

Supply Chain Finance, Supply Chain Concentration and Corporate ESG Performance

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Abstract. Creating diversified value has become a strategic goal for contemporary corporate development, with supply chain finance offering new avenues to enhance environmental, social, and governance (ESG) practices. This study analyzes a dataset from A-share listed companies spanning 2014 to 2023 to empirically investigate how supply chain finance influences ESG performance and the moderating role of supply chain concentration. Results indicate that advancements in supply chain finance positively impact ESG performance, providing companies with a pathway to strengthen sustainable practices. However, a higher supply chain concentration has a significant negative relationship with supply chain financing, indicating that companies with more concentrated supply chains may face challenges in fully leveraging supply chain finance to enhance ESG outcomes. Additionally, supply chain concentration negatively mediates the relationship between supply chain finance and ESG performance, suggesting that supply chain structure influences the effectiveness of financial strategies on ESG outcomes. This research provides theoretical and empirical insights to guide companies toward sustainable decision-making and improved supply chain practices aligned with ESG objectives.

Keywords: Corporate ESG Performance; Supply Chain Finance; Supply Chain Concentration.

1. Introduction

With the release of the "Guidelines on Investor Relations Management for Listed Companies (2022)" by the Securities and Futures Commission (SFC), companies were required to move away from single-purpose pursuit of growth in financing and toward diversified value creation. 2024 In June, the "ESG Rating Analysis Report of A-share Listed Companies (2024)" released by Shangdao Ronglv shows that the average ESG performance of CSI 800 constituent stocks has rocketed by 31.1% in the past six years. Meanwhile, supply chain finance has become a more efficient means of financial support for resolving the difficulties of corporate financing constraints and measuring corporate value. Business entities must work in concert with social entities to achieve broader social responsibility; and business operations need to be harmonized with ecological development to ensure sustainable development [1].

Existing studies on ESG have mainly focused on its relationship with financial performance, and it is generally believed that good ESG performance can increase corporate green innovation, enhance firm value and improve investment efficiency [2-4]. In the field of supply chain finance research, scholars mostly focus on its synergy with blockchain technology, risk management and investment efficiency [5-7]. There is little literature linking supply chain finance to corporate ESG performance, and research is lacking, particularly when it comes to the moderating influence of supply chain concentration.

Therefore, this paper intends to investigate how the development of supply chain finance affect corporate ESG performance, while introducing supply chain concentration as a moderating variable. With the help of regression model and moderating effect model, this paper innovatively enriches the relevant theoretical research and helps enterprises explore the emerging development path of business decision-making and supply chain development in the context of ESG.

2. Theoretical Analysis and Research Hypotheses

2.1. Supply Chain Finance and ESG Performance

2.1.1 Environmental perspective (E)

Longer project cycle and larger capital investment constrain enterprises' responsibility for environmental protection. Financial service providers often choose to increase financing cost for SMEs to avoid risks especially potential opportunistic behavior, acting as the resistance of green technology innovation [8]. The supply chain involves collaboration between enterprises and their suppliers, customers and other entities in the flow of capital, information and technology [9]. By integrating financial business with low-carbon and energy-saving scenarios, it is possible to promote cooperation among carbon-reducing enterprises, financial institutions, and science and innovation organizations to substantially ameliorate environmental performance.

2.1.2 Social perspective (S)

By collaborating with financial institutions, media companies and other parties, supply chain core businesses can improve the openness of collaborative corporate social responsibility information disclosure both upstream and downstream, thus stimulating enterprises' enthusiasm to undertake social responsibility. Supply chain finance promotes information sharing and harmonization of capital, technology, logistics and ESG information of supply chain enterprises, thus realizing value co-creation.

2.1.3 Governing perspective (G)

It primarily concerns whether corporate governance decisions about risk management, internal control, and shareholder structure adequately take social responsibility and people's welfare into account. Each company in the chain is jointly supervised by financial institutions and core companies, which strengthens the internal governance of the chain's businesses by preventing shortsighted and self-interested behavior to some extent [10]. Accordingly, this paper proposes:

H₁: Supply chain finance development has a positive contribution to corporate ESG performance.

2.2. Supply Chain Finance and Supply Chain Concentration

Supply chain finance eases the pressure on enterprises' capital by offering flexible financing services, including order-based financing and "insurance+financing". SMEs are provided mostly to lower dependence on a single supplier, thus debasing supply chain concentration. Furthermore, it helps firms better evaluate and control supply chain risks, confidently building relationships with additional suppliers and encouraging supply chain variety.

