Quantitative Analysis and Risk Management of Core Enterprise Credit Spillover Effects in Supply Chain Finance

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Abstract: This study focuses on the credit spillover effects of core enterprises in supply chain finance, addressing the insufficient quantification in existing research. Using a sample of 128 core enterprises and 846 upstream and downstream associated enterprises listed on China's A-share market from 2018 to 2023, the paper studies and constructs a panel data regression model to explore the influence of core enterprise credit status on the financing of upstream and downstream enterprises and industry differences, identify risks and put forward control strategies.. Empirical results reveal that the credit status of core enterprises negatively correlates with financing costs for upstream and downstream firms while positively correlating with financing accessibility. Furthermore, the credit spillover effect is stronger in the electronics and information industry than in traditional agriculture. The study identifies three categories of risk—credit, market, and operational—and proposes a multi-stakeholder collaborative risk management framework. These findings contribute to refining supply chain finance theory and ensuring the stable operation of related business activities.

1. Introduction

In the era of rapid economic globalization and digitalization, supply chain finance has emerged as a pivotal force driving industrial development and addressing financing challenges for small and medium-sized enterprises. According to the Global Supply Chain Promotion Report 2024 released by the China Council for the Promotion of International Trade at the second Supply Chain Expo, China's supply chain finance industry reached approximately 41.3 trillion yuan in 2023, marking an 11.9% year-on-year increase. Over the past five years, it has achieved a remarkable compound annual growth rate of 20.88%, demonstrating exceptionally robust development momentum. Within the supply chain finance ecosystem, core enterprises play a pivotal role. Leveraging their dominant position in the supply chain, robust financial strength, solid commercial credibility, and stable operational performance, these entities serve as the cornerstone of credit for the entire supply chain[1]. This credit advantage extends beyond the core enterprise itself, generating spillover effects through upstream and downstream relationships within the supply chain. Credit spillover enables small and medium-sized enterprises (SMEs) to leverage the core enterprise's credit endorsement, thereby gaining greater trust from financial institutions and accessing more favorable financing terms. This reduces financing costs, enhances capital liquidity, and ultimately promotes coordinated development and competitiveness across the entire supply chain.

However, current academic research on the credit spillover effect of core enterprises in supply chain finance still has certain limitations. While existing studies acknowledge the existence of credit spillover effects and their importance to supply chain finance, they remain insufficient in quantitative analysis. There is a lack of systematic, in-depth, and precise quantitative models and empirical research, making it difficult to accurately measure the extent and scope of credit spillover effects. This, to some extent, constrains the effective identification and management of risks in supply chain finance. In practice, as the scale of supply chain finance operations continues to expand and business models grow increasingly complex, the credit spillover effect, while yielding positive impacts, also conceals numerous risks. Should the creditworthiness of the core enterprise

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deteriorate, its credit risk can rapidly propagate through the supply chain to upstream and downstream enterprises, triggering chain reactions. This could potentially destabilize the entire supply chain finance system, inflicting substantial losses on financial institutions and enterprises within the supply chain[2]. Therefore, conducting in-depth quantitative analysis and risk management research on the credit spillover effect of core enterprises in supply chain finance holds profound significance. This research not only contributes to refining the theoretical framework of supply chain finance but also ensures the stable operation of supply chain finance operations in practice.

2. Research Hypothesis

The stronger the credit standing of a core enterprise, the more pronounced its credit spillover effect. During the financing process for upstream and downstream enterprises, financial institutions will reduce their risk premium requirements for these entities due to the credit endorsement from the core enterprise, thereby lowering their financing costs[3]. In supply chain finance scenarios, metrics such as the core enterprise's credit rating and debt-servicing capacity directly reflect its creditworthiness. A core enterprise with excellent credit status implies lower performance risk and stronger capacity to provide joint liability guarantees for upstream and downstream enterprises in case of default. When pricing risk, financial institutions incorporate the core enterprise's creditworthiness into their assessment systems. When the core enterprise has strong credit, financial institutions perceive a reduced default risk for upstream and downstream enterprises due to the core enterprise's credit endorsement. Consequently, they reduce the risk premium component, leading to lower financing costs such as interest rates and fees for these enterprises. Based on the above theoretical mechanism analysis, the following research hypothesis is proposed:

H1: The creditworthiness of the core enterprise is negatively correlated with the financing costs of upstream and downstream enterprises.

