A Study on the Assessment of Supply Chain Resilience in Chinese Enterprises —An Empirical Analysis of Panel Data from A-Share Listed Companies

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Abstract. Supply chain resilience is critical to enterprises in resisting external shocks and maintaining stable operations. Based on panel data from Chinese A-share listed companies, this study designs an evaluation index system for supply chain resilience from three dimensions: adaptability, resistance and recovery, and employs the entropy-weighted TOPSIS method to measure corporate supply chain resilience. The research findings are as follow: Firstly, the supply chain resilience of Chinese A-share listed companies generally exhibits a fluctuating upward trend, characterized by a rapid increase from 2005 to 2011, a slight decline from 2012 to 2015, a renewed rise from 2016 to 2021, and a modest decrease from 2022 to 2024, the overall level remains higher than that at the beginning of the sample period. Secondly, changes in supply chain resilience varied across the three dimensions: adaptability rose initially before declining later on, resistance steadily increased, and recovery capacity showed the most remarkable improvement. Thirdly, improvements in corporate supply chain resilience gradually shifted from enhanced adaptability to strengthened resistance and recovery capacity. Based on these findings, it is recommended that enterprises enhance their market responsiveness and resource allocation efficiency, manage financial risks appropriately, and refine diversified supply channels and disruption recovery mechanisms to promote the development of all dimensions of supply chain resilience.

Keywords: supply chain resilience, A-share listed companies, entropy-weighted TOPSIS method.

1. Introduction

As global economic ties grow ever closer and the division of labour and collaboration between enterprises continue to deepen, supply chains are increasingly characterized by networked, globalized and highly interconnected development. Data from the United Nations Conference on Trade and Development (UNCTAD) shows that in the first quarter of 2026, the value of global merchandise trade grew by approximately 12.5% year-on-year, representing an increase of around $1.5 trillion[1] .At the same time, risks arising from natural disasters, public health emergencies and geopolitical conflicts can be transmitted to upstream and downstream enterprises through supply relationships and logistics networks, resulting in production stoppages, delivery delays or rising operating costs.For example, the US-Iran conflict that erupted in late February 2026 led to the near-closure of the Strait of Hormuz, disrupting international transport and exacerbating global supply shortages. By May 2026, the number of reported global supplier shortages had risen to approximately 2.5 times the normal level, with 95% of monitored commodities experiencing above-normal supply shortages, and supplier delivery delays worsening to their most severe level since 2022[2].As such vulnerabilities have become more pronounced, improving supply chain resilience has moved to the forefront of China's policy agenda. Reflecting this policy direction, the 'State Council Regulations on the Security of Industrial and Supply Chains', issued in 2026, call for integrated mechanisms for risk surveillance, advance warning and emergency response. The regulations also encourage firms to broaden their sourcing networks and reduce their exposure to potential supply interruptions.

As of March 2026, China's A-share market comprised more than 5,400 listed companies, with a total market capitalization exceeding 110 trillion yuan, the combined annual revenue of these listed companies accounted for more than half of China's gross domestic product[3] .In terms of industry composition, the A-share market covers not only traditional sectors such as manufacturing, energy and transport, but also emerging industries such as information technology and high-end manufacturing, enterprises in strategic emerging industries account for 45% of the total weight in the

China Securities Index (CSI) 300[4].Within China's corporate network, A-share listed companies often function as important nodes linking purchasing, manufacturing and distribution activities. Their operational decisions can influence both suppliers and customers through changes in order volumes, payment arrangements and the movement of goods. These characteristics provide a sound empirical basis for tracking supply chain resilience across companies and over time. Accordingly, Chinese A-share listed companies are selected as the study sample.

At present, no consensus has been reached about the quantitative evaluation of supply chain resilience. Although existing studies have constructed supply chain resilience indicator systems from different perspectives, discrepancies remain in terms of indicator selection and quantification methods. These differences call for a firm-level measurement framework based on observable indicators that captures resilience across the pre-disruption, disruption and recovery stages and enables consistent comparisons across firms and over time. Therefore, this study draws on long-term panel data from Chinese A-share listed companies to measure the level of supply chain resilience among A-share listed firms.