From another perspective, supply chain finance further enhances the dominant position of core enterprises, as well as the improvement of relevant service platforms, which promotes the sharing of information, thus enhancing collaborative efficiency of the supply chain and increasing the concentration ratio. Accordingly, this paper proposes:

H_{2a}: Supply chain finance development positively affects supply chain concentration.

H_{2b}: Supply chain finance development negatively affects supply chain concentration.

2.3. Supply Chain Finance, Supply Chain Concentration and ESG Performance

According to the social relationship theory, it is easier to establish good relational transactions when a company has a higher supply chain concentration. Good relationship-based transactions can bring stable procurement channels to enterprises, reduce the uncertainty of procurement activities, and enterprises can realize scale effects at low costs [11]. High customer concentration reduces operating costs and contributes to increased market value of the enterprise [12]. Good business performance sends favorable information to the market, prompting banks to relax lending condition restrictions to meet innovative financing needs. The degree of information asymmetry between enterprises is reduced, and enterprises in the chain are able to keep abreast of the environmental

requirements of supply chain stakeholders and consumers' demand for green products, thus positively contributing to corporate ESG performance.

From the opposite angle, the performance of enterprises with higher supply chain concentration is more susceptible to the impact of risk shocks from upstream and downstream enterprises, and vice versa, the performance is more resilient [13]. The bargaining power of big suppliers and customers makes it easier for businesses to make concessions when supply chain concentration is strong, weakening the competitiveness of their own products, and signaling to the bank that the enterprise's future repayment ability is low, which is not conducive to the efficacy of supply chain financial financing. As a result, businesses' sustainable development and ESG performance suffer. Accordingly, this paper proposes:

H_{3a}: The association between supply chain financing and business ESG performance is positively moderated by supply chain concentration.

H_{3b}: The association between supply chain finance and business ESG performance is negatively moderated by supply chain concentration.

3. Research Design

3.1. Sample Selection and Data Sources

This paper takes A-share listed companies from 2014-2023 as the original data and carries out the following treatments: excluding the samples of financial and insurance listed companies; excluding the samples with missing data of relevant indexes; excluding the samples of ST, *ST, and PT in the study period; in order to eliminate the influence of extreme values, Winsorize shrinkage is carried out on the quartiles of all continuous variables below 1% and above 99%. Processing. Supply chain finance data are from corporate annual reports, corporate ESG performance data are selected from CSI ESG ratings, and data for other model variables are from the CSMAR database.

3.2. Variables and Modeling

3.2.1 Explained variable

Corporate ESG performance (ESG). Based on the CSI ESG ratings, nine different grades are assigned, of which AAA is allocated nine, AA is allocated eight, A is allocated seven, BBB is allocated six, BB is allocated five, B is allocated four, CCC is allocated three, CC is allocated two, and C is allocated one.

3.2.2 Explanatory variable

Supply chain finance development level (SCF). In this paper, the supply chain finance dictionary is extended to Python's Jieba Chinese lexicon. By counting the frequency of the occurrence of each keyword in the annual reports of firms from 2014 to 2023. This paper uses the total frequency number plus 1 and takes the natural logarithm to measure the development level of enterprise supply chain finance.

3.2.3 Moderating variable

Supply chain concentration (Scii). Supply chain concentration is a measure of the level of concentration of the enterprise's transactions with suppliers and customers, this paper uses the average of the concentration of the enterprise's top five suppliers and the concentration of the top five customers to measure.

3.2.4 Control variables

Control variables (Controls): gearing ratio (Lev), return on total assets (ROA), growth rate of total operating income (Growth), proportion of shares held by the first shareholder (Top1), the firm's age (Age), proportion of independent directors (Indep), size of the board of directors (Board), cash flow

of the firm (CashFlow), quality of the audit (Big4), firm's production and technology conditions (Fixed) and capital utilization by major shareholders (Occupy).
The variable definitions are listed in the Table 1 below.

