



Research on the Mechanism of Digital Finance Enabling Supply Chain Resilience Enhancement

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Abstract. This study measures the impact of digital finance on supply chain resilience through entropy-weighted firm-level metrics using A-share listed Chinese firms from 2013-2022. The findings show that digital finance significantly enhances supply chain resilience, which is verified by robustness checks. Mechanistic analysis reveals a dual pathway: mitigating financial mismatch through precise resource allocation and accelerating digital transformation through cloud-based solutions. Heterogeneity tests highlight the amplification effect of financially constrained firms, non-state-owned firms and small firms, demonstrating the role of digital finance in leveling the playing field. The findings advocate the establishment of a digital finance-supply chain synergy ecosystem to balance innovation incentives with systemic risk mitigation. These insights inform policymakers in realizing the goals of China's 14th Five-Year Plan, particularly in the development of smart self-healing supply chains that can withstand geopolitical and operational disruptions. The study provides empirical evidence for supply chain theory in the digital age, while suggesting feasible strategies for achieving secure, innovation-driven industrial modernization.

Keywords: Digital Finance, Supply Chain Resilience, Digital Transformation

1 Introduction

As global supply chains face growing fragmentation risks, As global supply chains face increasing risks of fragmentation, China's 14th Five-Year Plan emphasizes building resilient systems. Supply chain resilience-the ability to prevent disruptions, maintain operations, and recover from shocks-has become critical to competitiveness. Digital financial tools using cloud analytic and artificial intelligence can improve supply chain resilience in two ways: (1) balancing real-time supply and demand matching; and (2) enabling rapid crisis response. These tools reduce financial inefficiencies while accelerating digital upgrades, strengthening China's industrial modernization.

This study examines the influencing factors of supply chain resilience through dual dimensions: external environment and internal enterprise capabilities. Externally, the deep integration of the digital economy with real industries enables enterprises to utilize digital infrastructure for real-time monitoring of supply chain operations, fa-

ilitating rapid risk identification and response mechanisms^[1]. Concurrently, government policies promoting supply chain innovation have accelerated cross-organizational collaboration and digital transformation across supply chain tiers, thereby enhancing systemic stability^[3]. Internally, enterprises strengthen adaptive capacities through technological innovation and operational optimization. The adoption of advanced production technologies and intelligent management models improves resource allocation efficiency and risk resistance^[4]. Moreover, the convergence of information and logistics technologies mitigates operational uncertainties, enhancing supply chain security and economic resilience in the face of external shocks^[5].

Our study utilizes data from listed companies in China from 2013-2022 to link digital finance to supply chain resilience. Advanced metrics and mediation models reveal two paths to improvement: first, addressing the “triple mismatch” (attribute/domain/stage) of traditional finance to alleviate small and medium-sized enterprises (SME) financing gaps^[6]; and second, facilitating digital transformation through transparent operations and supplier networks. The direct and mediating effects influence the mechanism, with a view to revealing the complexity of the relationship between the two more comprehensively.

2 Theoretical Analysis and Research Hypotheses

Supply chains confront structural deficiencies, operational volatility, and insufficient restorative capacity, driving operational fractures that undermine resilience. This study examines digital finance's dual-path enhancement mechanism: direct resource optimization and indirect technological synergies to strengthen risk resistance and adaptive recovery protocols.

2.1 Digital Finance Directly Strengthens Corporate Supply Chain Resilience

The traditional financial system relies on fragmented corporate information disclosure, leading to persistent information asymmetry. Digital finance solves this problem by integrating real-time supply chain data on production, sales, and logistics into financial decisions, improving transparency and risk identification^[6]. Rooted in resource-based theory, digital finance uses core operational metrics to dynamically allocate credit to SMEs, replacing rigid lending models with responsive capital flows.

Digital finance mitigates supply chain disruptions through real-time demand synchronization, which aligns production with actual consumption, thereby curbing the bullwhip effect. For example, retailers' sales data can directly inform production adjustments, thereby reducing speculative inventories. After disruptions, AI-driven tools match idle capacity with urgent demand, while multi-channel financing speeds recovery^[2]. By converting offline transactions into a continuous stream of data, digital finance enables proactive risk management. Upstream firms can detect changes in demand early, thus facilitating flexible adaptation. Unlike traditional reactive approach-

es, digital finance enables resilience through predictive analytic and dynamic resource optimization. Digital finance transforms supply chains from passive risk buffers to active, self-regulating ecosystems. Based on this, the hypothesis is formulated:

H1: Digital finance can significantly contribute to supply chain resilience.

