

Analysis of Strategies for Enhancing Digital Transformation of Manufacturing Industry and Supply Chain Resilience

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Abstract. In the context of the deep restructuring of the global supply chain and the integration of the digital economy, digital transformation has become the core way to improve the toughness of the manufacturing supply chain. As the foundation of the real economy, manufacturing industry is very important to ensure the safety and stability of its supply chain for the virtuous cycle of the national economy. As the integration product of digital technology and financial services, digital finance plays an important supporting role in ensuring the smooth operation of the supply chain. Using the method of literature research and industry empirical analysis, this paper combs the digital transformation logic and supply chain toughness evaluation system, and analyzes its mechanism. Based on the empirical results of A-share listed companies, it is found that both digital transformation and digital finance can significantly and positively promote the toughness of manufacturing supply chain. Among them, digital transformation needs multi-dimensional collaborative promotion, while digital finance can be enabled by improving information transparency, alleviating financing bottlenecks and reducing financial risks. Based on this, this paper puts forward the hierarchical classification optimization strategy, which provides theoretical and practical ideas for the construction of modern digital supply chain.

1 Introduction

At present, the global supply chain pattern continues to adjust, with multiple uncertain factors such as geopolitical conflicts, public emergencies, and fluctuations in raw material supply and demand. The fragility of traditional manufacturing supply chains continues to be highlighted, and enterprises generally face operational difficulties such as increased risk of chain breakage, rising operating costs, and lagging market response. Ponomarov and Holcomb found that traditional supply chains excessively pursue lean cost control, have insufficient systematic risk reserves, and are prone to interruption problems when exposed to external shocks [1]. Research by Zhang Shushan and Gu Cheng shows that digital transformation can effectively compensate for the flexible shortcomings of traditional supply chains, while significantly enhancing the supply chain's risk resistance and post disaster

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recovery capabilities, and the improvement effect on chain recovery efficiency is more prominent [2]. With the continuous maturity of technologies such as big data, artificial intelligence, the Internet of Things, and cloud computing, the deep integration of the digital economy and the manufacturing real economy provides technical support for the reconstruction of supply chain models. Digital finance relies on digital systems to optimize capital flow, mitigate financial risks in the supply chain, and form a synergistic effect with digital technology to jointly strengthen the supply chain's resilience to shocks [3]. Artificial intelligence can effectively improve the problems of single supply chain channels and inefficient fund allocation, and comprehensively enhance the stability of the entire chain operation [4]. At the policy level, China continues to promote the implementation of the strategy of building a strong manufacturing country and a digital China, and has introduced multiple special policies for the digital transformation of the manufacturing industry. At the same time, it regulates the healthy development of digital finance and takes multiple measures to ensure the security of the industrial and supply chains. The digital transformation of the manufacturing industry has become a strategic development direction for the country. The core competitive logic of manufacturing enterprises is gradually changing, no longer simply pursuing economies of scale and cost advantages, but paying more attention to supply chain stability, adaptability, and risk prevention and control capabilities. Supply chain resilience has become a key indicator for measuring the core competitiveness of enterprises. Chowdhury et al. proposed that supply chain resilience is the core competitiveness for the sustainable development of the manufacturing industry in complex and uncertain environments [5]. Digitization can break down information barriers on the chain, optimize global resource allocation, and fundamentally improve the operational deficiencies of traditional supply chains. Liang and Zhuang believe that the manufacturing industry can systematically enhance the long-term resilience of the supply chain through comprehensive risk prevention and control, data-driven resource optimization, and upstream and downstream ecological coordination [6]. The stable development of the manufacturing industry is related to the security of the national economic cycle, and stabilizing and strengthening the chain has important strategic value. Wang and Zhou empirically verified based on long-term A-share samples that digital transformation has multidimensional transmission paths and cross upstream and downstream spillover effects, which can significantly enhance supply chain resilience and provide sufficient empirical evidence for the theoretical analysis in this article [7].

1.1 Significance of the study

On a theoretical level, this article relies on existing research frameworks to clarify the intrinsic relationship between digital transformation, digital finance, and supply chain resilience, enrich the theoretical content of risk management in manufacturing supply chains under the background of digital economy, and improve the research system of domestic manufacturing resilience. At the practical level, integrating multiple domestic empirical research results, clarifying the specific path for digital technology and digital finance to synergistically empower supply chain resilience, providing practical reference for different types of manufacturing enterprises to formulate transformation plans and optimize supply chain management models, and providing reference for the government to improve industrial support policies and build a collaborative digital supply chain system.

1.2 Research objectives

Define the core concepts of digital transformation and supply chain resilience in the manufacturing industry, sort out the internal and external driving factors of transformation,

and construct a scientific and comprehensive evaluation index for supply chain resilience. Clarify the inherent logic of digitalization and digital finance empowering supply chain resilience, and sort out the multidimensional transmission mechanism. Summarize the heterogeneity characteristics of digital empowerment under different enterprise sizes, industry attributes, and regional environments; 4. Combining theoretical and empirical conclusions, construct a supply chain resilience enhancement strategy system that involves the linkage of enterprises, governments, and industries.

2 The connotation of digital transformation in manufacturing industry

2.1 Definition of digital transformation

The digital transformation of manufacturing industry is driven by digital technology, which comprehensively optimizes and reconstructs the production process, internal management mode, organizational structure, and upstream and downstream supply chain system of enterprises. By collecting, transmitting, analyzing, and implementing data throughout the entire process, people aim to break down departmental and industrial chain information silos, achieve intelligent operation of the entire process of research and development, production and processing, warehousing and logistics, market sales, and after-sales operation and maintenance, and ultimately achieve the goals of cost reduction and efficiency improvement, controllable risks, innovative upgrading, and stable chain development. This is a systematic transformation of the manufacturing industry from traditional extensive mode to intelligent and efficient mode [8].