2. Literature Review

With global corporate supply chains becoming increasingly interconnected, localized shocks can spread easily through the supply chain to upstream and downstream enterprises. Consequently, how to scientifically assess a supply chain's ability to withstand shocks and resume operations has gradually become a key area of research focus within the academic community. Existing research on supply chain resilience primarily focuses on evaluation criteria, the selection of indicators and quantification methods.

Firstly, in terms of evaluation criteria, early research primarily focused on the relationship between supply chain vulnerability and resilience, incorporating factors such as flexibility, redundancy, collaboration and visibility into the supply chain resilience evaluation framework[5] . Subsequently, supply chain resilience gradually evolved from an abstract concept into a measurable organizational capability, with evaluation criteria beginning to cover aspects such as an organization's ability to identify changes, adapt to disruptions and respond rapidly[6]. With the introduction of dynamic capabilities theory, proactive response capacity, reactive capacity and the quality of supply chain design were further incorporated into the measurement framework, enabling the evaluation of supply chain resilience to evolve from a single-dimensional assessment to a multidimensional measurement[7].Secondly, with regard to the selection of indicators, those adopted in existing studies can be summarized into three aspects: loss outcomes, recovery processes and supporting conditions. Loss outcomes are used to reflect the extent of damage sustained by the supply chain following a shock, commonly used indicators include profit loss and its duration[8] . The recovery process primarily examines the transition of the supply chain from a decline in operations to gradual recovery, typically employing indicators such as the extent of performance decline, the lowest operational level and recovery time[9]. Based on indicators such as network structure and operational performance, differences in resilience across supply chains exposed to similar shocks can be further explained[10]. Furthermore, whether a firm's supply chain can maintain operations and achieve recovery following a disruption also depends on the firm's own resource support capacity. Resuming procurement, production and inventory management requires sustained financial investment, therefore, indicators such as costs, profitability and cash flow, used in research on supply chain financial performance, also provide a reference for evaluating the resource conditions required for firms to sustain operations and support recovery[11] .Finally, with regard to quantitative methods, existing research has established various types of quantitative research approaches, providing methodological support for measuring supply chain resilience under different scenarios[12] . Centred on the supply chain resilience curve, relevant studies have further systematized the indicators used to reflect the processes of shock absorption, operational adjustment and recovery, thereby clarifying the relationships between different resilience indicators[13] .

Overall, existing research has laid the foundations for the evaluation of supply chain resilience and provided a reference for this paper in delineating evaluation dimensions and selecting specific indicators. However, there are two areas where existing research could be improved. Firstly, some studies depend on self-reported questionnaire data or analyses of particular disruption incidents, which can restrict the validity of findings due to inherent subjectivity and limited data availability. Secondly, existing evaluation indicator systems are often designed for specific industries, supply chain networks or particular scenarios, making it difficult to support continuous comparisons between different enterprises or across different years for the same enterprise. Accordingly, the marginal contribution of this paper is primarily reflected in two aspects: firstly, to address the issue of existing evaluations relying on subjective judgements or specific disruption scenarios, this paper designs a supply chain resilience evaluation system using observable data such as corporate operations, financial performance and upstream and downstream transactions, and employs the entropy-weighted TOPSIS method for measurement to enhance the objectivity and scientific rigour of the evaluation. Secondly, to address the limited research on long-term trends in corporate supply chain resilience, this paper employs long-term panel data from Chinese A-share listed companies to analyse annual changes in the overall level of supply chain resilience and across its constituent dimensions, thereby extending current understanding of firm-level supply chain dynamics.

3. Research Design

3.1. Introduction to Research Methods

The entropy-weighted TOPSIS method combines objective weighting with comprehensive ranking. This paper adopts the entropy-weighted TOPSIS method to measure the supply chain resilience levels of Chinese A-share listed companies, with the specific calculation process outlined below.

Step 1: Perform dimensionless processing on the original indicators, as follows:

Positive indicators:

$$z_{jn} = \frac{r_{jn} - \min(r_{jn})}{\max(r_{jn}) - \min(r_{jn})} \quad (1 < j < i,\ 1 < n < m) \tag{1}$$

Negative indicators:

$$z_{jn} = \frac{max(r_{jn}) - r_{jn}}{max(r_{jn}) - min(r_{jn})} \quad (1 < j < i,\ 1 < n < m) \tag{2}$$

In Equations (1) and (2), z_{jn} represents the standardized indicator value, r_{jn} represents the raw indicator value, and $max(r_{jn})$ and $min(r_{jn})$ denote the maximum and minimum values of the corresponding indicator in the sample, respectively.

