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Navigating Growth: The Nexus of Supply Chain Finance, Digital Maturity, and Financial Health in Chinese A-Share Listed Corporations

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Abstract: As a derivative of traditional finance, supply chain finance plays a crucial role in facilitating the sound and stable operation of enterprises. This paper investigates the impact of supply chain finance on corporate sustainable growth. The findings reveal that supply chain finance not only fosters sustainable growth but also amplifies this effect through digital technology integration. Moreover, for firms and service-oriented businesses located in the central region, supply chain finance exerts a more pronounced positive influence on sustainable growth. In addition, the impact of supply chain finance on firm sustainable growth can be stage-specific depending on the financial situation.

Keywords: supply chain finance; sustainability; digital technology; moderating effect; threshold effect



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1. Introduction

In the current context of intensifying global competition and increasingly severe environmental challenges, sustainability of firms has become a key measure of an enterprise's long-term competitiveness and market adaptability. Sustainability of firms refers to the pursuit of economic benefits by enterprises while fully considering environmental protection, social responsibility, and the long-term availability of resources, ensuring their long-term stable growth and positive contributions to society. Sustainable growth of enterprises is an important component of a sustainability strategy, requiring businesses to maintain economic benefits while ensuring the long-term viability of their growth models. The attainment of sustainable growth goals signifies that a company is capable of not only sustaining profitability through innovation and resource optimization within the dynamic market landscape but also plays a significant role in enriching societal wealth, fostering high-caliber economic advancement, and thereby more effectively discharging its social obligations. This capacity is instrumental in shaping the company's trajectory of prosperity and development. In the context of globalization and the ongoing challenges posed by the pandemic, the pursuit of sustainable growth has become an imperative for businesses. It not only bolsters their resilience in the face of market fluctuations and external disruptions but also guarantees their ongoing operations and innovation through the implementation of robust supply chain management strategies and sophisticated risk control mechanisms.

Within the unique and vast economic entity of China, the concept of corporate sustainable growth carries profound implications and pressing practical significance in China, the unique and second largest economic entity in the world. China is currently at a pivotal stage in transitioning from rapid growth to high-quality development, where plays an essential role in promoting the optimization and upgrading of economic structures and in fostering innovation-driven development strategies. However, sustainable growth of firms is often constrained by financing challenges, especially within Chinese enterprises that commonly face such financial constraints [1]. These financing difficulties limit the enterprises'

ability to invest in normal operations and innovative research and development, affecting their innovation capabilities and market adaptability. The existence of financing challenges directly impacts the enterprises' ability to explore new markets, develop new products, and technologies, thereby affecting their long-term growth potential. Therefore, addressing the financing issues faced by enterprises is of significant importance for promoting their sustainable growth.

Supply chain finance integrates the upstream and downstream product systems of the supply chain, covering financing needs at every stage, and provides enterprises with services such as capital support and risk management [2]. The goal of supply chain finance is to optimize various segments of the supply chain through means such as financing, settlement, and logistics, thereby enhancing operational efficiency and competitiveness, reducing capital costs, and accelerating cash flow [3], leading to a win-win situation for all parties involved [4]. To encourage enterprises to use supply chain finance to alleviate financing difficulties, the Chinese government has introduced a series of policy measures to steadily promote the development of supply chain finance and to actively encourage the provision of industry chain supply chain financial services [5]. Concurrently, the rapid development of digital technology has provided new opportunities and momentum for supply chain finance [6,7]. Currently, many enterprises are addressing innovation challenges and improving production efficiency through digital transformation, reducing issues caused by information asymmetry, and thus promoting sustainable growth for the enterprise.

How does supply chain finance influence corporate sustainable growth amidst the wave of digital transformation? To address this question, this paper embarks on an exploration from a digital perspective, examining the impact of supply chain finance on the sustainable growth of enterprises. Utilizing different financial conditions of enterprises as samples, this study investigates the moderating role of digital technology and the threshold effects of financial status, providing an in-depth corroborative analysis of the relationship between supply chain finance and corporate development. Furthermore, this research delves into the heterogeneous relationship between supply chain finance and corporate sustainability development by considering both internal and external environments of the enterprises.

The principal contributions of this study are as follows: Firstly, it explores the impact of supply chain finance (SCF) on corporate sustainable growth from the perspective of digital development, offering a novel lens through which to understand the contemporary role of SCF. Secondly, it investigates the varying impacts of supply chain finance on corporate sustainability based on the financial health of enterprises, thereby enriching the existing literature. Lastly, it analyzes the regional disparities in the influence of supply chain finance on corporate sustainable growth across different areas of China, providing a basis for the formulation of regional policies.

The structure is as follows: literature review as well as our relevant hypotheses in Section 2, followed by the description of the data, variables, and models in Section 3. In Section 4, we present the empirical findings on the impact of supply chain finance on corporate sustainable growth and then discuss the moderating role of digital technology and the threshold effects of financial conditions. Section 5 summarizes the conclusions and implications. In Section 6, we present the limitations of the study and future research directions.

2. Literature Review and Research Hypotheses

2.1. Literature Review

Financing challenges are significant barriers affecting corporate development, and the introduction of supply chain finance offers a potential solution to alleviate corporate financing constraints [8]. By simplifying the financing process and reducing the barriers to financing, supply chain finance plays a crucial role in promoting the development of businesses, especially small and medium-sized enterprises (SMEs). The application and impact of supply chain finance in businesses are gradually becoming a focal point of research. Internationally, scholars tend to explore supply chain finance from the perspectives

of corporate operations and finance, while in China, research focuses more on corporate management practices. Additionally, existing studies have concentrated on topics such as supply chain finance models, risk management, and green supply chain finance [9–13].