A creditworthy core enterprise enhances financial institutions' trust in upstream and downstream enterprises, making institutions more willing to provide financing and increasing the likelihood of these enterprises securing funds. The stronger the core enterprise's credit standing, the greater its influence and bargaining power within the supply chain, enabling more effective oversight of the operational performance and fulfillment capabilities of upstream and downstream enterprises[4]. When backed by a core enterprise with excellent credit standing, financial institutions tend to apply relatively relaxed credit approval standards and streamlined processes for upstream and downstream enterprises, thereby increasing their financing opportunities. For instance, in accounts receivable financing models, the core enterprise's confirmation of receivables significantly enhances financing feasibility, with receivables confirmed by creditworthy core enterprises more readily accepted by financial institutions. Based on the above theoretical mechanism analysis, the following research hypothesis is proposed:

H2: The creditworthiness of the core enterprise is positively correlated with the financing accessibility of upstream and downstream enterprises.

Supply chains across different industries exhibit distinct characteristics, such as the intensity of industry competition, market stability, and the closeness of relationships between core enterprises and their upstream and downstream partners. These factors influence the effectiveness of credit spillover effects from core enterprises. In the electronics and information technology sector, strong technological interdependencies exist between upstream and downstream enterprises. Core enterprises exert significant control and influence over their partners, often forming long-term, stable strategic alliances. Consequently, the creditworthiness of core enterprises can be more effectively transmitted to upstream and downstream partners, potentially resulting in more pronounced credit spillover effects. In contrast, traditional agricultural supply chains feature loose industrial linkages, with collaborations often based on short-term transactions. Core enterprises have weaker constraints over upstream and downstream players, and supply chain stability is relatively low due to factors like natural conditions and market price volatility. Consequently, the credit spillover effect from core enterprises may be relatively weaker[5]. Furthermore, differences

in asset specificity and capital turnover cycles across industries can lead to variations in financial institutions' assessments of credit spillover effects, thereby influencing their actual outcomes. Based on the above theoretical analysis, the following research hypothesis is proposed:

H3: Under the supply chain finance model, the credit spillover effect varies across supply chains in different industries.

3. Research Design

3.1 Sample Selection and Model Construction

This study selects core enterprises and their upstream and downstream affiliated companies among Chinese A-share listed companies from 2018 to 2023 as research samples. A-share listed companies possess relatively standardized financial disclosure systems, providing comprehensive and reliable financial data and operational information that facilitate variable measurement and empirical analysis. As core enterprises within supply chains, listed companies exhibit relatively transparent credit conditions and exert credit spillover effects across broad scopes, ensuring strong representativeness.

During sample selection, the following principles were adhered to: 1. Financial listed companies were excluded, as their business models and operational characteristics differ significantly from non-financial enterprises, and their credit spillover transmission mechanisms vary; 2. Listed companies with abnormal financial conditions, such as those designated as ST or *ST, were excluded to prevent extreme values from influencing empirical results; 3. Excluded samples with severe data gaps to ensure data integrity and validity. Ultimately, 128 core enterprises and their corresponding 846 upstream and downstream associated enterprises were selected as the research sample.

The research data primarily originated from the following sources: 1. Financial and corporate governance data for core enterprises and their upstream/downstream enterprises were sourced from the Guotai An database (CSMAR) and Wind database; 2. Credit rating data for core enterprises was sourced from reports issued by authoritative credit rating agencies such as United Credit Rating and Dagong Global Credit Rating; 3. Supply chain relationship data was derived from “Top Five Suppliers” and “Top Five Customers” disclosures in listed companies' annual reports, with manual compilation establishing the correspondence between core enterprises and their upstream/downstream counterparts; 4. Industry classification data was based on the “Guidelines for Industry Classification of Listed Companies” (2012 revision) issued by the China Securities Regulatory Commission. To mitigate the impact of extreme values, all continuous variables underwent tail trimming at the 1% and 99% percentiles.