2.2 Digital Financial Empowerment's Indirect Role in Supply Chain Resilience

Digital finance strengthens supply chain resilience through two interrelated mechanisms. First, it uses advanced analytic to align credit allocation with the risk profile of SME, countering systemic financial exclusion through inclusive design^[7]. By distributing risk equitably, this approach addresses resource mismatch and ensures liquidity flows to viable businesses. Second, digital finance drives the digital transformation of firms by embedding real-time supply chain analytic and shared information platforms. These tools enable proactive risk mitigation and enhanced post-disruption coordination. For example, downstream firms use consumer and market data to optimize R&D investments and align production with actual demand, thereby minimizing the risk of "broken chains" due to supply-demand mismatches.

Together, these mechanisms address structural vulnerabilities and operational rigidity. By synchronizing financial flows with dynamic market signals, digital finance facilitates the development of adaptive systems that can pre-empt disruptions and accelerate recovery^[8]. We hypothesize:

H2: Digital finance strengthens resilience by mitigating financial mismatches through risk-optimized resource allocation.

H3: It enhances supply chain agility via data-driven operational alignment, minimizing disruption propagation.

The dual effects demonstrate how intelligent resource orchestration (credit optimization) and systemic adaptability (real-time analytic) jointly reconfigure supply chains into vulnerable networks. This transformation shifts governance paradigms from reactive risk buffering to proactive resilience embedding, where financial-technological synergies convert disruptions into innovation catalysts.

3 Research Design

3.1 Modeling

1. Baseline Regression Model. According to the previous analysis, digital finance can empower the improvement of supply chain resilience, in order to verify the hypothesis, the benchmark regression model is constructed as follows: Displayed equations are centered and set on a separate line.

$$SCR_{it} = a_0 + a_1 DIF_{it} + a_2 Control_{it} + v_{it} + \mu_{it} + \varepsilon_{it} \quad (1)$$

Where i and t denote firms and years, respectively; SCR_{it} is the explanatory variable, supply chain resilience; DIF_{it} is the explanatory variable, digital finance; $Control_{it}$

denotes a series of control variables; v_{it} , μ_{it} , ε_{it} are time effects, individual effects, and random disturbance terms, respectively.

2. Mediating Effects Model. In order to further test the possible mediating effects of financial mismatch and enterprise digital transformation in digital finance-enabled supply chain resilience enhancement, a mediating effect model is constructed based on equation (1) according to Jiang as follows: Displayed equations are centered and set on a separate line^[9].

$$\text{Mediator}_{it} = b_0 + b_1 \text{DiF}_{it} + b_2 \text{Control}_{it} + v_{it} + \mu_{it} + \varepsilon_{it} \quad (2)$$

Where Mediator_{it} is the mediating variable, which in the article represents the degree of financial mismatch and digital transformation.

3.2 Definition of Variables

1. Explained Variables. This study measures supply chain resilience (SCR) through a dual-dimensional indicator system encompassing resistance and regulation capacities. The resistance dimension evaluates structural vulnerabilities via five metrics: supplier concentration (proportion of top five suppliers in total procurement), customer concentration (share of top five customers in total sales), financial relationships (aggregate ratio of receivables and prepayments to revenue), return on equity (dividend-reinvested annualized returns), and the whiplash effect (deviation between production volatility and demand fluctuations). The regulation dimension quantifies operational adaptability through inventory turnover, accounts receivable turnover, and accounts payable turnover. To ensure methodological objectivity, the entropy weighting method is employed to determine indicator weights based on intrinsic data variability, effectively mitigating subjective bias through information entropy calculations that capture underlying data patterns. The composite SCR index is derived from the entropy-weighted aggregation of these eight indicators. Logarithmic transformation is further applied to normalize scale discrepancies across heterogeneous metrics, enhancing data comparability while preserving the statistical validity of resilience measurement. This systematic approach integrates structural robustness and operational flexibility to holistically assess supply chain resilience dynamics.