Table 1. Variable definitions

	Name	Symbol	Definition
Explained variable	Corporate ESG performance	ESG	ESG Rating Assignment(CSMAR)
Explanatory variable	Supply chain finance development level	SCF	$\text{Ln}(1+\text{Keyword Frequency})$
Moderating variable	Supply chain concentration	Scii	$(\text{Concentration of top five suppliers}+\text{Concentration of top five customers})/2$
	Gearing ratio	Lev	$(\text{Total liability}/\text{Total assets}) * 100\%$
	Return on total assets	ROA	$\text{Net profit}/\text{Average balance of total assets}$
	Gross operating income growth rate	Growth	$(\text{Total operating income for the year}-\text{Prior year's total operating income}) * 100\% / \text{Prior year's total operating income}$
	Shareholding ratio of the first shareholder	Top1	$\text{Number of shares held by the largest shareholder}/\text{Total shares}$
	Age of enterprise	Age	$\text{Ln}(\text{Current year}-\text{Date of Establishment}+1)$
Control variables	Percentage of independent directors	Indep	$\text{Total number of independent directors}/\text{Total number of board members}$
	Board size	Board	$\text{Ln}(\text{Total number of board members})$
	Corporate cash flow	CashFlow	$\text{Net cash flows from operating activities of the enterprise}/\text{total assets}$
	Audit quality	Big4	1 if it is a Big 4 audit, 0 otherwise
	Technical conditions of enterprise production	Fixed	$\text{Ln}(\text{Net fixed assets})$
	Utilization of funds by major shareholders	Occupy	$\text{Other receivables}/\text{total assets}$
	Time fixed effect	year	Annual dummy variables

To verify the effect of supply chain finance on ESG performance and its mechanism, the following models are established:

$$ESG_{it} = \beta_0 + \beta_1 SCF_{it} + \sum_1^m \beta_m Controls_{it} + \sum year + \varepsilon_{it} \quad (1)$$

$$Scii_{it} = \beta_0 + \beta_1 SCF_{it} + \sum_1^m \beta_m Controls_{it} + \sum year + \varepsilon_{it} \quad (2)$$

$$ESG_{it} = \beta_0 + \beta_1 SCF_{it} + \beta_2 (Scii \times SCF) + \sum_1^m \beta_m Controls_{it} + \sum year + \varepsilon_{it} \quad (3)$$

In the above equations, “ β ” denotes the to-be-estimated coefficients, “Controls” denotes the control variables and “ ε_{it} ”denotes the random perturbation term. “i” represents the individual enterprises and “t” denotes the year. “ESG” denotes corporate ESG performance, “Scii”denotes supply chain concentration, and “SCF” denotes the degree of supply chain finance development.

Eq. (1) tests the influence of SCF on ESG; Eq. (2) tests the influence of SCF on Scii, and Eq. (3) examines the moderating effect of Scii.

4. Empirical Results and Analysis

4.1. Descriptive Analysis

The ESG performance of the sample firms varies greatly, as Table 2 illustrates. The enterprises selected still need to put more of an emphasis on ESG practices, as indicated by the mean value of 4.21. SCF has a maximum value of 3.47 and a mean value of 0.55, manifesting that most sample enterprises are still at the early stage of supply chain finance development or have not yet developed, and the degree of unevenness is obvious during the period of the study.

The correlation coefficients of all the variables are less than 0.3. The average value of VIF is 1.28, which is less than 3, which indicates that no serious multicollinearity happens among the selected samples.

Table 2. Results of descriptive analysis

Variable	Obs	Mean	Std.dev.	Min	Max	Correlation coefficient	VIF
ESG	6220	4.207074	1.034949	1	8	1.0000	
SCF	6220	0.5472241	0.8163519	0	3.465736	0.0286**	1.05
Scii	6220	29.17206	14.79826	1.45	94.705	-0.1421***	1.08
Lev	6220	50.38576	16.74972	13.79751	84.83566	-0.0305**	1.51
ROA	6220	0.0331265	0.0480129	-0.151551	0.164956	-0.1768***	1.42
Growth	6220	14.19409	29.26612	-40.45236	157.1351	0.1755	1.13
Top1	6220	32.04271	14.05147	7.82	67.5	0.0903***	1.11
Age	6220	3.261837	0.1906557	2.772589	3.806662	-0.0050	1.05
Indep	6220	0.3770831	0.0569407	0.3333333	0.6	0.0822***	1.48
Board	6220	2.135105	0.1891474	1.609438	2.639057	0.0444***	1.54
CashFlow	6220	0.5502371	1.879454	-0.947542	14.51551	0.1568***	1.29
Big4	6220	0.0757235	0.2645764	0	1	0.1559***	1.17
Fixed	6220	21.24727	1.504316	18.27712	25.47727	0.2279***	1.64
Occupy	6220	0.0143334	0.0184659	0.0002493	0.102386	-0.0501***	1.16

Note: *** p<0.01, ** p<0.05, * p<0.1.

4.2. Baseline Regression Analysis

According to models (1)-(3), the results of the regression models are listed in the Table 3 below.

