7.89)
Em	-0.041*** (-3.34)

6. CONCLUSIONS AND POLICY RECOMMENDATIONS

Through practical research, this paper draws the following conclusions.

First, in general, Supply Chain Finance can significantly improve the total factor productivity of listed manufacturing enterprises. This conclusion still holds after a series of robustness tests.

Second, the promotion of supply chain finance to total factor productivity is different in different enterprises. Specifically, its promotion effect on non-high-tech enterprises, polluting enterprises and non-state-owned enterprises is more obvious. On the contrary, in high-tech enterprises, non-polluting enterprises and state-owned enterprises, this effect is not so obvious. This shows that the promotion of supply chain finance to total factor productivity depends on the specific characteristics of enterprises themselves.

Thirdly, the mechanism test shows that supply chain finance can improve the total factor productivity at the micro level, mainly by improving the working capital efficiency. Specifically, it can improve the total factor productivity by reducing the occupation of working capital (alleviating asset solidification) and optimizing the inventory turnover rate.

According to the above actual research results, we put forward the following policy suggestions.

At the enterprise level, we should promote the shift from passive financing to active empowerment. First of all, we should establish a dual-engine strategy of “industry+finance”. Manufacturing enterprises should promote supply chain finance to a strategic level and create a dual-engine model of “industry+finance”. Core enterprises should play the role of chain owners, and transform their credit advantages into the financing ability of the whole chain by establishing an industrial Internet platform or deepening cooperation with financial institutions. Secondly, implement precise financial strategies according to the characteristics of enterprises. For non-high-tech and traditional manufacturing enterprises: introduce medium and long-term supply chain financial products, and accurately guide funds to intelligent upgrading and digital transformation projects, thus making up for technical shortcomings and improving total factor productivity. High-tech and emerging manufacturing enterprises: Due to the limited promotion of supply chain finance, we should explore a new “R&D+Finance” model. Finally, strengthen the refined management of liquidity. Because supply chain finance mainly plays a role by improving the efficiency of capital turnover, enterprises must establish a dynamic inventory and cash flow

management system. Use big data analysis to monitor the changes of asset turnover and inventory turnover in real time, and optimize the rhythm of the whole chain of procurement, production and sales. At the same time, strictly control the operating expenses-especially the hard-to-compress expenses such as sales and management costs-to ensure that the capital dividends released by supply chain finance can be transformed into the improvement of production efficiency to the maximum extent.

At the government level, we should shift from policy support to ecosystem construction. First, implement differentiated support policies with classified guidance. The government should abandon the “one size fits all” subsidy mode and take targeted measures according to the characteristics of enterprises. We must give priority to supporting non-high-tech, high-pollution (requiring green transformation) and non-state-owned manufacturing enterprises, and set up special supply chain financial guidance funds. Guide financial institutions to increase support for such enterprises, help them achieve technological upgrading and green transformation, and narrow the productivity gap with high-tech enterprises. At the same time, optimize the regulatory environment: for state-owned enterprises and high-tech enterprises, the government should focus on optimizing the regulatory environment and encourage them to play a central role in the industrial chain. Through tax incentives and other policies, core enterprises are encouraged to provide credit to upstream and downstream small and medium-sized enterprises to promote the coordinated development of the entire industrial chain. Finally, we should establish a mechanism that can prevent risks and optimize costs for a long time. It is necessary to build a risk monitoring system that can cover the whole industrial chain, especially the supply chains of key raw materials and core parts, and to monitor them in real time to prevent the whole system from going wrong because too much money is used. In addition, measures such as reducing taxes and fees and optimizing the business environment should help companies reduce their operating expense ratio. This will ensure that the money of supply chain finance is really used to improve production efficiency, rather than being consumed by high operating costs. At the same time, it is necessary to strengthen the supervision of the supply chain finance market, prevent money from being “divorced from reality” and ensure that financial resources can accurately flow to the key links of the real economy.

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