2. Core Explanatory Variables. This study utilizes the Peking University Digital Inclusive Finance Index (developed by their Digital Finance Research Center) to measure regional development^[10]. City-level enterprise data undergo logarithmic transformation to mitigate numerical disparities, ensuring robust assessment of digital financial inclusion.

3. Mediating Variables. Financial mismatch indicator (*FD*): The indicator uses the degree of deviation of the cost of firms' access to finance from the average cost of firms' access to finance in the industry to measure the degree of deviation.

Digital transformation (*DCG*): Following Wu's (2021) methodology, *DCG* is measured by the frequency of digitization-related words $\ln(\text{total}+1)$ in annual reports across five dimensions^[11].

4. Control Variables. The following control variables are selected: (1) corporate growth (*GROWTH*): expressed as the growth rate of the firm's operating income; (2)

gearing ratio (*LEV*): expressed as the ratio of total assets to total liabilities; (3) management expense ratio (*MFEE*): expressed as the ratio of management expenses to operating income; (4) return on total assets (*ROA*): expressed as the ratio of net profit to total assets; (5) Number of shares held by the first largest shareholder (*TOPI*): expressed as the ratio of the number of shares held by the first largest shareholder to the total number of shares, and the descriptions and descriptive statistics of each of the above variables are shown in Table 1.

Table 1. Variable definitions and descriptive statistics

Variable type	VarName	Obs	Mean	Median	SD	Min	Max.
explanatory variable	<i>SCR</i>	18585	-2.509	-2.600	0.472	-3.310	-0.775
explanatory variable	<i>DIF</i>	18585	5.535	5.592	0.229	4.890	5.862
	<i>GROWTH</i>	18584	0.317	0.117	7.497	-0.952	944.100
	<i>LEV</i>	18585	0.417	0.407	0.200	0.010	1.957
control variable	<i>MFEE</i>	18585	0.087	0.069	0.097	-0.111	7.630
	<i>ROA</i>	18585	0.036	0.037	0.080	-1.856	0.786
	<i>TOPI</i>	18585	33.819	31.400	14.897	2.430	89.990

3.3 Data Sources

This paper selects A-share listed companies from 2013-2022 as the research object, and the relevant data are obtained from CSMAR, China Research Data Service Platform (CNRDS), and the digital finance data are obtained from “Peking University's Digital Inclusive Finance Index (2013-2022)”. Data processing: ST/*ST/listed companies and financial firms were excluded; continuous variables were subjected to 1% Winsorization. Table 1 shows the SCR statistics, which reveal significant differences in corporate supply chain resilience and potential for improvement.

4 Analysis of Empirical Results

4.1 Baseline Regression

Table 2. Baseline regression results

variant	(1)	(2)
<i>DIF</i>	0.2725** (2.053)	0.2642** (1.973)
<i>GROWTH</i>		0.0060** (2.133)
<i>LEV</i>		0.0396 (1.044)
<i>MFEE</i>		-0.3874** (-2.335)
<i>ROA</i>		0.4414***

		(6.064)
<i>TOPI</i>		0.0013**
		(2.186)
Constant	-3.8797***	-3.8866***
	(-5.757)	(-5.724)
Observations	18,585	18,584
Number of id	3,288	3,288
R-squared	0.125	0.168
year FE	YES	YES
stkcd FE	YES	YES

In order to determine the type of the benchmark regression model, Hausman test was conducted and according to the results the fixed effect model should be selected. Table 2 presents baseline regression results using a time-individual two-way fixed-effects model. *DIF* coefficients are 0.2725 and 0.2638, both Significant at the five percent level, confirming H1 that digital finance enhances supply chain resilience. This effect arises from its dual role: providing timely financial support through inclusive credit tools and improving inter-firm information transparency via block chain and big data analytic. These mechanisms help firms stabilize operations during shocks, accelerate recovery, and maintain supply chain continuity, thereby strengthening systemic resilience and security.

