

The Impact of Supply Chain Finance on Supply Chain' Operational Efficiency

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Abstract: This study examines the impact of supply chain finance (SCF) on supply chain operational efficiency using panel data from Chinese listed companies between 2014 and 2022. The findings show that SCF significantly improves operational efficiency. Mechanism analysis reveals that faster fund turnover and better information flow are the main ways SCF enhances efficiency. Heterogeneity analysis further shows that SCF has a stronger effect in environments with higher supply chain uncertainty and greater concentration. These results offer a theoretical foundation for using SCF to improve supply chain efficiency in China.

Keywords: Supply Chain Finance (SCF); Operational Efficiency; supply chains; Fund Flow; Information Flow

I. INTRODUCTION

Small and medium-sized enterprises (SMEs) are vital to economic growth but face chronic financing constraints due to limited scale and capital. In a volatile global economy, these constraints manifest as unstable cash flows and restricted credit access, posing serious risks to sustainability. Supply Chain Finance (SCF) offers an effective remedy by leveraging the credit strength of core enterprises to provide SMEs with faster, lower-cost financing, while improving information transmission and mitigating risks from information asymmetry. In doing so, SCF enhances overall supply chain efficiency. Yet adoption in China remains limited, leaving many SMEs excluded from its benefits despite their crucial role in economic and social development. Exploring SCF's impact on supply chain efficiency and mechanisms is therefore essential for supporting SME sustainability, optimizing supply chain operations, and fostering broader economic resilience.

II. LITERATURE REVIEW

The capital management objective of "delayed payments and accelerated receipts" exposes suppliers within supply chains to significant financial risks. Information asymmetry between SMEs and banks creates substantial financing difficulties, hindering capital resolution^[1]. SCF, deeply integrated with supply chains, provides financing solutions for SMEs based on authentic intra-chain transactions and core enterprises' creditworthiness. SCF substantially advances supply chain development^[2]. From a supply chain perspective, it accelerates fund flow formation and alleviates financial pressure on chain enterprises. Functioning as an information platform, SCF connects entities across supply chain tiers, enabling cross-chain information transmission. For core enterprises, it enhances capital market image and strengthens supply chain control^[3].

Operational efficiency serves as a critical metric for assessing overall corporate performance, influenced by multifaceted factors. As a vital bridge connecting finance and supply chains, SCF's impact on operational efficiency warrants significant attention. Enhancing core enterprises' operational efficiency requires close collaboration and efficient communication among supply chain participants. Yet, factors

like information asymmetry and the bullwhip effect often impede effective coordination, with erroneous information transmission severely disrupting normal operations^[4]. By introducing financial institutions' credit support and core enterprises' guarantees, SCF provides accessible, low-cost financing channels, thereby fostering inter-firm collaboration. Concurrently, it optimizes fund and information flows^[5], elevating overall supply chain efficiency.

III. THEORETICAL ANALYSIS AND RESEARCH HYPOTHESES

(A) Relationship Between SCF and Core Enterprises' Operational Efficiency

A supply chain is a loosely connected network where firms operate independently, often facing inefficiencies from information asymmetry and conflicting objectives. Core enterprises impose standardized contracts to secure their own stability but increase upstream firms' financial risks, while payment uncertainty further aggravates suppliers' funding constraints. SCF addresses these issues by introducing financial institutions, accelerating capital circulation, easing financing pressures, and improving information flows.

SCF boosts efficiency by optimizing capital flows and leveraging core firms' credit strength. Tools like reverse factoring allow suppliers to access cheaper financing while giving banks greater visibility into operations, reducing information asymmetry and monitoring costs. This alleviates SMEs' financing constraints, improves repayment capacity, and strengthens production. For downstream firms, SCF restructures accounts payable into formal loans, reducing repayment burdens and stabilizing transactions, thereby fostering liquidity, efficiency, and trust across the chain.

SCF also mitigates risks from the Bullwhip Effect, where distorted demand signals inflate upstream inventories and costs. By fostering contractual trust among core firms, suppliers, and financial institutions, SCF promotes accurate, real-time data sharing. Centralized information nodes and fintech tools like big data and blockchain further enhance transmission efficiency, reduce demand distortion, and strengthen operational stability.

Thus, Hypothesis H1: SCF enhances core enterprises' operational efficiency.