To test hypotheses H1 and H2, this study constructs the following panel data regression model:

$$Cost_{it} = \alpha_0 + \alpha_1 \mathrm{Credit}_{ct} + \alpha_2 \mathrm{Controls}_{it} + \varepsilon_{it}$$

$$Access_{it} = \beta_0 + \beta_1 \mathrm{Credit}_{ct} + \beta_2 \mathrm{Controls}_{it} + \varepsilon_{it}$$

Where the subscript i represents upstream and downstream enterprises, c denotes the core enterprise, and t signifies the year.$Cost_{it}$ is the dependent variable, measuring the financing cost of the i^(th) upstream and downstream enterprise in year t; $Access_{it}$ is the dependent variable, measuring the financing accessibility of upstream and downstream enterprises in year t; c is the core explanatory variable, measuring the credit status of core enterprises in year t; t represents a series of control variables, serving as the random error term.

To test research hypothesis H3, the heterogeneity of credit spillover effects across industries—this study introduces an interaction term between the core explanatory variable and an industry dummy variable into the aforementioned model, constructing the following regression model:

$$Cost_{it} = \gamma_0 + \gamma_1 \mathrm{Credit}_{ct} + \gamma_2 \mathrm{Credit}_{ct} * \mathrm{Industry}_{it} + \gamma_3 \mathrm{Controls}_{it} + \varepsilon_{it}$$

$$Access_{it} = \delta_0 + \delta_1 \mathrm{Credit}_{ct} + \delta_2 \mathrm{Credit}_{ct} * \mathrm{Industry}_{it} + \delta_3 \mathrm{Controls}_{it} + \varepsilon_{it}$$

Industry_{it} represents an industry dummy variable. Based on the preceding theoretical analysis, the electronic information industry is coded as 1, while the traditional agriculture industry is coded as 0. The coefficient of the interaction term $\text{Credit}_{ct} * \text{Industry}_{it}$ is used to test for differences in credit spillover effects across industries.

3.2 Variable Selection

Financing Cost (Cost): This paper measures the financing cost of upstream and downstream enterprises using the ratio of interest expense to interest-bearing debt. Interest-bearing debt includes short-term borrowings, long-term borrowings, bonds payable, etc. Interest expense refers to the total interest expense disclosed in the enterprise's annual financial report. This indicator directly reflects the interest cost borne per unit of interest-bearing debt. A higher value indicates a higher financing cost for the enterprise.

Access to Financing: Drawing on existing research, this study measures access to financing using the ratio of new interest-bearing debt to total assets. New interest-bearing debt = ending interest-bearing debt - beginning interest-bearing debt. A higher value indicates greater access to financing, as it reflects increased new financing obtained during the period.

Core Enterprise Credit Status (Credit): Credit ratings serve as authoritative indicators of corporate creditworthiness. Therefore, this study employs the long-term credit rating of the core enterprise as a proxy variable for the core explanatory variable. Referencing credit rating agencies' standards, credit ratings are assigned values as follows: AAA = 7, AA+ = 6, AA = 5, AA- = 4, A+ = 3, A = 2, A- and below = 1. Higher values indicate better creditworthiness of the core enterprise.

To control for other factors affecting upstream and downstream enterprises' financing costs and accessibility, this study selects the following control variables: Enterprise Size (Size), measured by the natural logarithm of total assets, as larger enterprises typically possess stronger risk-bearing capacity and more financing channels; Debt-to-Asset Ratio (Lev), measured by the ratio of total liabilities to total assets, reflecting an enterprise's financial leverage level, where excessively high leverage may increase default risk; Profitability (ROA), measured by return on assets (ROA), i.e., net profit divided by total assets. Firms with stronger profitability demonstrate greater repayment capacity and access more favorable financing terms; Growth, measured by revenue growth rate, calculated as (current period revenue - previous period revenue) / previous period revenue. Firms with strong growth potential typically exhibit higher financing needs and better financing prospects; Current Ratio (Current), measured as current assets divided by current liabilities, reflects a company's short-term debt repayment capability; Company Age (Age), measured as the number of years from the company's founding to the sample year. Companies with longer histories possess richer operational experience and more established credit records; Macroeconomic Growth Rate (GDPg), measured as the annual GDP growth rate, reflects the impact of the macroeconomic environment on corporate financing. The specific definitions of each variable are shown in Table 1:

Table1 Variable Selection

Variable Type	Variable Name	Variable Symbol	Variable Definition
Dependent variable	Financing Costs	Cost	Interest Expense / Interest-Bearing Liabilities
	Financing Availability	Access	New Interest-Bearing Liabilities / Total Assets
Independent variable	Core Enterprise Creditworthiness	Credit	Credit Rating Assignment
Control variable	Enterprise Scale	Size	Natural Logarithm of Total Assets
	Debt-to-Asset Ratio	Lev	Total Liabilities / Total Assets
	Profitability	ROA	Net Profit / Total Assets
	Growth Potential	Growth	Operating Revenue Growth Rate
	Current Ratio	Current	Current Assets / Current Liabilities
	Enterprise Age	Age	Sample Year - Year of Company Establishment
	Macroeconomic Growth Rate	GDPg	Annual GDP Growth Rate

3.3 Empirical Findings and Analysis

Model (1) and Model (2) respectively examine the impact of the core enterprise's creditworthiness on the financing costs and financing accessibility of upstream and downstream enterprises. The results of Model (1) show that the coefficient for Credit is -0.008, which is significantly negative at the 1% level. This indicates that the better the creditworthiness of the core enterprise, the lower the financing costs for upstream and downstream enterprises, thereby validating H1. This result aligns with theoretical expectations: the credit spillover effect from the core enterprise reduces financial institutions' risk assessments of upstream and downstream enterprises, thereby lowering risk premiums and financing costs. Economically, each credit rating upgrade of the core enterprise reduces the average financing cost of upstream and downstream enterprises by 0.8 percentage points, demonstrating significant practical implications. Model (2) results show that the coefficient for Credit is 0.006, significantly positive at the 5% level. This indicates that better creditworthiness of core enterprises leads to stronger financing accessibility for upstream and downstream enterprises, validating H2. It suggests that the credit endorsement from core enterprises enhances financial institutions' trust in upstream and downstream enterprises, increasing their likelihood of obtaining new financing. Regarding control variables, the coefficient for Size is significantly positive in both Model (1) and Model (2), indicating that larger enterprises face relatively lower financing costs and higher financing accessibility, consistent with existing research. The coefficient for ROA is significantly negative, suggesting that enterprises with stronger profitability incur lower financing costs, aligning with the logic that stronger repayment capacity correlates with lower credit risk. The coefficient for GDP growth is significantly positive, indicating that a stronger macroeconomic environment correlates with greater financing accessibility and relatively lower financing costs for enterprises are shown in Table 2.

Table 2 Baseline regression results

Variable	(1)Cost	(2)Access
Credit	-0.008***	0.006**
	(-3.25)	-2.48
Size	-0.003***	0.004***
	(-2.98)	-3.12
Lev	0.025***	-0.012**
	-4.15	(-2.35)
ROA	-0.156***	0.089***
	(-5.68)	-4.92
Growth	-0.002	0.005*
	(-0.85)	-1.76
Current	-0.001**	0.002***
	(-2.15)	-2.89
Age	-0.0005*	0.0003
	(-1.82)	-1.25
GDPg	-0.125***	0.098***
	(-3.85)	-4.21
Con	0.256***	-0.189***
	-5.21	(-4.85)
Individual fixed effects	Yes	Yes
Time fixed effects	Yes	Yes

Note: ***p<0.01, **p<0.05, *p<0.1, values in parentheses indicate t-values.

Table 3 reports the regression results for industry heterogeneity, where Model (1) and Model (2) respectively reflect the regression outcomes for financing costs and financing accessibility. In Model (1), the coefficient for Credit*Industry is -0.005, which is significantly negative at the 10% level. This indicates that compared to traditional agricultural industries, the negative impact of core