Corporate sustainable growth is a key indicator for measuring long-term financial health and market competitiveness of businesses. The concept of corporate sustainable growth was first introduced by Higgins [14] and rapidly became a central issue in strategic corporate research. As a tool for supporting corporate liquidity and risk management, supply chain finance has a potentially significant role in promoting corporate sustainable growth. By providing financing support and optimizing cash flows, supply chain finance aids in corporate innovation activities and enhances corporate innovation efficiency [15], thereby better facilitating long-term, stable corporate growth. Research indicates that supply chain finance can effectively alleviate capital constraints for businesses, improve operational efficiency and market competitiveness, and thus positively impact corporate performance [9,16–18].

Existing research [19–21] widely acknowledges the pivotal role of digital technology in propelling the development of supply chain finance and posits that digitalization optimizes supply chain activities. Scholars such as Banerjee, Gong, Zheng, Du, and Lu have found that supply chain collaboration, through the utilization of digital technology, facilitates information sharing to address trust issues, thereby promoting the adoption of supply chain finance by enterprises [22–25]. Bai [26] confirms that digital transformation accelerates the integration of technology and corporate development, which can foster business growth and enhance corporate performance. Concurrently, digital technology plays an essential role in driving corporate transformation and upgrading, as well as improving innovation efficiency [27–29]. Digital transformation not only provides businesses with new operational models and tools but also significantly advances them in areas such as product and service innovation and market responsiveness. Moreover, the application of digital technology is closely linked to corporate sustainable growth [30,31], as it optimizes resource allocation and enhances resource utilization efficiency [32].

Supply chain finance, while providing some relief from corporate financial constraints [33], is inherently a financing mechanism. As companies harness financing to propel their growth, the escalation of debt from overborrowing poses the risk of severe repercussions, possibly precipitating the enterprise into a state of financial hardship. The gravity of the situation is compounded by the potential for supply chain risks to cascade downstream, thereby amplifying the overall risk exposure across the supply chain [34]. Hence, in deliberating the interplay between supply chain finance and the sustainable growth of corporations, it is imperative to acknowledge the pivotal role of robust corporate financial health. Cheng [35] has illustrated an inverted U-shaped relationship with a triple threshold effect between the leverage ratio and corporate value, shedding light on the non-linear influence that debt levels exert on corporate valuation. Building on this, Molinari further discovered that when debt risk surpasses a critical threshold, it can exert detrimental effects on the company's expansion and growth prospects. Echoing this sentiment, Zhang highlighted that the degree of financial market development exerts a threshold effect on corporate investments in research and development, as well as financial assets. When enterprises apply the tool of supply chain finance, it becomes extremely important to fully consider their internal circumstances. Through effective risk control and management [36], they can better promote sustainable growth and ensure their long-term financial stability and market competitiveness.

Despite the well-documented recognition of the role supply chain finance plays in fostering the development of enterprises, particularly small and medium-sized enterprises (SMEs), and the existing literature's exploration of supply chain finance models and risk management, as well as its impact on corporate performance and innovation efficiency, there remains a notable gap in understanding how supply chain finance can drive sustainable growth in enterprises, especially in the context of developing countries. This is particularly the case in the backdrop of rapidly advancing digital technologies, where the

micro-mechanism of corporate digital transformation and its influence on the relationship between supply chain finance and corporate sustainability have yet to be fully elucidated. Furthermore, while existing studies acknowledge the benefits that supply chain finance brings to enterprises, they have overlooked the potential varying impacts of supply chain finance as a financing method on sustainable growth under different corporate financial conditions. The nuances of how supply chain finance might affect sustainable growth differently across enterprises with varying financial health have not been sufficiently addressed.

2.2. Research Hypotheses

The sustainable growth of firms depends on not only their own operation and management but also the financial support provided by each link in the supply chain. Supply chain finance, as the central driving force behind supply chain development, plays a crucial role in addressing the financing challenges faced by numerous small and medium-sized firms in both the upstream and downstream of the supply chain [37]. Supply chain finance offers organizations an external funding option to address financing challenges, enabling them to overcome limits in financing innovation. This, in turn, encourages firms to boost their investment in research and development, thereby fostering sustainable growth.

Supply chain finance, through the integration of logistics, information flow, and capital flow, can effectively address capital shortages, facilitate the implementation of integration strategies, and reduce overall supply chain costs. Additionally, it enhances resource allocation efficiency [38]. Thus we propose the following hypotheses:

Hypothesis 1 (H1). *Supply chain finance plays a beneficial role in promoting sustainable growth of firms.*

The adoption of digital technology in businesses will reinforce the substitution of external and internal financing, thereby mitigating the issue of corporate financing constraints [39]. Simultaneously, digital technology has the potential to improve collaboration within supply chains across different firms, mitigate trust-related risks, and alleviate challenges associated with corporate financing, thereby fostering the growth of organizations. Furthermore, the utilization of digital technology enables firms to enhance collaboration in business operations, facilitating the growth of their operations. Additionally, it improves the efficiency of fund and information flow, thereby enhancing the financial environment of the enterprises. This enables timely mitigation of financial risks and proactive maintenance of credit, ultimately fostering sustained and stable firm development [40]. Based on this premise, this paper proposes hypothesis:

Hypothesis 2 (H2). *Firms' development of digital maturity has a moderating effect in promoting firms' supply chain finance and sustainable growth.*