Hypothesis H2a: SCF improves supply chains' operational efficiency through enhanced capital flow.

Hypothesis H2b: Supply chain finance improves supply chains' operational efficiency by suppressing the Bullwhip Effect.

IV. RESEARCH DESIGN

(A) Sample Selection

The initial sample comprises listed firms from 2014 to 2022, processed as follows: (1) Exclude financial and insurance sector firms; (2) Remove companies labeled ST/PT; (3)

Eliminate samples with missing or anomalous data. The final dataset contains 12,326 valid observations. To mitigate extreme value effects, all continuous variables were winsorized at the 1% and 99% percentiles. Data sources: CSMAR and WIND databases. Statistical tool: STATA 16

(B) Paragraph Translation: Variable Definitions

Dependent Variable: Inventory Days (sce2), adopted from Feng^[5], serves as the metric for core enterprises' operational efficiency. It is calculated as $\ln(365 / \text{Inventory Turnover Ratio})$, where $\text{Inventory Turnover Ratio} = \text{Cost of Goods Sold (COGS)} / \text{Average Net Inventory Balance}$.

Independent Variable: Supply Chain Finance (sfr) is quantified following Caniato et al.^[6] through keyword frequency analysis. The raw frequency data undergoes logarithmic transformation $\ln(1 + \text{SCF Keyword Count})$, with keyword specifications provided in Table 1.

Control variables: Drawing on studies by Caniato et al.^[6], we select the following control variables: firm size (size), cash holdings (cash), corporate growth (growth), asset-liability ratio (lev), return on assets (roa), proportion of independent directors (idr), administrative expense ratio (aer), tangible asset ratio (tar), management shareholding ratio (mhd), board size (bs), executive compensation (ms1), and firm age (age2). Detailed variable definitions are provided in Table 2.

Table 2 Variable Names and Definitions

Variable Name	Symbol	Definition
Inventory Days	sce2	$\ln(365 / \text{Inventory Turnover Ratio})$
Supply Chain Finance	sfr	$\ln(1 + \text{Frequency of SCF-related keywords in annual reports})$
Firm Size	size	$\ln(\text{Total Assets})$
Cash Holdings	cash	Cash & Cash Equivalents / Total Assets
Corporate Growth	growth	$(\text{Current Year Revenue} - \text{Prior Year Revenue}) / \text{Prior Year Revenue}$
Asset-Liability Ratio	lev	Total Liabilities / Total Assets
Return on Assets	roa	$(\text{Total Profit} + \text{Financial Expenses}) / \text{Total Assets}$
Independent Director Ratio	idr	Number of Independent Directors / Board Size
Administrative Expense Ratio	aer	Administrative Expenses / Operating Revenue
Tangible Asset Ratio	tar	Total Tangible Assets / Total Assets
Management Shareholding	mhd	Shares Held by Directors & Supervisors / Total Shares Outstanding
Board Size	bs	$\ln(\text{Number of Board Members})$
Executive Compensation	ms1	$\ln(1 + \text{Executive Total Compensation})$
Firm Age	age2	$\ln(1 + \text{Current Year} - \text{Establishment Year})$

(C) Model Specification

To test the research hypotheses, we develop the following empirical model:

$$sce2_{i,t} = \beta_0 + \beta_1 sfr_{i,t} + \beta_2 Controls_{i,t} + \sum Year + \sum Ind + \varepsilon_{i,t} \quad (1)$$

Inventory turnover days (sce2_{i,t}) represents the inventory turnover days for firm i in year t. Supply chain finance index (sfr_{i,t}) denotes the supply chain finance index for firm i in year

t. Control variables (controls_{i,t}) are the firm-level controls for firm i in year t. $\sum year$ represents year fixed effects (dummy variables), and $\sum ind$ represents industry fixed effects (dummy variables). The coefficient β_1 measures the impact of supply chain finance on inventory turnover days: If β_1 is significantly negative, this indicates that supply chain finance reduces inventory turnover days, thereby improving operational efficiency. Conversely, if β_1 is statistically insignificant, this demonstrates that supply chain finance has no measurable effect on inventory turnover days or operational efficiency.