enterprises' credit status on the financing costs of upstream and downstream enterprises is stronger in the electronic information industry, meaning the credit spillover effect is more pronounced. In Model (2), the coefficient for Credit*Industry is 0.004, significantly positive at the 5% level. This indicates that within the electronic information industry, the positive impact of core enterprises' creditworthiness on the financing accessibility of upstream and downstream enterprises is also stronger. This result validates H3: credit spillover effects vary across industries. Due to its tightly integrated supply chains and strong technological interdependence, the electronics and information industry exhibits more pronounced credit spillover effects from core enterprises. Conversely, the traditional agricultural industry, characterized by loose industrial chains and lower stability, demonstrates relatively weaker credit spillover effects. Further analysis of the causes of industry heterogeneity reveals that the electronics and information industry supply chain features “deep technological integration and long cooperation cycles.” Core enterprises and their upstream/downstream counterparts exhibit high synergy in R&D design and manufacturing processes. This close collaboration enables core enterprises to more accurately assess the operational risks of upstream/downstream firms, while financial institutions place greater trust in the validity of credit endorsements from core enterprises. In contrast, traditional agricultural supply chains are constrained by “extended production cycles and high natural risks.” Core enterprises primarily engage in short-term order-based collaborations with farmers and small distributors, resulting in limited operational oversight over upstream and downstream entities. Financial institutions adopt a more cautious approach when evaluating credit spillover effects in this sector, thereby diminishing the transmission of credit.

Table 3 Regression Results for Industry Heterogeneity

Variable	(1)Cost	(2)Access
Credit	-0.006***	0.004**
	(-2.91)	-2.23
Credit*Industry	-0.005*	0.004**
	(-1.78)	-2.15
Size	-0.002***	0.003***
	(-2.65)	-2.87
Lev	0.023***	-0.011**
	-3.98	(-2.18)
ROA	-0.145***	0.082***
	(-5.12)	-4.56
Growth	-0.001	0.004*
	(-0.72)	-1.69
Current	-0.001**	0.002***
	(-2.03)	-2.75
Age	-0.0004	0.0002
	(-1.56)	-1.12
GDPg	-0.118***	0.092***
	(-3.62)	-4.01
Con	0.245***	-0.178***
	-4.98	(-4.52)
Individual fixed effects	Yes	Yes
Time fixed effects	Yes	Yes

To ensure the reliability of the benchmark regression results, this paper conducted robustness tests by replacing the core explanatory variables and narrowing the sample time range. The results are shown in Table 4:

Table 4: Robustness Test Results

Robustness Test Method	Dependent Variable	Core Explanatory Variable	Coefficient	t-Value
Replace Core Explanatory Variables (Core_Lev)	Cost	Core_Lev	0.012	4.02
	Access	Core_Lev	-0.008	-2.31
Narrow the Sample Time Range (2021-2023)	Cost	Credit	-0.007	-2.89
	Access	Credit	0.005	2.25

Replace the core enterprise credit status metric from “credit rating assignment” to “debt-to-asset ratio (Core_Lev)” and remove the debt-to-asset ratio from the control variables. A lower debt-to-asset ratio indicates stronger debt repayment capacity and better credit status for core enterprises. Regression results indicate that Core_Lev has a coefficient of 0.012 for financing costs, significant at the 1% level, and a coefficient of -0.008 for financing accessibility, significant at the 5% level. This confirms that lower debt-to-asset ratios among core enterprises correlate with lower financing costs and higher financing accessibility for upstream and downstream enterprises, consistent with baseline regression findings. This validates the robustness of the core explanatory variable measurement approach.

Considering the potential impact of the 2020 pandemic's short-term supply chain disruptions on empirical results, the sample period was narrowed to 2021-2023. The regression results show that Credit has a coefficient of -0.007 for Cost, significant at the 1% level, and a coefficient of 0.005 for Access, significant at the 5% level. This aligns with the direction and significance of the benchmark regression coefficients, ruling out interference from short-term external shocks on the results.

4. Risk Identification and Risk Management Strategies

4.1 Risk Identification

In supply chain finance, while the credit spillover effect from core enterprises facilitates financing, it also carries multiple risk types that pose potential threats to the stable operation of supply chains and the capital security of financial institutions. Credit risk stands out as one of the most prominent risk types. Backed by the core enterprise's credit endorsement, financial institutions often extend financing to upstream and downstream SMEs based on trust in the core enterprise. However, when SMEs face operational difficulties, deteriorating financial health, or moral hazards, they may default on loan repayments, triggering credit events. For instance, some SMEs may falsify financial data or fabricate transaction backgrounds to secure financing. Should their capital chain break, financial institutions could incur substantial losses. From a macroeconomic perspective, during economic downturns, overall market demand shrinks, reducing sales revenue for enterprises along the supply chain and diminishing their debt-repayment capacity, thereby increasing credit risk. The characteristics of different industries also cause varying degrees of impact on corporate creditworthiness. For instance, in cyclical industries, operational pressures intensify during industry troughs, leading to a significant rise in credit risk.