As an element of corporate sustainability, financial health is critical to the continued health of the business situation. Financial leverage as a use of debt: on the one hand, firms with excessive financial leverage face direct financial costs of not being able to service their debt and other indirect costs, such as operational disruptions caused by the drawdown of credit lines and business partners. On the other hand, underleveraged firms face the risk of missing out on growth opportunities due to underinvestment and managerial conservatism, leading to competitive disadvantages [41]. Therefore, when the firm's own financial situation is different in the case of supply chain finance, the sustainable growth of the firm's role will also show different forms. When the firm's financial leverage is too high or the turnover ratio of operating current assets is too low, the increase in the supply chain level may further exacerbate the firm's business risk, which is not conducive to the sustainable growth of the firm. Consequently, this paper proposes a hypothesis:

Hypothesis 3 (H3). *Supply chain finance, under different financial positions, exerts a threshold effect over influencing sustainable growth of firms.*

China possesses an extensive land area, with significant disparities in the development of various regions, particularly between the eastern, central, and western regions. Regional variations in supply chain financing development arise from disparities in regional economic development, the foundation of industrial development, and the level of synergistic collaboration among firms. Moreover, the presence of diverse core firms in various locations results in distinct effects on the long-term viability of firms in the overall supply chain finance. Hence, the influence of supply chain finance on the future growth of firms would vary across different development regions in China. Furthermore, the role of supply chain finance in financing the production and development of firms varies due to disparities in industrial development methods, capital demand patterns, supply chain link settings, and other aspects resulting from the nature of different industries. Supply chain finance plays a crucial role in optimizing capital flows, reducing inventory costs and capital occupancy costs, and enhancing the efficiency of capital utilization. These benefits have varying impacts on the future operations and sustainable growth of firms. Thus, this paper posits a hypothesis:

Hypothesis 4 (H4). *The diversity of firms' locations and the nature of company industries have varying degrees of influence on supply chain finance as well as sustainable growth of firms.*

3. Research Design

3.1. Data Sources and Sample Selection

To delve deeper into the role of supply chain finance in promoting corporate sustainable growth within China's unique economic entity, this study selects A-share companies listed on the Shanghai and Shenzhen Stock Exchanges in China as research samples, covering the period from 2011 to 2021. The financial data in this paper come from China Stock Market and Accounting Research Database (CSMAR). Corporate digital assets are obtained from year-end intangible asset breakdowns disclosed in the notes to financial reports of listed companies. Financial reports are obtained from the China Research Data Service Platform (CNRDS) and exclude companies with missing financial data, financial industries, ST companies, and delisted companies. A total of 17,413 valid sample data points were obtained through screening.

3.2. Definition of Variables

3.2.1. Definition of Dependent Variables

Corporate sustainable growth refers to an enterprise's ability to operate on a long-term and stable basis while maintaining its current business model. This concept encompasses not only the company's survival capabilities but also multiple dimensions such as financial stability, profitability, and market competitiveness, aiming to provide a comprehensive assessment of the company's long-term development potential in a dynamic market environment. Higgins, from a financial management perspective, first introduced the concept of sustainable growth rate. Within Higgins' [14] framework, the sustainable growth rate is defined as the maximum sales growth rate that an enterprise can achieve based on current financial policies and operational efficiency without depleting existing financial resources and without reliance on external equity financing. Van Horne [42] posits that the sustainable growth rate is the maximum annual growth rate in sales that a company can support using internally generated funds, given a set level of operating efficiency and capital structure. In this study, we employ the Van Horne model to calculate the dependent variable in the base regression model. This selection underscores the ability of firms to grow without long-term external financing support and offers a dynamic perspective for assessing the potential for sustainable corporate growth. In the robustness tests, we utilize the Higgins model to recalculate the sustainable growth rate.

3.2.2. Explanatory Variables

In the realm of academic inquiry, a singular and definitive yardstick for quantifying and gauging the efficacy of corporate supply chain finance initiatives remains elusive [8]. The extant scholarly discourse has posited a duo of principal methodologies for evaluating supply chain finance: The initial technique harnesses textual analysis to discern and quantify the activities encapsulated by supply chain finance [43–45]. This methodology is predicated on the dissection of narrative content within corporate disclosures, aimed at distilling text pertinent to supply chain financial mechanisms. The alternative approach, as articulated by Yao and Huang, appraises supply chain financing through the computation of the proportion of short-term debt and notes payable in relation to overall corporate assets [46,47]. Expanding upon the conceptualization of supply chain finance and its tangible business applications, the present study advances the investigative work pioneered by Liu [9]. This research employs a composite metric, aggregating current short-term borrowings, current deferred revenues, current notes payable, and current accounts payable, in relation to total assets at the fiscal period's conclusion, to quantify supply chain financial activities. This enhanced quantification strategy mitigates the influence of subjective analysis, thereby bolstering the reliability and reproducibility of the study's conclusions. Furthermore, diverging from Yao and Huang's methodology, our enhanced metric encompasses not solely short-term borrowings and notes payable but also deferred revenues. This inclusive approach affords a more holistic representation of the financial dynamics between enterprises and their consumer base downstream, painting a comprehensive portrait of the enterprise's cash flow mechanisms and the architecture of its financial support within the supply chain ecosystem. By integrating this multifaceted evaluative technique, the study endeavors to craft a more exact and encompassing framework, designed to more accurately capture the nuances of corporate supply chain financial realities.

