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Measuring Dairy Supply Chain Resilience Using the Entropy Weight-TOPSIS Method

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Abstract

In the context of globalization, the dairy supply chain faces increasingly complex risks and challenges, making the enhancement of its resilience to respond to emergencies a critical issue. This paper addresses this issue by employing the Entropy Weight-TOPSIS method to measure the resilience of dairy agricultural supply chains. An evaluation indicator system was constructed, with weights assigned to each indicator using the entropy weight method. Combined with the TOPSIS method, the relative strengths and weaknesses of each supply chain segment were calculated, thereby identifying vulnerabilities and areas for improvement. The findings reveal significant disparities in supply chain resilience development capabilities among the five listed dairy companies. In single-indicator assessments, Company Y Corporation stands out, ranking first in resistance capacity, recovery capacity, and learning capacity, outperforming its peers. Comprehensive evaluation revealed Company Y's dairy supply chain resilience as the strongest, while Company N, Company S, Company B, and Company T demonstrated relatively weaker resilience capabilities. Based on these findings, the study proposes measures to enhance dairy supply chain resilience, including strengthening government policy guidance and support, establishing diversified and risk-managed supply chain systems, and improving corporate capabilities.

Keywords

Dairy Supply Chain Resilience; Entropy-TOPSIS Method; Supply Chain Resilience Capability Measurement

1. Introduction

Driven by the current waves of globalization and digitalization, the field of supply chain management has encountered unprecedented opportunities and challenges. Particularly for the agricultural products industry, maintaining supply chain stability and flexibility within an unpredictable market environment has become an urgent issue requiring resolution at both the corporate and national levels. As a vital segment of agricultural products, the resilience of the dairy supply chain not only impacts corporate economic efficiency but also directly affects national food safety

and public health security. As consumers increasingly pursue healthier lifestyles, demand for dairy products continues to rise. However, from raw material procurement and production processing to final consumption, the dairy supply chain faces multiple risks. These uncertainties make supply chain resilience crucial for the industry's sustainable development. Therefore, scientifically measuring and enhancing the resilience of dairy supply chains is vital for improving corporate competitiveness and safeguarding public interests.

The term "resilience" originated in materials science, referring to an object's ability to deform under impact and return to its original shape without exceeding its limit capacity[1]. Subsequently, the concept expanded into other fields such as ecology and psychology. In supply chain management, Rice and Caniato (2003) pioneered the concept of supply chain resilience, defining it as the ability to respond promptly to disruptions and recover from them[2]. This definition highlights resilience's core emphasis on resistance to disruption risks and recovery capacity. This conceptual framework equally applies to analyzing agricultural supply chain resilience, meaning that building resilience in agricultural supply chains must also emphasize their capacity to withstand external shocks and rapidly recover from disruptions. Existing research indicates that scholars both domestically and internationally have primarily conducted resilience studies centered around the definition of supply chain resilience. Fan Xuemei (2020) developed a supply chain resilience evaluation framework comprising five dimensions—predictive capability, adaptability, responsiveness, recovery capacity, and learning ability—to withstand pandemic-induced shocks[3]. Dong W (2020) employed the AHP-FCE method to assess agricultural supply chain resilience, concluding that resilience evaluation holds significant implications for supply chain management[4]. Tutur Wicaksono et al. (2022) proposed that preventive maintenance, supply chain forecasting, and continuous training can effectively enhance the resilience of agri-food supply chains [5]. Hao Li and Pei Xueying (2023) employed the Entropy Weight-TOPSIS method to investigate how early warning capability, response capability, recovery capability, and innovation capability influence the resilience of fresh agricultural product supply chains, concluding that enhancing these capabilities strengthens supply chain resilience[6]. Youan Ke (2023) identified six key elements of supply chain resilience through grounded theory and constructed a resilience formation mechanism model based on three stages—preparation, response, and recovery—to enhance supply chain resilience[7]. Tao Zheng (2024) et al., drawing on resilience definitions, divided food supply chain resilience into three components—fracture resilience, shock resilience, and collaborative resilience—to measure food supply chain resilience[8].

In summary, while numerous studies exist on optimizing supply chain resilience and enhancing agricultural supply chain resilience, few scholars have investigated the measurement of dairy supply chain resilience. In recent years, frequent food safety incidents have occurred, particularly within the dairy supply chain. Given the high

sensitivity of dairy products to time and temperature, researching dairy supply chain safety to enhance supply chain resilience is essential to ensure stable supply chain operations. This study employs the Entropy Weight-TOPSIS method to measure the resilience capacity of the dairy supply chain and conducts empirical analysis using data from five major listed dairy companies as samples.