V. EMPIRICAL TESTS AND RESULTS ANALYSIS

(A) Descriptive Statistics

Table 3 presents descriptive statistics for the main variables. The minimum value of inventory turnover days (sce2) is 0.96 and the maximum is 6.61, indicating significant disparities in supply chain operational efficiency among Chinese enterprises. The median value of supply chain finance (sfr) is 0, revealing that over half of the enterprises do not utilize supply chain finance services. This suggests substantial growth potential in China's supply chain finance market and highlights the currently limited service coverage of supply chain finance as an inclusive financial service.

Table 3 Descriptive Statistics of Main Variables

Variable	Observations	Mean	Min	Max	Std. Dev.	Median
sce2	12326	4.59	0.96	6.61	0.91	4.65
sfr	12326	0.45	0	3.05	0.70	0
size	12326	21.93	20.04	25.84	1.07	21.79
cash	12326	0.18	0.03	0.58	0.12	0.153
growth	12326	1.20	0.63	2.8	0.33	1.145
lev	12326	3.90	1.29	17.52	2.93	2.88
roa	12326	0.07	0.003	0.25	0.05	0.06
idr	12326	37.87	33.33	57.14	5.25	36.36
aer	12326	0.07	0.002	1.31	0.05	0.07
tar	12326	0.92	0.57	0.99	0.08	0.95
mhd	12326	23.04	0	70.7	21.32	19.03
bs	12326	2.07	1.61	2.49	0.18	2.20
ms1	12326	15.07	13.41	17.10	0.72	15.04
ppc1	12326	11.30	8.23	13.86	1.092	11.37
age2	12326	2.89	1.61	4.17	0.3	2.89

(B) Baseline Regression Analysis

To test Hypothesis H1, we performed ordinary least squares (OLS) regression on Model (1). The results are presented in Table 4. Column (1) shows that without control variables, the coefficient of inventory turnover days (sce2) is significantly negative at the 1% level. After adding control variables, Column (2) shows the coefficient of supply chain finance (sfr) is -0.084, significant at the 1% level. When controlling for year and industry effects, Column (3) indicates the coefficient of supply chain finance remains significantly negative at -0.098 (1% significance level). These results demonstrate that higher supply chain finance indices correspond to reduced inventory turnover days, signifying improved supply chain efficiency. The robustness of these findings across specifications – including added control variables and fixed effects – confirms Hypothesis H1.

Table 4: Baseline Regression Results

Variable	(1) sce2	(2) sce2	(3) sce2
sfr	-0.148***	-0.084***	-0.098***

	(-6.035)	(-3.454)	(-4.670)
<i>size</i>		-0.003	0.021
		(-0.123)	(0.983)
<i>Control</i>	Yes	Yes	Yes
<i>Year</i>	No	No	Yes
<i>Ind</i>	No	No	Yes
<i>Constant</i>	4.658***	3.123***	2.414***
	(213.771)	(4.482)	(3.677)
<i>N</i>	12,326	12,326	12,326
<i>R</i> ²	0.013	0.098	0.275

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

(C) Endogeneity and Robustness Tests

1. Heckman Two-Stage Model

To address potential sample selection bias in SCF adoption, we employ a Heckman two-stage correction. The Inverse Mills Ratio is significant, confirming selection bias. Crucially, after adjustment, the coefficient on *sfr* remains negative and highly significant, showing that SCF consistently reduces inventory days. This robustness underscores SCF's role in enhancing operational efficiency through accelerated inventory turnover in core enterprises.

2. Propensity Score Matching (PSM) Analysis

To address confounding from firm heterogeneity, we apply Propensity Score Matching (PSM). Post-matching regressions show that the SCF coefficient remains negative and significant at the 1% level, confirming its inverse relationship with inventory days. Covariate balance is strong, and the ATT is significantly negative, consistent with baseline results. These findings provide robust support for Hypothesis H1, underscoring SCF's efficiency gains through reduced inventory turnover days.

Table 5: Propensity Score Matching Balance Diagnostics

1:1 Nearest-Neighbor Matching					
Variable	Sample	Treated	Control	Difference	t-value
	Unmatched	4.505	4.642	-0.137	-8.10
<i>sce2</i>	ATT	4.520	4.580	-0.060	-3.37
	ATU	4.622	4.506	-0.116	
	ATE			-0.089	

Table 6 PSM and Heckman Two-Stage Test Results

Variable	PSM <i>sce2</i>	Heckman <i>sce2</i>
<i>imr</i>		-6.213*** (-5.766)
<i>sfr</i>	-0.111*** (-4.838)	-0.090*** (-4.313)
<i>Control</i>	Yes	Yes
<i>Year</i>	Yes	Yes
<i>Ind</i>	Yes	Yes
<i>Constant</i>	2.084*** (2.945)	22.985*** (6.363)
Observations	7,236	12,326
<i>R</i> ²	0.289	0.287

4. Replacement of Dependent Variable

We test robustness by replacing inventory days with inventory turnover ratio (*itr*), defined as cost of goods sold

over ending inventory ^[7]. Results (Table 8) show SCF positively affects *itr*, confirming SCF accelerates inventory conversion, consistent with baseline findings.