3.2.3. Moderating Variables

Enterprise digitization is a complex and variable process, and it is extremely hard to accurately portray digitization at the micro-enterprise level; thus, existing studies have mainly developed from a macro perspective and mostly used regional or industry-level digital economy indicators to measure digitization levels. In the few micro-enterprise-level empirical research literature, scholars mainly measure from the perspectives of information assets, information technology employees, and information system applications, based on the definition of firm digital transformation. This paper draws on the existing literature to measure the digitalization level of a firm by the proportion of the digital transformation-related portion of the year-end intangible asset breakdown items to the total intangible assets disclosed in the notes to the financial reports of listed companies [48]. Specifically, when the intangible assets detailed items include “software”, “management system”, “intelligent platform”, “blockchain” and other technologies related to digital transformation, the proportion of intangible assets to total intangible assets is calculated. When the intangible asset item contains keywords related to digital transformation technology, such as “software”, “management system”, “intelligent platform”, “blockchain”, etc., and patents related to them, the item will be defined as “digital technology intangible assets”, and then add up several intangible assets of digital technology of the same company in the same year and calculate the proportion of the current year's intangible assets, i.e., a proxy variable for the degree of digital transformation of the firm. This is a proxy variable for the degree of digital.

3.2.4. Threshold Variables

The financial leverage of the firm uses the effect of changes in EBITDA on earnings per share (elasticity); financial leverage coefficient = rate of change in earnings per share/rate of change in EBITDA.

Firm operating working capital turnover using working capital turnover = net sales revenue/average balance of working capital, working capital = current assets – current

liabilities, average balance of working capital = (beginning of year working capital + end of year working capital)/2.

3.2.5. Control Variables

Based on drawing on the existing literature [9,49], selected variables including firm size (SIZE), inventory ratio (INV), return on total assets (ROA), current assets return on investment (CAROI), the ratio of the first big proportion of shareholding; (FBPOS), earnings before interest and taxes of shareholding (EBITOS), and book value per share (BPS) among other control variables. The specific meaning of each variable is shown in the Table 1.

Table 1. Summary of control variables.

Variable	Method of Calculation
SIZE	Take the logarithm of total annual assets
INV	Net balance of Inventory/Total assets
ROA	Net Profit/Average balance of Total assets
CAROI	Net profit/Average Balance of Circulating Funds
FBPOS	The first big number of shareholding/Total number of shares
EBITOS	Earnings Before Interest and Tax/Total number of shares
BPS	Shareholders' equity/total number of shares

3.3. Construction of the Model

3.3.1. Baseline Model

The benchmark model is used to estimate the impact of supply chain finance on sustainable growth of firms, and the following model is constructed:

$$SGR_{it} = \alpha_0 + \alpha_1 SCF_{it} + \alpha_2 Control_{it} + \alpha_3 \sum year_t + C_i + \varepsilon_{it} \quad (1)$$

Here the subscripts i and t stand for individual firms and years, respectively. SGR stands for sustainable growth of firms. SCF stands for the level of supply chain finance of firms. $Control_{it}$ represents control variables that may affect the sustainable growth of firms. C_i denotes the individual fixed effect for firm i , which is utilized to control for unobservable factors that influence firm performance and remain constant over time. $\sum year_t$ is employed to control for time-varying factors that are invariant across individuals. Additionally, ε is incorporated as the model's stochastic error term.

3.3.2. Moderating Effects Modelling

To further analyze the relationship between the development of digital technology of firms on supply chain finance and sustainable growth of firms, we set up a moderating effect model for empirical analysis. Based on the baseline model, we add the interaction term ($Dig_{it} * SCF_{it}$) between digital technology development and supply chain finance. The presence of a moderating effect is determined by assessing the significance of the interaction term. The role of the development of digital technology is discerned by examining the coefficient of the interaction term, which allows us to ascertain the impact that the evolution of digital technology has on the model.

$$SGR_{it} = \beta_0 + \beta_1 SCF_{it} + \beta_2 Control_{it} + \beta_3 Dig_{it} + \beta_4 Dig_{it} * SCF_{it} + \beta_5 \sum year_t + C_i + \varepsilon_{it} \quad (2)$$

In the study, Dig represents the level of digital technology development within a firm.

3.3.3. Threshold Model Construction

To further investigate whether the impact of supply chain finance on corporate sustainability will have nonlinear characteristics under different financial conditions, the panel model is extended by embedding the threshold model in the panel model and determining the threshold value through the lattice search algorithm.

We first test the threshold effect of financial leverage. Based on the threshold regression model, the model is constructed as follows:

$$SGR_{it} = \gamma_0 + \gamma_1 SCF_{it} * \tau(LEV_{it} < \theta_1) + \gamma_2 SCF_{it} * \tau(\theta_1 < LEV_{it} < \theta_2) + \gamma_3 SCF_{it} * \tau(LEV_{it} > \theta_2) + \gamma_4 Control_{it} + \gamma_5 \sum year_t + C_i + \varepsilon_{it} \quad (3)$$

In this context, γ represents the unknown threshold value; LEV_{it} denotes the threshold variable, which is utilized to identify and capture the non-linear or structural change points in the relationship between the explanatory and the explained variables; τ signifies a dummy variable taking the value of 0 or 1, with all other variables remaining consistent with the previous formulation.

Finally, we examine the threshold effect of the turnover rate of operating current assets. Based on Model (3), we replace the threshold variable with the following model:

$$SGR_{it} = \delta_0 + \delta_1 SCF_{it} * \tau(WCTR_{it} < \sigma_1) + \delta_2 SCF_{it} * \tau(\sigma_1 < WCTR_{it} < \sigma_2) + \delta_3 SCF_{it} * \tau(WCTR_{it} > \sigma_2) + \delta_4 Control_{it} + \delta_5 \sum year_t + C_i + \varepsilon_{it} \quad (4)$$

where σ denotes the threshold variable, WCTR is the operating current asset turnover ratio, and the other variables are the same as in the previous equation.