2. Selection of Resilience Evaluation Indicators for the Dairy Supply Chain

When constructing indicators, it is essential to consider their systematic nature, scientific rigor, and applicability, ensuring they can objectively evaluate a company's development status. Drawing upon Ambulkar's[9] definition of supply chain resilience, this paper defines dairy supply chain resilience as the capability of dairy enterprises to maintain vigilance against risk disruptions, respond promptly and react swiftly, and recover effectively following disruptions. Based on this concept, a dairy supply chain resilience evaluation framework is constructed across four dimensions: resistance capability, response capability, recovery capability, and learning capability. The specific components are as follows:

1. Resistance Capacity. This dimension reflects the supply chain's ability to withstand external shocks while maintaining its integrity. Drawing on Zhang Shujian's[10] perspective, this study selects evaluation indicators from an asset-based approach, including net assets, debt-to-equity ratio, and non-current assets.

2. Responsiveness. This dimension primarily measures the supply chain's capacity to respond promptly and react swiftly when facing shocks. Drawing on the perspective of Cheng Qingqing[11], this paper selects evaluation indicators from the perspectives of market scale and turnover, including four metrics: market transaction volume, return on net assets, inventory turnover rate, and asset turnover rate.

3. Recovery Capacity. Recovery capacity reflects an enterprise's ability to restore its original development level through a series of measures after suffering external shocks. Drawing on the perspectives of Fan Xuemei[3] and Hao Aimin[12], this study selects evaluation indicators from the capital return perspective, including four metrics: net profit margin, gross profit margin, net profit, and net cash flow.

4. Learning Capability. Learning capability refers to the capacity of supply chain entities to continuously accumulate knowledge capital and pursue technological innovation after recovering from shocks, thereby enhancing risk resilience and cultivating competitive advantages. As such, learning capability emphasizes innovation. This paper adopts the perspective of Zhang Wei[13] et al., selecting four evaluation indicators: patent authorization volume, R&D expenditure, R&D investment ratio, and proportion of personnel with higher education to measure learning capability.

Table 1. Dairy Supply Chain Resilience Evaluation Index System.

Primary indicator	Secondary Indicators	Tertiary Indicators	attribute

Primary indicator	Secondary Indicators	Tertiary Indicators	attribute
Dairy Supply Chain Resilience	Resistance Capacity	Net Assets (RMB billion)	Positive
		Debt-to-Asset Ratio	Negative
		Non-Current Assets (RMB billion)	Positive
	Responsiveness	Market Transaction Volume (RMB billion)	Positive
		Return on Equity	Positive
		Inventory Turnover (times)	Positive
		Asset Turnover (times)	Positive
	Recovery capacity	Net Profit Margin	Positive
		Gross Profit Margin	Positive
		Net Profit (RMB billion)	Positive
		Net Cash Flow (RMB billion)	Positive
	Learning capacity	Number of Patents Granted	Positive
		R&D Expenditures (RMB billion)	Positive
		R&D Investment Ratio	Positive
		Percentage of Personnel with Higher Education	Positive

3. Entropy-Weighted TOPSIS Model Construction

The Entropy Weight-TOPSIS method, as an integrated comprehensive evaluation approach, aims to precisely identify key influencing factors and vulnerabilities in supply chain resilience through quantitative analysis. The construction of the indicator evaluation system involves two approaches: subjective weighting and objective weighting[14]. To establish a scientifically rigorous evaluation framework, this study avoids subjective factors and objective constraints in the weighting process by employing the entropy weighting method. Based on actual data from five major listed dairy companies, the weights for each indicator are objectively determined. Subsequently, the TOPSIS method was applied to normalize these weighted data, establishing positive and negative ideal solutions as evaluation benchmarks. By calculating the relative proximity of each evaluation object, a ranked assessment of supply chain resilience was achieved, intuitively illustrating the risk levels across different supply chains. The specific steps are as follows:

Step 1: Based on the data from the five listed companies, construct the initial matrix A in the model, comprising i research objects and j evaluation indicators.

$$A=(X_{ij})=\begin{bmatrix} x_{12} & x_{12} & \cdots & x_{1j} \\ x_{21} & x_{22} & & x_{2j} \\ \vdots & & \ddots & \vdots \\ x_{31} & x_{32} & \cdots & x_{ij} \end{bmatrix}$$

Step 2: Standardize the original matrix to obtain the standardized matrix B. The evaluation indicators involved in this paper are categorized into positive indicators, negative indicators, and moderate indicators. To ensure the accuracy of the results, each type of indicator must undergo separate standardization processing.