4.2 Robustness Tests

1. Consider Omitted Variables. Two control variables are introduced: firm age and auditor type. Firms with longer years of experience have better management systems and experience in dealing with market volatility, which can positively affect supply chain resilience. Big 4 audit firms tend to be perceived as having higher financial transparency and audit quality, which is associated with a firm's risk management capabilities and supply chain transparency, which in turn affects supply chain resilience. The regression results displayed in columns (1) and (2) of Table 3 show that the coefficient on digital finance is significantly positive at the 5% level, which is consistent with the results of previous studies.

2. Use of more stringent fixed effects. In addition to controlling for time-individual fixed effects, incorporate industry fixed effects. Since there may be inherent differences in the operating models and market environments of different industries, these factors may have an impact on supply chain resilience. The coefficient of digital finance after regression is significantly positive at the 10% level, indicating the robustness of the empirical results.

3. Instrumental Variables Approach. 2SLS uses instrumental variables combining regional internet penetration and firm-provincial capital distance to address endogenous. The regional Internet penetration rate reflects the infrastructure level of digital financial development in the region, and the distance between the enterprise and the provincial capital city affects the enterprise's convenience and efficiency in accessing digital financial services. The interaction term can comprehensively reflect the state of digital finance development in the region where the enterprise is located and is

related to the enterprise's supply chain resilience performance. After estimation, digital finance retains a significant positive coefficient, a significant coefficient on the unidentifiable test, and a weak instrumental variable test with a coefficient of 24.417, which passes the under-identified and weak instrumental diagnostics. Together, these tests validate that the increase in supply chain resilience stems from the adoption of digital finance rather than unobserved factor, exceeding critical thresholds in both statistical significance and economic significance dimensions.

4. Other Robustness Tests. Firms whose location is a municipality are excluded, considering that the degree of digital finance varies somewhat by city administrative level. To control for unobserved financial shocks, stock market anomalies in 2015 are excluded because their effects cannot be quantified. The coefficients are 0.2868 and 0.2450 for digital finance respectively are significantly positive, confirming the findings.

Table 3. Robustness test results

	(1)	(2)	(3)	(4)	(5)	(6)
	Consider omitted variables	Tighter fixed effects	Excluding municipalities	Shorten the sample interval	first satge	second satge
<i>VI</i>					0.0211*** (0.0043)	
<i>DIF</i>	0.2635** (1.967)	0.2383* (1.918)	0.2868** (2.086)	0.2450* (1.814)		1.3060** (0.4922)
Controls	YES	YES	YES	YES	YES	YES
Constant	-3.6695*** (-7.108)	-3.7691*** (-6.011)	-3.9741*** (-5.749)	-3.7807*** (-5.519)	5.6096*** (0.0077)	-9.9833*** (2.7654)
Observations	18,578	18,584	14,629	17,281	14604	14604
year FE	YES	YES	YES	YES	YES	YES
stkcd FE	YES	YES	YES	YES	YES	YES
industry FE	NO	YES	NO	NO	NO	NO

5 Further Analysis

5.1 Analysis of Mediating Effects

The theoretical framework argues that digital finance can mitigate financial mismatches and facilitate digital transformation of firms, thereby increasing risk resilience. Drawing on Jiang's framework for mediation analysis, the article employs a simplified two-step approach to address endogenous issues inherent in traditional three-step mediation tests^[9].

1. Financial Mismatch Mitigation. To verify that digital finance enhances supply chain resilience by mitigating financial mismatch, the mediation model is adopted, and the results are shown in Table 4. column (1) shows that digital finance exhibits significant negative coefficients, confirming its role in mitigating financial mismatch.

It enhances the overall continuity, operational efficiency and adaptability of the supply chain by directing the flow of financial resources to firms with high innovation capacity and management efficiency. From the empirical point of view, it verifies that digital finance improves the elasticity of the supply chain by alleviating financial mismatch, which supports the hypothesis H2.

2. Digital Transformation Impact Analysis. Column (2) of Table 4 shows that the coefficient of digital transformation is 1.3896 and significant at 1% level. Digital transformation disseminates information technology, data and knowledge elements through supply chain networks, strengthens upstream and downstream cooperative operations, and improves the efficiency of matching supply and demand, thus enhancing the supply chain's ability to resist risks. Empirical evidence shows that digital finance improves the risk-resistant ability of supply chain by promoting digital transformation, and hypothesis H3 is verified.