4. Empirical Results

4.1. Descriptive Statistical Analysis

The descriptive statistics are presented in Table 2 below. The minimum value of SGR is -0.223 ; the maximum value is 0.944 , which indicates that there is a significant difference in sustainable growth among the firms. The minimum SCF value is 0 and the maximum value is 0.745 , indicating an overall growth in the level of supply chain finance among firms. Other variables also differed to varying degrees, setting the stage for this study.

Table 2. Benchmark regression and the moderating effect.

Variables	(1) SGR	(2) SGR
SCF	0.016 *** (0.00)	0.014 *** (0.01)
SIZE	-0.003 *** (0.00)	-0.003 *** (0.00)
INV	-0.021 *** (0.00)	-0.022 *** (0.00)
ROA	0.309 *** (0.01)	0.309 *** (0.00)
CAROI	-0.017 *** (0.00)	-0.017 *** (0.00)
FBPOS	0.000 *** (0.00)	0.000 *** (0.00)
BPS	-0.002 *** (0.00)	-0.002 *** (0.00)
EBITOS	0.011 *** (0.00)	0.011 *** (0.00)
DIG		0.002 (0.00)
DIG * SCF		0.026 *** (0.01)
CONSTANT	0.095 *** (0.01)	0.095 *** (0.01)
N	17,413	17,413
R ²	0.37	0.37
ID	Control	Control
YEAR	Control	Control

Note: *** in the table are significant at the level of 1%; values in parentheses are standard errors.

4.2. Benchmark Regression Results

Initially, a panel unit-root test was conducted on the variables, and the results indicated stationarity; that is, the variables were found to be free from unit roots. Subsequently, a Hausman test was employed to determine the appropriate panel data model specification. The outcome of the Hausman test provided evidence in favor of employing a fixed effects model over a random effects model. As can be seen from column 1 of Table 2, the regression coefficient between SCF and SGR is positive, and the regression coefficient is 0.016 , which is significant at the 1% level. In other words, SCF can promote the sustainable growth of firms, so Hypothesis 1 is verified. This finding is consistent with the research of Huang [47]

and supports Hypothesis 1. A potential explanation is that supply chain finance enables enterprises to secure financing for a set period, which in turn ameliorates their financial status. This assistance allows for the expansion of the enterprise's scale and an increase in R&D investment, leading to an improvement in core competitiveness and fostering sustained enterprise growth.

4.3. Analysis of Moderating Effect

To test the hypothesis, this paper discusses the impact of lower supply chain finance on the sustainable growth of firms under digital technology from the perspective of firm digital transformation.

4.3.1. The Impact of Firm Digital Technology

In Table 3, Column (2), the main effect coefficient is positive and significant at the 1% level, and the interaction term coefficient is also positive. This indicates that digital technology enhances the positive impact of supply chain finance on the sustainable growth of firms, thereby providing strong support for Hypothesis 2, which is corroborated to some extent by related research [50]. A possible explanation for this is that, on one hand, the development of digital technology can strengthen a firm's technological capabilities by investing funds obtained through supply chain finance into technological research and development, allowing the firm to maintain its core competitive edge. On the other hand, the advancement of digital technology within firms reduces information asymmetry between businesses, thereby diminishing moral hazard and the likelihood of default events, which in turn further enhances the firm's capacity for sustainable growth.

Table 3. Threshold estimates and confidence intervals.

Threshold Variables	Number of Thresholds	Estimated Threshold	95% Confidence Interval	Interval
LEV	Double threshold	0.953 ***	0.949	0.953
		1.258 ***	1.257	1.259
WCTR	Double threshold	0.584 ***	0.561	0.585
		1.201 ***	1.166	1.202

Note: *** in the table are significant at the level of 1%.

4.3.2. Threshold Model Analysis Results

LEV 5% critical value construction of the thresholds and WCTR 5% critical value construction of the thresholds as follows Figures 1 and 2. The threshold analysis model can give us a clearer understanding of the estimation of the threshold and the construction process of the confidence interval.

The parameter estimation results reflect the statistical relationship between the core explanatory variables and the explanatory variables after dividing the threshold variable into several intervals. The estimated results of the model parameters are shown in Tables 3 and 4.

Table 4. Regression results of threshold effect.

Variables	LEV	WCTR
Col($LEV < \theta_1$)	0.000 (0.00)	
Col($\theta_1 < LEV < \theta_2$)	0.028 *** (0.00)	
Col($LEV > \theta_2$)	−0.024 *** (0.00)	
Col($WCTR < \sigma_1$)		−0.015 *** (0.00)
Col($\sigma_1 < WCTR < \sigma_2$)		0.007 * (0.00)

Table 4. Cont.

Variables	LEV	WCTR
Col(WCTR > σ_2)		0.025 *** (0.00)
SIZE	−0.002 *** (0.00)	−0.002 *** (0.00)
INV	−0.016 *** (0.00)	−0.017 *** (0.00)
ROA	0.294 *** (0.01)	0.306 *** (0.01)
CAROI	−0.017 *** (0.00)	−0.017 *** (0.00)
FBPOS	0.000 *** (0.00)	0.000 *** (0.00)
BPS	−0.002 *** (0.00)	−0.002 *** (0.00)
EBITOS	0.010 *** (0.00)	0.011 *** (0.00)
CONSTANT	0.089 *** (0.01)	0.083 *** (0.01)
N	17,413	17,413
R ²	0.37	0.36

* and *** in the table are significant at the level of 10% and 1% respectively; values in parentheses are standard errors.