Step 2:Further determine the weights of the indicators， as follows:

$$h_n = -\frac{1}{lni}\sum_{j=1}^{i}\left[\frac{z_{jn}}{\sum_{j=1}^{i} z_{jn}} \times ln\left(\frac{z_{jn}}{\sum_{j=1}^{i} z_{jn}}\right)\right] \tag{3}$$

$$\alpha_n = \frac{1-h_n}{\sum_{n=1}^{m}(1-h_n)} \tag{4}$$

In Equations (3) and (4), h_n denotes the entropy value of the nth indicator, and α_n denotes the weight corresponding to the nth indicator.

Step 3: Based on the standardized results and the indicator weights, construct *the* weighted standardized decision matrix B, and determine the positive ideal solution B^+ and the negative ideal solution B^-. Subsequently, calculate the distances S^+ and S^- between each evaluation object and the two types of ideal solutions, respectively, to ultimately obtain the relative proximity *C*. The specific calculations are shown in Equation (5) to Equation (10).

$$B = \alpha_n \times \frac{z_{jn}}{\sum_{j=1}^{i} z_{jn}} \tag{5}$$

$$B^+ = [b_1{}^+, b_2{}^+, \dots, b_m{}^+] \tag{6}$$

$$B^- = [b_1{}^-, b_2{}^-, \dots, b_m{}^-] \tag{7}$$

$$S^+ = \sqrt{\sum_{n=1}^{m} (B - B^+)^2} \tag{8}$$

$$S^- = \sqrt{\sum_{n=1}^{m} (B - B^-)^2} \tag{9}$$

$$C = \frac{S^-}{S^+ + S^-}, 0 < C < 1 \tag{10}$$

In Equation (5) to Equation (10), B denotes the weighted standardized decision matrix, $b_n{}^+$ and $b_n{}^-$ denote the positive and negative ideal values for indicator *n*, respectively. The positive and negative ideal-solution vectors, B^+ and B^- are then constructed by combining the corresponding benchmark values across all indicators. S^+ and S^- denote the distances between the evaluation object and the positive and negative ideal solutions, respectively. *C* represents the relative proximity of the evaluated entity to the positive ideal solution, the larger the value of *C*, the closer the evaluated entity is to the positive ideal state, and the higher the level of supply chain resilience of the enterprise.

3.2. Design of the Indicator System

Supply chain resilience reflects an enterprise's comprehensive ability to promptly adjust its business operations, maintain supply chain operations and return to normalcy in the face of changes in the external environment and sudden shocks[14]. Drawing on the approach adopted by Li et al. in constructing a multidimensional supply chain resilience indicator system using objective data from listed companies[15], this paper, taking into account the availability of data on Chinese A-share listed companies and research requirements, designs evaluation indicators for supply chain resilience across three dimensions: adaptability, resistance and recovery (see Table 1). The rationale for the selection of indicators for each dimension is explained as follows:

Firstly, adaptability reflects a company's ability to adjust its business operations and resource allocation in response to changes in market demand, the financial environment and production scale. In terms of market demand, operating revenue reflects a company's market scale and operational foundation, relatively stable revenue provides support for adjustments to procurement, production and logistics[16] .With regard to the financial environment, the ratio of operating revenue to accounts receivable reflects a company's efficiency in cash recovery and turnover[17] . In terms of production scale, the total number of employees reflects the scale of human resources available to the company for production, operations and supply chain coordination[18]. Consequently, this paper selects secondary indicators of adaptability from three dimensions:market foundation, capital turnover and production and operational resources,and measures these respectively using operating revenue, the