5.2 Heterogeneity Analysis

1.Level of Financing Constraints. Based on the SA index to divide the level of enterprise financing constraints (the larger the value, the stronger the constraint), According to the SA index to classify the level of enterprise financing constraints, column (3) (4) of Table 4 shows that in the group with high financing constraints, the effect of digital finance on the supply chain's ability to resist risks is more significant. This is because the digital finance of enterprises with high financing constraints alleviates capital pressure through convenient financing channels, improves capital liquidity to reduce transaction costs, and at the same time provides risk management tools to improve the ability to cope with risks, thus enhancing the stability of the supply chain.

2. Other Heterogeneity Test. The regressions grouped according to the nature of property rights find that the effect of non-state-owned enterprises is more significant compared to state-owned enterprises. Non-state-owned enterprises face stronger financing constraints and credit discrimination, and are more in need of digital finance to alleviate information asymmetry and broaden financing channels, thus enhancing supply chain resilience. After grouping by enterprise size, the effect of small enterprises is more significant, and digital finance alleviates the urgent financing pressure of small and medium-sized enterprises and optimizes the allocation of funds. It strengthens supply chain management capabilities through information tools, makes up for shortcomings in resource integration, and enhances risk resistance and market resilience.

Table 4. Further analysis of the results.

	(1)	(2)	(3)	(4)	(5)	(6)	(6)	(7)
	FD	DCG	Low financing	High financing	Non-State-owned Enterprises	state enterprise	Large-scale enterprises	Small-scale enterprises
<i>DIF</i>	-0.1850**	1.3896***	0.2275	0.4334**	0.4038**	0.1357	0.1542	0.4333*
	(-2.125)	(30.537)	(1.111)	(2.086)	(2.372)	(0.684)	(0.983)	(1.865)

Controls	YES	YES	YES	YES	YES	YES	YES	YES
Constant	-3.8866*** (-5.724)	0.6002 (1.127)	-3.6852*** (-3.561)	-4.7016*** (-4.487)	-4.5630*** (-5.273)	-3.1244*** (-3.116)	-3.1585*** (-3.955)	-4.7904*** (-4.046)
Observations	18,584	8,411	9,305	9,279	12,068	6,516	9,305	9,279
year FE	YES	YES	YES	YES	YES	YES	YES	YES
stacked FE	YES	YES	YES	YES	YES	YES	YES	YES

6 Conclusions and Insights

6.1 Conclusion

Digital finance enhances supply chain resilience. It utilizes big data to increase transparency, improve the efficiency of matching supply and demand, and reduce costs. At the same time, it reduces capital mismatches and directs capital flows to innovative and efficient enterprises. This accelerates the technological upgrading and risk resistance of enterprises. Digital transformation of enterprises optimizes business processes and management, and enhances adaptability and synergy with digital financial tools.

6.2 Revelations

Based on the above findings, in order to more effectively promote the digital financial empowerment of supply chain resilience enhancement, this paper puts forward the following more detailed policy recommendations:

1. Strengthening Digital Financial Infrastructure. The government should increase its support for the research and development of financial technology, encourage financial institutions to cooperate with technology enterprises to develop financial technology products and services applicable to supply chain management. Promote the widespread application of these technologies in the supply chain, encourage traditional financial institutions to accelerate digital transformation, and improve service efficiency and intelligence.

2. Strengthening Support for Enterprise Digital Transformation. Introduce relevant policies to provide the necessary policy and financial support for the digital transformation of enterprises. Through the establishment of special funds and the provision of tax relief and other measures, reduce the costs and risks of enterprises in the process of digital transformation. At the same time, enterprises are encouraged to make use of digital financial technologies to optimize their production, management and sales processes in order to enhance the overall level of digitization.

3. Promote the Deep Integration of Digital Finance with the Real Economy. By providing policy support and financial guidance to promote the wide application and in-depth development of digital finance in the real economy, the synergy between industrial policy and digital finance will form a policy synergy. By optimizing resource allocation and enhancing synergy efficiency, it will promote the overall com-

petitiveness of the supply chain and the sustainable and healthy development of the real economy.

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