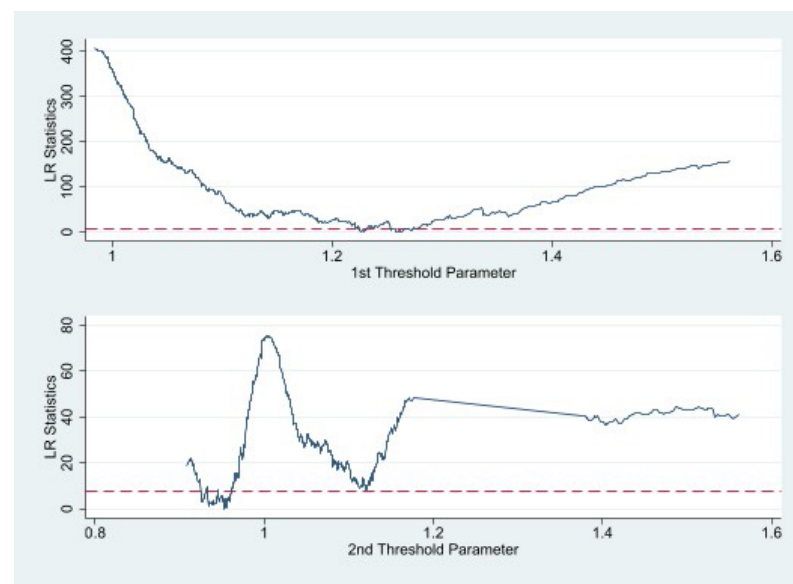


Figure 1. LEV 5% critical value construction of the thresholds.

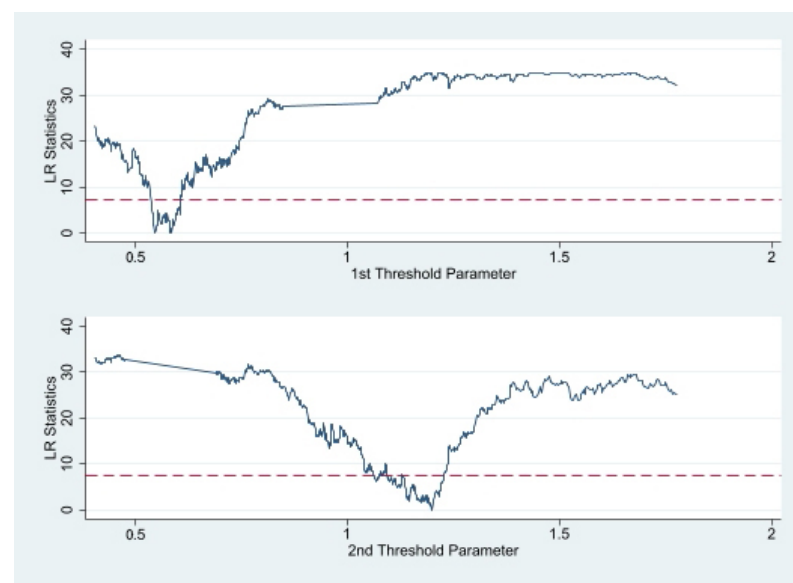


Figure 2. WCTR 5% critical value construction of the thresholds.

When corporate financial leverage is the threshold variable, the regression coefficients of are 0.00, 0.028, and -0.024 in the three stages, respectively, and the second and third are all significant at the 1% level. The regression coefficient of the second paragraph is positive, indicating that when the financial leverage is less than the second threshold value, the impact of supply chain finance on the sustainable growth of firms is positive. However, when the financial leverage reaches a certain level and crosses the corresponding threshold, the financial leverage harms the sustainable growth of firms. The empirical results show that under the influence of financial leverage, there is a nonlinear transition between supply chain finance and corporate sustainability, which indicates that there is a threshold effect. In the current academic field, the role of financial leverage as a moderating factor and the threshold effect in the specific context of China's stock market have not been deeply explored.

When the operating asset turnover is used as the threshold variable, the regression coefficients are -0.015 , 0.007, and 0.025, respectively, in the three stages, which are significant at the 1% level, the 10% level, and the 1% level, respectively. The regression coefficient of the first paragraph is negative. The regression coefficient of the first paragraph is negative, indicating that when the turnover of operating assets is less than the threshold value, the impact of supply chain finance on the sustainable growth of firms is negative, but when the turnover of operating capital crosses the second corresponding threshold, the impact of operating asset turnover on the sustainable growth performance of firms becomes positive. At the same time, when it crosses the third threshold, the impact of supply chain finance on corporate sustainable growth is greatly increased. The empirical results show that there is a threshold effect on operating asset turnover.

A possible explanation for this phenomenon is that once a company's financial condition reaches a certain critical threshold, supply chain finance may exacerbate the firm's financial risks. This heightened risk could pose a significant threat to the enterprise. Research in the existing literature on the relationship between corporate financial risk and business development [51] provides theoretical support for our findings. Consequently, the empirical results further substantiate Hypothesis 3, indicating a nonlinear transformation in the impact of supply chain finance on corporate sustainable development under different financial health conditions, suggesting the presence of a threshold effect. Within the current academic domain, the role of varying financial health as a moderating factor, as well as the threshold effects within the specific context of the Chinese stock market, have not been deeply explored. This study not only offers a new perspective for understanding the complex mechanisms of supply chain finance but also provides empirical support for the associated theories.