Positive indicators: $Z_{ij}=\frac{x_{ij}-x_{jmin}}{x_{jmax}-x_{jmin}}$

Negative indicators: $Z_{ij}=\frac{x_{jmax}-x_{ij}}{x_{jmax}-x_{jmin}}$

The standardized matrix B is obtained by standardizing each indicator:

$$B=(Z_{ij})=\begin{bmatrix} z_{11} & \cdots & z_{1j} \\ \vdots & \ddots & \vdots \\ z_{i1} & \cdots & z_{ij} \end{bmatrix}$$

Step 3: Calculate the proportion Pij of the value of indicator j under research subject i relative to the total value of that indicator.

$$P_{ij}=z_{ij}/\sum_{i=1}^{n} z_{ij}$$

Step 4: Calculate the entropy value Ej for each indicator.

$$E_j=-\frac{1}{\ln(n)}\sum_{i=1}^{n} P_{ij}\ln(p_{ij})$$

Step 5: Calculate the difference coefficient Gj based on the entropy value Ej.

$$G_j=1-E_j$$

Step 6: Calculate the weight Wj for each indicator.

$$W_j=\frac{G_j}{\sum_{j=1}^{m} G_j}$$

Step 7: Construct the weighted normalized matrix. Since the evaluation indicators in the model carry different levels of importance, the entropy weights calculated earlier must be multiplied by the normalized matrix B.

$$F_i=\sum_{j=1}^{m} W_j Z_{ij}=\begin{bmatrix} W_1\times Z_{11} & W_2\times Z_{12} & \cdots & W_m\times Z_{1m} \\ W_1\times Z_{21} & W_2\times Z_{22} & & W_m\times Z_{2m} \\ \vdots & & \ddots & \vdots \\ W_1\times Z_{n1} & W_2\times Z_{n2} & \cdots & W_m\times Z_{nm} \end{bmatrix}$$

Step 8: Locate the positive ideal solution and negative ideal solution based on the weighted standardized matrix, and calculate the distance D+ to the positive ideal solution and distance D- to the negative ideal solution for each indicator of each evaluation object.

$$D_+=\sqrt{\sum_{j=1}^{m}(Z_j^+ - Z_{ij})^2}$$

$$D_-=\sqrt{\sum_{j=1}^{m}(Z_j^- - Z_{ij})^2}$$

Step 9: Calculate relative label progress and rank the five major listed companies. Relative label progress scores typically range from 0 to 1. Higher scores indicate superior performance, leading to higher rankings and signifying greater resilience in the dairy supply chain.

$$S_i=\frac{D_i^-}{D_i^+ + D_i^-}$$

4. Empirical Analysis of Resilience Capacity Measurement in Fresh Agricultural Product Supply Chains

4.1. Data Source

This study analyzes and processes 2023 data from five listed dairy companies: Inner Mongolia Company Y Industrial Group Co., Ltd., Xinjiang Company T Co., Ltd., Com-

pany B Holdings Co., Ltd., Company N Group Co., Ltd., and Beijing Company S Co., Ltd. The raw data primarily originates from the annual reports of each company.

4.2. Single-item indicator evaluation

This paper employs the specific steps of the Entropy-TOPSIS method to analyze and evaluate data across four dimensions of supply chain resilience—resistance capability, responsiveness, recovery capability, and learning capability—for five major listed dairy companies. Si denotes relative progress, with specific values shown in Table 2.

Regarding the resilience indicator, analysis reveals that net assets carry the highest weight among the three sub-indicators, indicating its critical importance in resilience assessment. This stems from net assets representing a company's financial stability and resource reserves, enabling it to address uncertainties like supply chain disruptions and market volatility. By providing ample financial support and buffers, net assets ensure operational continuity during adversity, thereby enhancing overall supply chain resilience and risk resistance. Regarding relative alignment progress in Table 2, Company Y ranks first with a significant lead over the other four companies. This stems from Company Y's absolute advantages in net assets and non-current assets, enabling it to top the resilience rankings. This also indicates Company Y's superior single-item resilience performance in the dairy supply chain compared to its peers.