5. Lagged Independent Variable Specification

To address reverse causality, we lag SCF by one period. Results (Table 8, right) show its negative, significant effect on *sce2* persists, confirming SCF precedes efficiency gains and reinforcing causal inference.

Table 8 Robustness Check Regression Results

Variables	Replacing Dependent Variable <i>itr</i>	One-Period Lag <i>sce2</i>
<i>sfr</i>	0.691* (1.674)	
<i>L.sfr</i>		-0.099*** (-4.166)
<i>Control</i>	Yes	Yes
<i>Year</i>	Yes	Yes
<i>Ind</i>	Yes	Yes
<i>Constant</i>	11.912 (1.130)	2.431*** (3.304)
<i>N</i>	12,314	8,968
<i>R</i> ²	0.236	0.279

(D) Heterogeneity Analysis

1. Differential Impact of Supply Chain Uncertainty

Supply chains, as flexible non-contractual networks, face efficiency losses from member turnover and unstable relationships. SCF mitigates these risks by guaranteeing receivables, improving cash and information flows, and fostering trust—especially valuable in volatile chains. Following Shen et al. ^[8], we measure supply chain uncertainty (*scu*) via the standard deviation of top-five supplier/customer transactions. Splitting samples by annual *scu* median, regressions (Table 9) show SCF significantly reduces inventory days (*sce2*) in both groups, with stronger effects under high uncertainty than low. A positive, significant interaction term confirms SCF's greater efficacy in volatile supply chains.

Table 9: Regression Results for Supply Chain Uncertainty Heterogeneity

Variables	Low Uncertainty	High Uncertainty	Coeff. Diff. Test
<i>sfr</i>	-0.085*** (-3.288)	-0.098*** (-3.981)	-0.135*** (-5.659)
<i>discusfr</i>			0.123*** (4.802)
<i>Control</i>	Yes	Yes	Yes
<i>Year</i>	Yes	Yes	Yes
<i>Ind</i>	Yes	Yes	Yes
<i>Constant</i>	1.141 (1.283)	1.921** (2.548)	2.279*** (3.465)
Observations	4,586	7,740	12,326
<i>R</i> ²	0.254	0.291	0.277

2. Supply Chain Structural Heterogeneity

Supply chain finance (SCF) leverages soft information—such as long-term creditworthiness—formed through stable partnerships, making it more effective in concentrated supply chains. In high-concentration networks, core firms access richer information and offer stronger support, while fragmentation weakens these effects. Measuring supply chain concentration (SCC) as the share of core firms' key partner business, regressions show SCF reduces inventory days (*sce2*)

in both groups, with significantly stronger effects in high-SCC chains. This confirms SCF's role as a relational governance mechanism whose benefits grow with supply chain cohesion.

Table 10: Regression Results for Supply Chain Structure Heterogeneity Analysis

Variables	Low-SCC group	High-SCC group	Coeff. Diff. Test
<i>sfr</i>	-0.091*** (-3.380)	-0.107*** (-3.913)	-0.132*** (-4.945)
<i>Dscs*sfr</i>			0.056* (1.900)
<i>Control</i>	Yes	Yes	Yes
Constant	2.349*** (2.866)	2.623*** (2.832)	2.462*** (3.737)
N	6,615	5,711	12,326
<i>R</i> ²	0.271	0.307	0.275

(E) Mechanism Test Analysis

1. Optimizing Intra-Chain Capital Flow

SCF improves capital mobility by transforming accounts payable into institutional loans, ensuring timely supplier repayment while reinforcing trust and stability, thereby enhancing supply chain efficiency^[9].