4.4. Heterogeneity Analysis

4.4.1. Heterogeneity of Different Industries

Columns 1 to 4 of Table 5 report the regression results by industry type. The SCF coefficients in columns 1 and 4 are positive at the significance level at the 1% level, indicating that supply chain finance has a positive impact on the sustainable growth of real estate firms, service firms, manufacturing firms, commercial and trade firms, and comprehensive firms. In addition, the comparison of coefficients shows that the supply chain plays different roles in different types of firms, and the promotion effect of supply chain finance on service and trade enterprises is more obvious. The possible reason for this is that supply chain finance is usually in the middle and lower reaches of the supply chain, which has a more urgent need for funds and is more susceptible to the influence of upstream and downstream links. Supply chain finance can integrate supply chain resources, provide more flexible financing services, and optimize capital flow so as to better promote the sustainable growth of firms.

Table 5. Heterogeneity of different types of enterprises.

Variables	Commercial Enterprise	Service- Oriented Businesses	Integrated Enterprises	Manufacturing Enterprises
	(1) SGR1	(2) SGR2	(3) SGR3	(4) SGR4
SCF	0.026 *** (0.01)	0.028 *** (0.01)	0.014 *** (0.00)	0.017 *** (0.00)
SIZE	−0.001 (0.00)	−0.005 ** (0.00)	−0.004 *** (0.00)	−0.002 *** (0.00)
INV	0.024 *** (0.01)	−0.057 ** (0.01)	−0.011 *** (0.00)	−0.013 *** (0.00)
ROA	0.170 *** (0.03)	0.344 *** (0.02)	0.234 *** (0.02)	0.371 *** (0.01)
CAROI	0.034 *** (0.01)	−0.045 ** (0.01)	−0.059 *** (0.01)	−0.007 ** (0.00)
FBPOS	0.000 *** (0.00)	0.000 ** (0.00)	0.000 *** (0.00)	0.000 *** (0.00)
BPS	−0.001 *** (0.00)	−0.0006 * (0.00)	−0.001 *** (0.00)	−0.002 *** (0.00)
EBITOS	0.005 *** (0.00)	0.007 *** (0.00)	0.008 *** (0.00)	0.008 *** (0.00)
CONSTANT	0.043 ** (0.03)	0.162 *** (0.03)	0.123 *** (0.12)	0.017 *** (0.00)
N	935	2915	1309	11,781
R ²	0.35	0.30	0.33	0.44
ID	Control	Control	Control	Control
YEAR	Control	Control	Control	Control

Note: *, ** and *** in the table are significant at the level of 10%, 5%, and 1% respectively; values in parentheses are standard errors.

4.4.2. Heterogeneity in Different Regions

Columns 1 to 3 of Table 6 report the regression results according to the types of eastern, middle, and western regions in China's administrative divisions. The coefficient is positive at the significance at the 1% level, indicating that the acquisition of supply chain finance has a positive impact on the sustainable growth of firms in different regions. However, the comparison of coefficients shows that the impact of supply chain finance on the sustainable growth of firms is different in different regions, and the influence coefficient of supply chain finance on the sustainable growth of firms is the largest in the central region. The explanation for this is that the economic development level of the central region is in the middle position, with both a certain industrial foundation and more development potential, so the demand for the supply chain is more urgent. Enterprises are more susceptible to the positive influence of supply chain finance. At the same time, due to the difference in financial resource allocation, compared with the eastern and western regions, the debt financing cost in the central region is the highest [52], so the enterprises in the central region are more likely to benefit from the financing of supply chain finance.

Table 6. Heterogeneity in different regions.

Variables	East	Center	West
	(1) SGR1	(2) SGR2	(3) SGR3
SCF	0.015 *** (0.00)	0.040 *** (0.01)	0.013 ** (0.01)
SIZE	−0.006 *** (0.00)	−0.004 *** (0.00)	−0.003 *** (0.00)
INV	−0.033 *** (0.00)	−0.030 *** (0.01)	−0.010 (0.01)
ROA	0.282 *** (0.01)	0.300 *** (0.01)	0.352 *** (0.08)
CAROI	0.040 *** (0.00)	0.026 *** (0.01)	−0.010 *** (0.00)
FBPOS	0.000 *** (0.00)	0.000 (0.00)	0.000 *** (0.00)
BPS	−0.002 *** (0.00)	−0.001 (0.00)	−0.001 *** (0.00)
EBITOS	0.017 *** (0.00)	0.012 *** (0.00)	0.011 *** (0.00)
CONSTANT	0.165 *** (0.01)	0.119 *** (0.25)	0.102 *** (0.02)
N	12,705	2222	1775
R ²	0.33	0.52	0.53
ID	Control	Control	Control
YEAR	Control	Control	Control

Note: ** and *** in the table are significant at the level of 5%, and 1% respectively; values in parentheses are standard errors.

The research findings on the heterogeneity across different industries and regions substantiate the validation of Hypothesis 4. The outcomes of this research align with the discoveries documented in the extant literature [46,53], thereby enhancing the credibility of the conclusions presented in this study.

4.5. Robustness Testing

4.5.1. Test Its Endogeneity with Two-Stage Regression

We use the idea of controlling endogenous problems for robustness tests. Since there may be endogeneity caused by missing variables in the selection process of model variables, we use a two-stage instrumental variable regression model to solve the endogeneity problem. Based on referring to existing literature [54]. The firm minus industry mean (ZASCF) and the first leg of SCF (LSCF) are used as instrumental variables. Specifically, in the weak instrumental variable test, the F-statistic reported in column 1 of Table 7 is 1570.30, which indicates that the instrumental variable we use is strong. The second-stage regression results in column 2 of Table 7 show that the relationship between supply chain finance and sustainable growth rate is still robust after considering the endogenous relationship. The supply chain finance variable passed the identification test (p value is 0.76, indicating that all instrumental variables are exogenous). Overall, the results suggest that the relationship between supply chain finance and sustainable growth of firms is not driven by endogeneity issues.

Table 7. Robustness analysis table.