ratio of operating revenue to accounts receivable, and the total number of employees on the payroll.Secondly, resistance is primarily manifested in an enterprise's ability to maintain core business operations and control losses through financial buffers, production safeguards and the management of transaction dependencies when the supply chain is disrupted. In terms of financial buffers, the equity multiplier and debt-to-equity ratio reflect the enterprise's debt burden, whilst the net profit margin on sales reflects the profit buffer available to cope with rising costs and falling revenue[19].With regard to production security, fixed assets represent the physical resources a firm possesses to sustain production activities, the more abundant these resources are, the better equipped the firm is to mitigate the impact of disruptions on normal operations[20]. In terms of commercial dependence, supply chain concentration denotes the degree to which a firm's operations are contingent upon a limited number of suppliers and customers, this paper primarily examines supply chain concentration from the perspective of commercial dependence risk. The higher the concentration, the greater the impact on the firm's operations when changes occur among its core trading partners[21]. Consequently, this paper selects secondary indicators of resilience from three aspects:financial buffers, production security and commercial dependence, and measures them using the equity multiplier, debt-to-equity ratio, net profit margin on sales, fixed assets and supply chain concentration, respectively. Finally, Recovery reflects a firm's ability to resume normal operations following a supply chain shock by mobilizing internal funds and upstream and downstream resources.With regard to internal funds, return on equity reflects a firm's ability to generate returns using its own capital,the current ratio reflects a firm's short-term debt-repayment capacity and liquidity levels.Cash generation, meanwhile, reflects a company's ability to continuously generate cash through its operating activities[22]. In terms of external transactions, the procurement value from the top five suppliers and sales revenue from the top five customers reflect the existing scale of a company's transactions with its key suppliers and customers, providing a foundation for re-establishing connections in raw material supply and product sales channels[23]. Consequently, this paper selects secondary indicators of recovery from the perspectives of internal financial support and external commercial foundations, measuring them respectively using return on equity, current ratio, cash generation capacity, procurement value from the top five suppliers and sales revenue from the top five customers.

Table 1. Evaluation Indicator System for Corporate Supply Chains

Primary Indicators	Second-level indicators	Indicator Definition(Unit)	Indicator Attribute	Weight
Adaptability	Sales Volume	Revenue (100 million yuan)	+	0.152
	Cash management efficiency	Revenue/Accounts Receivable (times/year)	+	0.218
	Production Capacity	Total number of employees (persons)	+	0.102
Resistance	Equity Multiplier	Total assets / Equity (times)	-	0.002
	Equity Ratio	Total Liabilities / Equity (%)	-	0.002
	Fixed assets	Original value of fixed assets less accumulated depreciation (100 million yuan)	+	0.157
	Supply chain concentration	Concentration of the top five suppliers and customers (%)	-	0.008
	Net profit margin	Net profit / Revenue (%)	+	0.003
Recovery	Return on Equity	Net profit / Shareholders' equity (%)	+	0.002
	Current ratio	Current assets / Current liabilities (times)	+	0.046
	Cash Generation	Cash Flow Position (%)	+	0.007
	Supply-side resource security	Procurement value from the top five suppliers (100 million yuan)	+	0.156
	Market Security on the Customer Side	Sales to the top five customers (100 million yuan)	+	0.145

3.3. Data Sources

This paper selects Chinese A-share listed companies from 2005 to 2024 as the research sample. The data employed consist predominantly of annual metrics pertaining to corporate operational performance, financial position, and interactions with upstream and downstream supply chain counterparts. Among these, indicators such as operating revenue, accounts receivable, number of employees, balance sheet position, profitability, cash flow status, supply chain concentration, procurement value from the top five suppliers and sales revenue from the top five customers are all sourced from the CSMAR China Economic and Financial Research Database maintained by Limited Company of Shenzhen Xishima Data Technology. In accordance with research conventions, the raw data were processed as follows: (1) samples with missing data were excluded, (2) continuous variables were trimmed at the top and bottom 1 percent. Ultimately, 38,807 firm-year observations were obtained from 5,019 A-share listed companies.

4. Empirical Analysis

This paper employs the entropy-weighted TOPSIS method to measure the supply chain resilience of 5,019 Chinese A-share listed companies from 2005 to 2024, presenting annual changes across three dimensions: adaptability, resistance and recovery.Specifically, adaptability primarily reflects a firm's ability to adjust its operational arrangements and resource allocation in response to changes in the external environment.Resistance reflects a firm's ability to maintain stable production and operations following a supply chain shock. Resilience reflects a firm's ability to restore supply chain operations after a shock by drawing on financial resources and upstream and downstream resources. To comprehensively measure corporate supply chain resilience, this research employs the entropy-weighted method to determine the weights of the three primary dimensions: adaptability, resilience and recovery capacity. The measurement results are shown in Table 2.