Regarding responsiveness indicators, analysis reveals that market transaction volume holds the highest weighting among the four responsiveness metrics, underscoring its critical importance. When risks arise, stable or growing market transaction volume enables supply chain segments to allocate resources and adjust production plans based on clear market signals, thereby enhancing flexibility and adaptability. Regarding relative progress as shown in Table 2, Company N ranks first and Company Y second, with a narrow gap between them. However, the other three companies lag significantly behind these two. This indicates that Company N and Company Y hold distinct advantages in individual responsiveness within dairy supply chain resilience, outperforming other firms.

Regarding the resilience metrics, analysis indicates that gross profit margin and net profit rank highly in weighting among the tertiary indicators, suggesting these metrics better reflect a company's resilience. This is because gross profit margin and net profit provide financial buffers for companies to cope with supply chain disruptions, enabling faster recovery and promoting sustainable development. In terms of relative adherence to schedule, Company Y remains ranked first in resilience. Company Y demonstrates strong comprehensive capabilities in capital, profits, and other aspects, standing out compared to the other four companies. Consequently, Company Y recovers faster from disruptions, fully demonstrating its superiority in individual recovery capability over other companies.

Regarding learning capability indicators, analysis reveals that the third-level indica-

tor patent authorization volume holds the highest weight, indicating that patent authorization volume fully reflects a company's learning capability. To prevent supply chain disruptions, enterprises must possess learning capabilities, with innovation being the most critical element. Patent grants serve as a key metric for evaluating technological innovation capacity and R&D strength. A high volume of patent grants indicates substantial investment in technological R&D and abundant outcomes, providing a solid foundation for continuous learning and improvement. This is one of the key factors driving enhanced supply chain resilience. In terms of relative progress, Company Y ranks first with a high score in learning capability. This indicates that following supply chain disruptions, Company Y responds swiftly and proactively, continuously accumulating innovative experience to address future risks. In other words, Company Y demonstrates significantly superior learning capability within the dairy supply chain resilience category compared to the other four companies.

Table 2. Evaluation Results of Individual Resilience Indicators for the Dairy Supply Chain.

Evaluation Subject	Resistance Capacity		Responsiveness		Recovery capacity		Learning capacity	
	Si	Ranking	Si	Ranking	Si	Ranking	Si	Ranking
Company Y	0.8940	1	0.6147	2	0.5610	1	0.7251	1
Company T	0.2749	4	0.1331	5	0.1813	4	0.2524	5
Company B	0.2988	3	0.3721	3	0.1008	5	0.4683	2
Company N	0.5658	2	0.6175	1	0.2739	3	0.4607	3

4.3. Comprehensive Indicator Evaluation

The comprehensive evaluation results of supply chain resilience for five major listed dairy companies using the Entropy Weight-TOPSIS method are shown in Table 2. Analysis of Table 2 reveals that Company Y Corporation achieved a relative proximity score of 0.6383, ranking first overall, indicating the strongest dairy supply chain resilience. Xinjiang Hope Group followed with a relative proximity score of 0.4531, ranking second. Although trailing Company Y, it maintained a significant gap over the third-place company, demonstrating robust supply chain resilience. Company S and Company B follow with relative alignment scores of 0.3562 and 0.3125, respectively, indicating a gradual decline in their dairy supply chain resilience development capabilities. Ranking last is Company T with a relative alignment score of only 0.2117, signifying the weakest supply chain resilience capability among the five listed companies.

Table 3. Comprehensive Evaluation Results of Dairy Supply Chain Resilience Indicators.

Evaluation Subject	Si	Ranking
Company Y	0.6383	1
Company T	0.2117	5
Company B	0.3125	4
Company N	0.4531	2
Company S	0.3562	3

5. Conclusions and Countermeasures

Against the backdrop of globalization, the dairy supply chain faces complex and evolving risks and challenges. This paper employs the Entropy Weight-TOPSIS method to measure data from five listed dairy companies, evaluating their supply chain resilience capabilities to provide scientific grounds for enhancing the overall resilience of the dairy supply chain. The findings reveal significant disparities in the development capabilities of supply chain resilience among the five listed dairy companies. In single-indicator assessments, Company Y Corporation stands out, ranking first in resilience, recovery capability, and learning ability, outperforming other companies. Xinjiang Hope Group follows, demonstrating strong responsiveness. Comprehensive evaluations reveal Company Y Corporation possesses the strongest dairy supply chain resilience, while Xinjiang Hope Group, Company S, Company B, and Company T exhibit relatively weaker resilience capabilities.