Table 3. Benchmark regression analysis

VARIABLES	(1) ESG	(2) Scii	(3) ESG
SCF	0.0342** (0.0160)	-1.510*** (0.235)	0.224*** (0.0282)
SCF*Scii			-0.00752*** (0.000912)
Lev	-0.00437*** (0.000912)	-0.0577*** (0.0135)	-0.00449*** (0.000920)
Growth	-0.00164*** (0.000465)	0.0557*** (0.00684)	-0.00142*** (0.000467)
ROA	3.218*** (0.305)	-51.40*** (4.475)	2.932*** (0.307)
Top1	0.000717 (0.000949)	0.0367*** (0.0140)	0.000481 (0.000955)
Indep	1.824*** (0.265)	-18.97*** (3.937)	1.759*** (0.269)
Board	0.301*** (0.0816)	-2.033* (1.207)	0.266*** (0.0824)
Age	0.0386 (0.0667)	0.289 (0.983)	-0.00219 (0.0672)
CashFlow	0.0242*** (0.00753)	-0.326*** (0.113)	0.0251*** (0.00770)
Big4	0.278*** (0.0511)	-2.002*** (0.757)	0.297*** (0.0517)
Fixed	0.119*** (0.0108)	0.327** (0.159)	0.122*** (0.0109)
Occupy	-0.269 (0.718)	-136.3*** (10.67)	-0.874 (0.737)
Constant	0.283 (0.345)	38.49*** (5.113)	0.481 (0.349)
Observations	6,220	6,100	6,100
R-squared	0.109	0.071	0.120

Note: *** p<0.01, ** p<0.05, * p<0.1.

In Table 3, model (1) shows how SCF affects ESG. The regression coefficient of SCF is significantly positive at the 5% level, manifesting that SCF positively influence ESG, and H1 is supported. Model (2) verifies the relationship between SCF and Scii, and the regression coefficient of Scii is significantly negative, supporting H2b that firms with higher levels of supply chain finance development tend to reduce supply chain concentration. Model (3) increases the interaction term between SCF and Scii, showing that Scii modifies the association between SCF and ESG negatively, as indicated by the considerably negative regression coefficient of the interaction term. This verifies H3b.

4.3. Robustness Test

This paper conducts robustness test by replacing the core explanatory variables. First, the samples that disclose the keywords in the annual reports of enterprises are set to 1, otherwise they are set to 0, and the variable is defined as SCF1; second, the indicator of the degree of development of supply chain finance is replaced by the sum of enterprises' short-term borrowings and bills payable and takes the natural logarithm of the variable, and the variable is defined as SCF2. The replacement variable is substituted into the model (1) again. The results are shown in the Table 4 below.

Table 4. Robustness test results

VARIABLES	(1) ESG	(2) ESG
SCF1	0.0440* (0.0266)	
SCF2		0.0895*** (0.0156)
Controls	Yes	Yes
year	Yes	Yes
Observations	6,220	6,220

Note: *** p<0.01, ** p<0.05, * p<0.1.

The results show that the effect of SCF1 on ESG is significantly positive at the 10% level, and the effect of SCF2 on ESG is significantly positive at the 1% level. In summary, the replacement of the core explanatory variables is generally consistent with the results of the benchmark regression, manifesting that the results are relatively robust and the findings are more objective and credible.

5. Conclusion

Supply chain finance is conducive to the realization of sustainable development goals and the enhancement of corporate ESG performance. Taking A-share listed companies from 2014 to 2023 as the research object, this paper empirically examines the effect of supply chain finance on corporate ESG performance and the moderating effect of supply chain concentration on the relationship between the two.

The following conclusions are drawn: (1) The development of supply chain finance has a significant positive effect on corporate ESG performance, and the conclusion still holds significantly after the robustness test of replacing explanatory variables. (2) Supply chain concentration is significantly harmed by the emergence of supply chain finance. (3) There is a notable moderating influence of supply chain concentration on the relationship between company ESG performance and supply chain financing.

According to the conclusion of this study, in order to give full play to the effect of supply chain finance in improving ESG performance, the following policy recommendations are put forward: (1) To boost supply chain finance capabilities and unleash the funding effect, strengthen strategic partnerships by fusing digital technologies like fintech, blockchain, and cloud computing. (2)

Businesses must be aware of how concentrated their own supply chains are and take all reasonable precautions to minimize risks associated with the supply chain's changes; they need to intensify leadership and avoid over-dependence on specific distributors. (3) Provide distinctive and superior supply chain financial services by innovating and developing a range of financial products and service packages.

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