Market risk remains equally critical, stemming primarily from price volatility, interest rate and exchange rate fluctuations, and demand uncertainty. Within supply chains, sharp increases in raw material costs burden upstream suppliers. If downstream enterprises cannot effectively pass on these costs, their profit margins shrink, undermining repayment capacity. Exchange rate volatility significantly impacts supply chain firms engaged in import/export activities; local currency appreciation may reduce exporters' revenues, heightening credit risk. Changes in market demand also pose risks. When demand for a particular product suddenly declines, manufacturers may face inventory buildup and cash flow difficulties, thereby intensifying credit risk.

Operational risks permeate every stage of supply chain finance operations, primarily encompassing inadequate internal procedures, human error, system failures, and external fraud.

During business execution, financial institutions may incur non-performing loans if they fail to rigorously verify financing applicants' documentation and identify false information. Staff negligence or non-compliant actions—such as data entry errors or unauthorized contract modifications—also trigger operational risks. With the widespread application of information technology in supply chain finance, the stability and security of information systems become critical. Hacker attacks, system failures, or data breaches can severely disrupt normal business operations and increase operational risk.

4.2 Risk Management Strategy

To address the three types of risks—credit, market, and operational—associated with credit spillover in supply chain finance, a control system featuring “multi-party collaboration, end-to-end coverage, and dynamic risk prevention” must be established. For credit risk management, a dual-track assessment and tiered mitigation approach should be implemented. Financial institutions should establish a dual-track assessment mechanism combining “core enterprise credit” with “substantive risks of SMEs.” Building upon the credit endorsement of core enterprises, they should integrate non-financial indicators such as SME tax payment data, logistics information, and transaction records through big data technology to develop credit scoring models. This enables independent risk rating for SMEs. Simultaneously, implement tiered risk mitigation: for Grade A SMEs, simplify guarantee procedures by leveraging core enterprise credit; for Grade B and C enterprises, require core enterprises to provide partial joint liability guarantees or introduce supply chain risk compensation funds. Fund size should be provisioned at 5%-8% of outstanding supply chain financing balances to cover default losses.

Market risks are managed through demand-linked hedging tools. To address price and exchange rate volatility, financial institutions and core enterprises collaborate to develop supply chain hedging instruments. Core enterprises centrally manage raw material futures hedging and foreign exchange forward contracts for upstream and downstream businesses, lowering the barriers and costs for SMEs to operate independently. Establish a market demand-capacity linkage adjustment mechanism. Core enterprises should regularly share market demand forecasts to guide upstream and downstream enterprises in rationally adjusting production scales and avoiding inventory buildup. For cyclical industry supply chains, set an “industry health-financing quota” linkage coefficient. When industry health falls below the threshold, automatically reduce financing proportions for high-risk enterprises, incorporating market risk into core credit approval metrics.

Operational risk management requires standardized processes and technological empowerment. Financial institutions must codify standardized operating procedures for the entire supply chain financing process, embedding steps like document review, contract signing, and fund disbursement into information systems. Implement control points such as dual verification and tiered access permissions to eliminate human operational vulnerabilities. Strengthen technological risk control measures by adopting blockchain technology to authenticate transaction backgrounds, ensuring the integrity of data such as orders, invoices, and logistics documents. Deploy AI-powered anti-fraud systems to monitor abnormal transaction behaviors and system access risks in real time.

5. Conclusion

This empirical study validates three hypotheses, confirming the significant impact of core enterprises' creditworthiness on the financing costs and availability of upstream and downstream enterprises. This effect exhibits industry-specific variations, with the electronics and information sector demonstrating the most pronounced impact. The study addresses gaps in quantifying credit spillover effects and advances supply chain finance theory. It identifies three risk categories—credit, market, and operational—and proposes targeted mitigation strategies, including dual-track assessments, hedging tools, and technology-enabled solutions. These findings offer practical guidance for financial institutions to optimize lending decisions, core enterprises to leverage their credit influence, and SMEs to improve financing conditions, thereby fostering the stable development of supply chain finance.

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