Variables	SCF	(1) SGR1	(2) SGR2	(3) SGR3
ZASCF	45.89 *** (1.04)			
SCF	−3.632 *** (1.12)			
SCF		0.032 *** (0.01)	0.116 *** (0.01)	0.009 *** (0.00)
Size	0.014 *** (0.00)	−0.003 *** (0.00)	−0.005 *** (0.00)	−0.004 *** (0.00)
INV	0.193 *** (0.01)	0.024 *** (0.00)	−0.033 *** (0.01)	−0.018 *** (0.00)
ROA	−0.023 *** (0.02)	0.342 *** (0.01)	0.495 *** (0.02)	0.309 *** (0.00)
CAROI	−0.031 *** (0.01)	0.030 *** (0.00)	−0.013 ** (0.01)	−0.022 *** (0.00)
FBPOS	0.000 **** (0.00)	0.000 *** (0.00)	0.000 *** (0.00)	0.000 *** (0.00)
BPS	−0.005 *** (0.00)	0.002 *** (0.00)	−0.005 *** (0.00)	−0.002 *** (0.00)
EBITOS	0.013 *** (0.00)	0.009 *** (0.00)	0.027 *** (0.00)	0.016 *** (0.00)
Constant	7.659 *** (0.16)	0.102 *** (0.01)	0.150 *** (0.03)	0.114 *** (0.01)
N	16,130	16,130	17,413	17,413
R ²	0.853	0.35	0.22	0.45
Anderson canon corr	2871.83 (0.00)			
LM Statistic				
Cragg-Donald	1570.30 (19.9)			
Wald F Statistic				
Sargan		0.09 (0.76)		

Note: ** and *** in the table are significant at the level of 5%, and 1% respectively; values in parentheses are standard errors. LM and F parentheses report critical values at the 10% level. Sargan shows the p -value in parentheses.

4.5.2. Using Alternative Variables

The robustness analysis is conducted by replacing variables, and Higgins' sustainable growth model is used to calculate the sustainable growth capacity of firms as the dependent variable for regression. The regression results in column 3 of Table 7 show that the SCF regression coefficient is still positive and significant at the 1% level.

4.5.3. Tail Reduction Test

The explained variable of firm sustainable growth in this paper is winnowing by 1% on both sides to avoid the possible impact of outliers on the regression results, and then a winnowing test is carried out. The results in column 4 of Table 7 pass the two-tailed test.

5. Conclusions

Currently, investigating the potential and impact of supply chain finance in advancing the sustainable growth of enterprises has garnered significant attention from both academia and industry. This study is centered on this topic and aims to elucidate how supply chain finance can facilitate enterprises in achieving sustainable growth. Through an analysis of data from China's A-share listed companies spanning the period between 2011 and 2021, this research reveals that supply chain finance significantly contributes to the promotion of corporate sustainable growth, particularly within commercial and trading enterprises, as well as regional enterprises with more developed financial systems. Moreover, this study delves into the moderating effects of firms' digitalization levels and financial health on the relationship between supply chain finance and firm sustainability, uncovering the pivotal roles played by these two factors. The findings indicate that the level of digital development within an enterprise positively regulates the relationship between supply chain finance and enterprise sustainable growth. Additionally, the financial condition of the enterprise exhibits a threshold effect on the relationship; when the enterprise's financial leverage falls below the threshold, it positively promotes sustainable growth, whereas the turnover rate of a firm's operating assets is below the threshold, it has a negative effect; however, once it exceeds the threshold, it exerts a positive promotional effect. The results above demonstrate that the influence of supply chain finance on corporate sustainable growth varies depending on different financial conditions.

Based on the above research conclusions, this paper puts forward the following recommendations. Firstly, enterprises should actively adopt supply chain finance tools to accelerate the flow of goods and funds in the supply chain to better enhance capital liquidity and operational efficiency, including the adoption of supply chain financing, payment solutions, and risk management, etc., with the aim of enhancing enterprise competitiveness and sustainable growth. Second, enterprises should integrate digital technologies like the Internet of Things, big data analytics, and artificial intelligence to improve the predictive and responsive capabilities of the supply chain, enhancing market adaptability and competitiveness. Third, enterprises need to implement dynamic financial risk management, use real-time data to monitor their financial health, and adopt flexible supply chain financial products to optimize capital efficiency. It is crucial for enterprises to tailor their supply chain finance strategies to regional financial ecosystems and business requirements, particularly in areas with limited financial resources, to address funding challenges and promote long-term growth through innovative financing models in collaboration with financial institutions. Lastly, governments should implement policies to encourage businesses to utilize supply chain finance. This can be carried out by offering financial and tax incentives to lower adoption expenses, integrating supply chain finance with digital technology, and establishing risk assessment and early warning systems. These measures will help foster a healthy market development and support the sustainable growth of businesses.

6. Research Limitations and Future Research Directions

While this study has delved into the impact of supply chain finance on the sustainable growth of Chinese A-share listed companies, it is not without its limitations. Firstly, our current research does not take into account the structural characteristics of the supply chain, such as customer and supplier concentration. Therefore, in future research, we will incorporate the structural features of the supply chain into our study. Secondly, we have only examined Chinese listed companies within a specific time frame. However, due to the unique national conditions of China, it is uncertain whether the conclusions drawn would hold in other countries. Thus, in future studies, we will expand our research subjects and sample scope, particularly to include other representative countries internationally and extend the time span. Lastly, our current research lacks consideration of factors beyond the enterprises themselves, which may have led to the omission or failure to explore some more interesting issues. In future research, we will consider the impact of macroeconomic policy changes and other factors on their mechanisms of action.

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