The inherent characteristics of dairy products make their supply chains more vulnerable to risk impacts. Based on these findings, the following countermeasures are proposed:

1. Strengthen government policy guidance and support. Governments should play a leading role by establishing industry norms and standards, offering fiscal and tax incentives, and promoting international cooperation and exchange to foster an environment conducive to enhancing dairy supply chain resilience. These measures aim to build a more robust and diversified supply chain system capable of addressing complex risks and challenges in a globalized context.

2. Develop a diversified and risk-managed supply chain system. Promote a diversified layout of the dairy supply chain to reduce reliance on single sources and strengthen supply chain risk management. Establish risk response mechanisms to ensure swift action during emergencies. Simultaneously, encourage dairy enterprises to build global supply chain networks to enhance flexibility and stability.

3. Enhance corporate capabilities. Dairy enterprises should increase investment in critical supply chain segments, such as constructing advanced cold chain logistics facilities, implementing intelligent management systems, and expanding storage and processing capacities to strengthen the physical and technological foundations of the supply chain. Concurrently, strengthen supply chain management teams to elevate employees' professional expertise and emergency response capabilities. Furthermore, actively establish long-term, stable partnerships with suppliers, distributors, and other stakeholders. Share information, jointly bear risks, and foster a collaborative supply chain ecosystem. This holistic approach will significantly enhance the resilience of the dairy supply chain, ensuring robust operations amid complex and volatile market conditions.

References

[1] Ma, X. Y., Huang, M. Z., & Yang, M. X. (2023). Factors influencing supply chain resilience:

An SEM and fsQCA approach. Systems Engineering Theory and Practice, 43(09), 2484-2501.

[2] Rice J B. Caniato F. Building a secure and resilience supply chain[J]. Supply Chain Management Review, 2003, 5(9): 22-30.

[3] Fan Xuemei, Lu Mengyuan. Factors Influencing and Evaluation of Supply Chain Resilience in Automobile Enterprises During the COVID-19 Pandemic [J]. Industrial Technology Economics, 2020, 39(10): 21-28.

[4] Dong W. Research on Supply Chain Resilience of Agricultural Products Based on AHP-FCE Model[J]. Learning & Education, 2020, 9(3): 114-117.

[5] Wicaksono T ,Csaba Bálint.Illés.From resilience to satisfaction: Defining supply chain solutions for agri-food SMEs through quality approach[J].PloS one, 2022, 17(2):e0263393.DOI:10.1371/journal.pone.0263393.

[6] Hao Li, Pei Xueying. Measurement of Fresh Agricultural Product Supply Chain Resilience Based on Entropy Weight-TOPSIS Method [J]. Logistics Technology, 2023, 42(11): 129-136.

[7] Ke Y, Lu L, Luo X. Identification and formation mechanism of key elements of supply chain resilience: Exploration based on grounded theory and verification of SEM. Plos one. 2023 Nov 2;18(11):e0293741.

[8] Zheng, T.; Zhao, G.; Chu, S. A Study on the Impact of External Shocks on the Resilience of China's Grain Supply Chain. Sustainability 2024, 16, 956.

[9] Ambulkar S, Blackhurst J, Grawe S. Firm's resilience to supply chain disruptions: Scale development and empirical examination[J]. In European Journal of Information Systems, 2015, 33: 111-122.

[10] Zhang Shujian. Research on Supply Chain Resilience Measurement and Influencing Factors of Automobile Manufacturing Enterprises in Chongqing[D]. Chongqing Jiaotong University, 2024.

[11] Cheng Qingqing. Research on the Concept, Mechanism, and Measurement of Industrial Chain and Supply Chain: Insights from Regional Industrial Chain and Supply Chain Resilience in Nantong[J]. Shanghai Economy, 2022, (06): 25-40.

[12] Hao Aimin, Xie Menghan, Liu Yuting. Measurement and Spatiotemporal Evolution of Agricultural Industrial Chain Resilience [J]. Statistics and Decision Making, 2024, 40 (16): 95-100.

[13] Zhang Wei, Li Hangyu, Zhang Ting. Measuring Resilience in China's Manufacturing Industry Chains and Their Spatiotemporal Variation Characteristics [J]. Economic Geography, 2023, 43 (04): 134-143.

[14] Liu Dan, Wu Guanrong. Measurement of Resilience in Manufacturing Industrial Chains and Analysis of Spatial Distribution Characteristics [J]. Logistics Science and Technology, 2024, 47 (17): 27-29+51.