Table 2. Comprehensive Measurement Results of Supply Chain Resilience for A-share Listed Companies

Year	Enterprise Supply Chain Resilience	Adaptability (47.199%)	Resistance (17.216%)	Resilience (35.585%)
2005	0.047	0.035	0.053	0.046
2006	0.045	0.035	0.054	0.043
2007	0.060	0.053	0.058	0.050
2008	0.066	0.061	0.058	0.056
2009	0.073	0.069	0.059	0.056
2010	0.085	0.085	0.063	0.061
2011	0.087	0.078	0.079	0.075
2012	0.073	0.059	0.069	0.069
2013	0.074	0.059	0.073	0.071
2014	0.071	0.053	0.073	0.071
2015	0.067	0.050	0.072	0.066
2016	0.074	0.057	0.081	0.073
2017	0.076	0.057	0.081	0.079
2018	0.076	0.058	0.081	0.081
2019	0.074	0.053	0.080	0.081
2020	0.076	0.056	0.083	0.084
2021	0.081	0.059	0.084	0.092
2022	0.079	0.055	0.084	0.093
2023	0.078	0.053	0.085	0.092
2024	0.075	0.048	0.084	0.090

Note: The figures in brackets represent the weights of each primary indicator calculated using the entropy weighting method

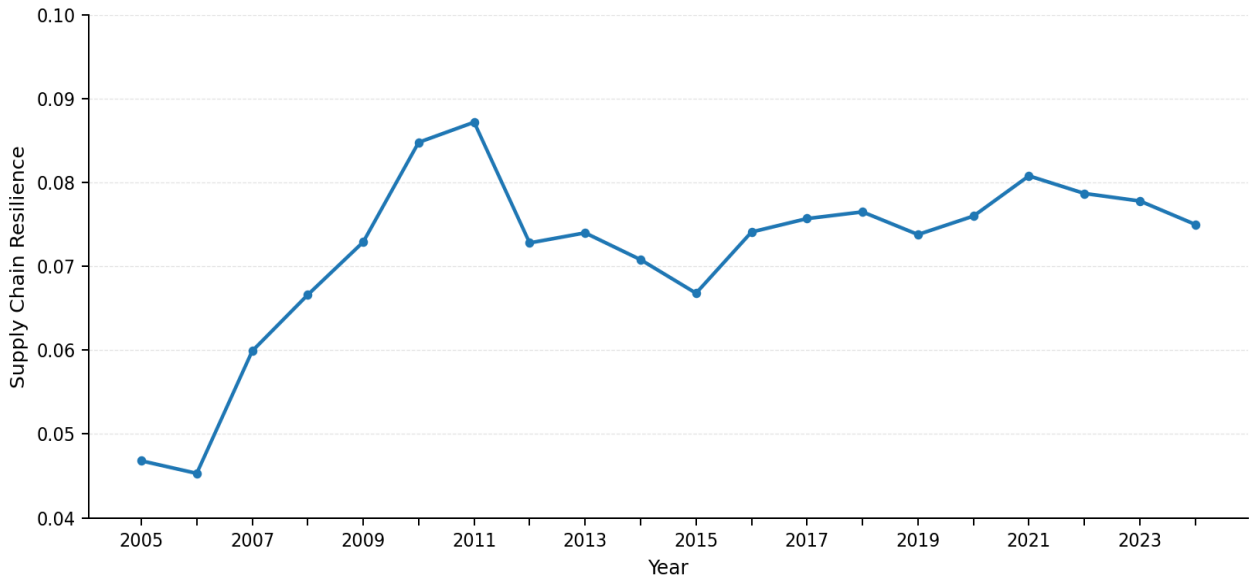

Fig. 1 Results of the measurement of supply chain resilience for Chinese A-share listed companies, 2005–2024