$$apr_{i,t} = \alpha_0 + \alpha_1 sfr_{i,t} + \alpha_2 Controls_{i,t} + \sum Year + \sum Ind + \varepsilon_{i,t} (2)$$

$$sce2_{i,t} = \gamma_0 + \gamma_1 apr_{i,t} + \gamma_3 sfr_{i,t} + \gamma_4 Controls_{i,t} + \sum Year + \sum Ind + \varepsilon_{i,t} (3)$$

Accounts Payable Ratio (*apri,t*), defined as accounts payable relative to operating costs for firm *i* in year *t*, is included with the same controls as Model (1). Mediation results (Table 12) show that SCF (*sfr*) significantly reduces *apr*, reflecting stronger repayment willingness. Meanwhile, *sfr* negatively affects inventory days, while *apr* positively relates to *sce2*. These results indicate that higher accounts payable hinder efficiency, and SCF enhances it by promoting earlier settlement of payables.

Table 12: Regression Results for SCF's Capital Flow Improvement Mechanism

Variables	(1) <i>apr</i>	(2) <i>sce2</i>
<i>apr</i>		1.064*** (11.112)
<i>sfr</i>	-0.006* (-1.672)	-0.092*** (-4.531)
<i>Control</i>	Yes	Yes
<i>Year</i>	Yes	Yes
<i>Ind</i>	Yes	Yes
Constant	-0.530*** (-4.287)	2.971*** (4.638)
Observations	12,309	12,309
<i>R</i> ²	0.270	0.314

2. Optimizing Intra-Chain Information Flow

Demand-side fluctuations amplify through supply chains, creating the bullwhip effect that undermines efficiency. SCF alleviates this problem by restructuring information flows: financial institutions act as centralized hubs directly connected to all nodes, shortening transmission chains, reducing distortion, and enabling real-time data sharing. In doing so, SCF effectively suppresses the bullwhip effect and enhances supply chain efficiency^[10].

$$fsd_w_{i,t} = \alpha_0 + \alpha_1 sfr_{i,t} + \alpha_2 Controls_{i,t} + \sum Year + \sum Ind + \varepsilon_{i,t} (4)$$

$$sce2_{i,t} = \gamma_0 + \gamma_1 fsd_w_{i,t} + \gamma_3 sfr_{i,t} + \gamma_4 Controls_{i,t} + \sum Year + \sum Ind + \varepsilon_{i,t} (5)$$

Following Cachon's [4] approach, the bullwhip effect (*fsd_w*) is measured by supply-demand coordination costs. Volatility is captured by the standard deviation $\sigma(\cdot)$, where production is proxied as operating costs (Cost) plus year-end inventory (Inv), and demand by Cost. Larger deviations indicate weaker supply-demand alignment and stronger bullwhip effects. Using controls from Model (1), Table 13 shows that SCF (*sfr*) significantly reduces *fsd_w*, confirming improved supply-demand matching. Moreover, *fsd_w* significantly increases inventory days, while *sfr* directly reduces them. These results indicate that SCF enhances efficiency both directly and indirectly by mitigating demand distortions.

Table 13 Regression Results for Bullwhip Effect Empirical Examination

Variables	(1) <i>fsd_w</i>	(2) <i>sce2</i>
<i>fsd_w</i>		0.074*** (6.681)
<i>sfr</i>	-0.025* (-1.812)	-0.101*** (-4.830)
<i>Control</i>	Yes	Yes
<i>Year</i>	Yes	Yes
<i>Ind</i>	Yes	Yes
Constant	1.389*** (3.262)	2.267*** (3.375)
N	12,105	12,105
<i>R</i> ²	0.024	0.279

CONCLUSIONS AND IMPLICATIONS

This study examines the impact of supply chain finance (SCF) on core enterprises in China, its underlying mechanisms, and heterogeneous effects under varying industry conditions, using regression analysis on listed firms from 2014–2022. The findings are threefold. First, SCF significantly enhances operational efficiency by leveraging its financial mechanisms to stabilize and strengthen supply chains, contributing both to empirical research and practical solutions for inefficiency. Second, SCF optimizes capital and information flows simultaneously: it accelerates intra-chain capital circulation to ease funding pressures and improves information transmission to reduce asymmetry and the bullwhip effect, thereby boosting responsiveness and decision accuracy. Third, heterogeneity tests show that SCF's efficiency gains are stronger in highly competitive industries, concentrated supply chains, and uncertain environments, offering valuable insights for policymakers and enterprises in diverse market contexts.

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