Combining Table 2 and Figure 1 reveals that, from2005 to 2024, the supply chain resilience of Chinese A-share listed companies generally followed a fluctuating upward trend, with the average level rising from 0.047 in 2005 to 0.075 in 2024. This indicates that the overall comprehensive capacity of the sample enterprises to cope with supply chain shocks and maintain business operations has strengthened.In terms of the evolution of this trend, supply chain resilience exhibits distinct phased characteristics and can be divided into four stages: 2005–2011 was a period of rapid growth, peaking at 0.087 in 2011, 2012–2015 was a period of decline, falling to 0.067 in 2015. From 2016 onwards, it re-entered a phase of growth, rising to 0.081 in 2021. The period from 2022 to 2024 was characterized by a series of slight declines. Overall, the sample enterprises' supply chain resilience has established a certain foundation for improvement. However, its growth continues to fluctuate in case of changes in the business environment and resource allocation.

Table 2 and Figure 1 also show that the three components of supply chain resilience followed distinct trajectories over the sample period. Adaptability was the most volatile dimension, increasing from 0.035 in 2005 to 0.085 in 2010 before declining overall to 0.048 in 2024. Its simultaneous fall with the composite resilience score during 2022–2024 suggests that the recent weakening of resilience was concentrated mainly in firms' capacity to respond to external change and reallocate resources. By contrast, resistance improved more steadily, rising from 0.053 in 2005 to 0.084 in 2024 and remaining close to 0.080 after 2016. This pattern indicates a gradual strengthening of firms' ability to preserve stable supply chain operations. Recovery capacity recorded the largest overall gain, increasing from 0.046 in 2005 to 0.090 in 2024 and reaching its highest value of 0.093 in 2022. These results point to clear improvements in working-capital support, cash-flow continuity and the restoration of upstream and downstream resources. Although recovery capacity decreased slightly during the final two years, it remained substantially above its initial level.

Overall, the supply chain resilience of Chinese A-share listed companies improved during the sample period, and their internal structure also changed: the growth trend in the early period was primarily driven by enhanced adaptability, whereas the growth trend in the later period was more reflective of improvements in resistance and recovery capabilities.

5. Conclusion

This paper measures the supply chain resilience level of Chinese A-share listed companies and finds the following: Firstly, the supply chain resilience of Chinese A-share listed companies generally followed a fluctuating upward trend, rose from 0.047 in 2005 to 0.075 in 2024, underwent four distinct phases: an initial rapid rise, a mid-period decline, a subsequent recovery, and a slight decline in recent years. Secondly, there were marked differences in the patterns of change across the three dimensions.Adaptability rose from 0.035 in 2005 to 0.085 in 2010, before declining overall to 0.048 in 2024, resilience increased steadily from 0.053 in 2005 to 0.084 in 2024, and recovery capacity rose from 0.046 in 2005 to 0.090 in 2024, representing the greatest increase.Thirdly, the internal structure of supply chain resilience has changed. In the earlier part of the sample period, gains in supply chain resilience were driven mainly by adaptability. After 2016, however, resistance and recovery capacity became the principal sources of improvement. By 2024, both recovery and resistance were significantly higher than adaptability, indicating that enterprises' performance in maintaining supply chain stability and resuming operations has continued to improve, however, their ability to respond to market changes and adjust resource allocation still needs to be enhanced.

Based on the research findings, three research recommendations are proposed: Firstly, enterprises should improve their responsiveness to external changes. They should strengthen monitoring of market demand and information sharing within the supply chain, enhance the efficiency of accounts receivable collection and cash flow management, and promptly adjust procurement, production and sales arrangements in response to changes in orders, inventory and production capacity.Second, establish a diversified and stable supply assurance system. Enterprises should reduce their reliance on a single or small number of suppliers, create a pool of alternative suppliers and regularly assess their delivery capabilities, whilst expanding procurement sources across different regions and channels to form a procurement system that combines primary and alternative suppliers. Third, refine supply chain recovery mechanisms.Enterprises should maintain stable operating cash flow, establish lists of key suppliers, customers and alternative resources, formulate contingency plans for scenarios such as procurement disruptions, production stoppages and sales impediments, and strengthen coordination with core trading partners. At the same time, they should avoid relying solely on the expansion of assets, capital or transaction volume to enhance resilience, and instead place greater emphasis on operational efficiency, market responsiveness and the flexible allocation of resources, thereby promoting coordinated improvements across these three dimensions.

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