2.2 Driving factors of digital transformation

At the external environmental level, relevant national policies continue to guide and support the deep integration of digital technology and manufacturing industry; The intensification of market homogenization competition and personalized upgrading of consumer demand are forcing enterprises to accelerate digital upgrading; The continuous improvement of digital finance effectively broadens the financing channels for enterprises, reduces the pressure of capital turnover, and provides financial support for the transformation of the manufacturing industry and the stable operation of the supply chain. Internal development level: Digitization can promote technological and operational model innovation, break through traditional production efficiency bottlenecks; Various external supply chain risks occur frequently, and enterprises urgently need digital means to achieve full process visualization control and reduce the risk of chain breakage; At the same time, enterprises have increased their demand for financial security and stability, promoting the coordinated and integrated development of digitalization and digital finance [9].

3 Concept and evaluation indicators of supply chain resilience

3.1 Definition of supply chain resilience

Supply chain resilience is the comprehensive ability of the entire chain to quickly identify risks, resist negative impacts, quickly restore normal operation, and use risks to force itself to optimize and upgrade in the face of external sudden shocks and internal operational fluctuations. Featuring three major characteristics of flexible adaptation, dynamic adjustment,

and rapid self-healing, resilient supply chains differ from traditional supply chains that solely pursue operational efficiency. They place greater emphasis on the ability to survive in complex environments and achieve long-term sustainable development. From a structural perspective, supply chain resilience mainly includes two core components: risk resistance and post resilience [2].

3.2 Evaluation indicators for supply chain resilience

Operational response and recovery capability: response speed of each link in the supply chain, process connection efficiency, and recovery time after risks. Full cycle cost control capability: overall cost fluctuation and control level of the supply chain under external shocks. Digital application level: depth of digital technology coverage in procurement, production, logistics, and sales. Supply channel diversification: number of cooperative suppliers, degree of geographical distribution dispersion. Upstream and downstream collaboration level: information sharing, resource linkage, and business collaboration efficiency of enterprises on the chain. Financial risk robustness: supply chain liquidity, financing guarantee ability, and overall financial security level. The impact of digital transformation on supply chain resilience

Transparent visualization of the entire chain, achieving precise risk prediction and prevention relying on the Internet of Things and intelligent sensing devices, real-time data collection and sharing throughout the supply chain process, completely breaking down information barriers, and significantly improving chain transparency [10]. Enterprises can real-time grasp key information such as procurement progress, production status, logistics transportation, and inventory levels, accurately identify potential hazards such as supply delays, inventory shortages, and logistics disruptions, and develop early warning and emergency plans to reduce the probability of supply chain disruptions from the source. Liang and Zhuang proposed that comprehensive digital risk prevention and control is the primary measure to enhance supply chain resilience [5]. At the same time, digital finance relies on the big data credit system to further enhance the transparency of on chain information and form a synergistic risk control effect with digitization.

Strengthen overall impact resistance and improve the efficiency of rapid chain recovery. Big data computing can accurately predict market supply and demand, policy environment, and supply fluctuation risks, optimize safety stock layout reasonably, expand diversified supply channels, and disperse single link risk impacts. When encountering sudden risks, the intelligent scheduling system quickly adjusts production plans, switches logistics paths, and changes cooperative suppliers, greatly reducing the time for risk disposal and chain recovery. Relevant empirical research has confirmed that digitization enhances the resistance and repair capabilities of the supply chain, and the optimization effect of post disaster recovery is more significant [2].

Optimize the efficiency of global collaboration, build a stable industrial ecosystem, digitize and construct an integrated supply chain collaboration platform, achieve information exchange, resource sharing, and business linkage between upstream and downstream enterprises, and improve the problems of scattered operation, lagging communication, and low efficiency in traditional supply chains. Effectively reducing resource waste, improving overall circulation speed, maintaining long-term stable upstream and downstream cooperation relationships, building a healthy industrial ecology, and continuously consolidating the overall resilience of the supply chain [5].

4 Diversified transmission mechanism, heterogeneity characteristics, and spillover linkage effects

4.1 Core transmission path

Five chain synergy to stabilize the supply chain: through information stabilization, management strengthening, labor extension, financing enhancement, and innovation supplementation, the underlying operation security of the supply chain is fully stabilized [6].

Supply and demand structure optimization: broaden the supply layout, accurately match upstream and downstream supply and demand relationships, and reduce the overall fluctuation risk of the chain [2].

4.2 Differentiated impact characteristics

The digital empowerment effect is more prominent in technology intensive, mature, business friendly, and policy volatile enterprises; The positive effect of digital finance is more pronounced in enterprises with higher supply chain concentration, larger cooperative supplier scale, and strict regional financial supervision; The resilience enhancement effect of artificial intelligence is stronger in the Yangtze River Delta and Pearl River Delta regions, among large private enterprises and leading enterprises.

4.3 Spillover and long term incentive effects

There is a significant positive spillover effect on the digital transformation of upstream and downstream enterprises, which can jointly enhance the resilience of the core enterprise supply chain. At the same time, digital upgrading will not harm the operational efficiency of enterprises, but will continue to promote performance improvement. The leadership of chain owners and support from relevant industry policies will further amplify the effect of digital empowerment. Digital finance will also continue to optimize the entire chain's capital structure, ensuring long-term stability. five Strategies for Enhancing the Resilience of Manufacturing Supply Chains

At the Enterprise Level: Driven by both digital and financial factors, with differentiated layout development, enterprises implement three core measures: comprehensive risk control, data-driven resource allocation, and ecological collaborative linkage. Based on their own industry type and development scale, they formulate digital solutions that are suitable for them. High tech enterprises are increasing their investment in artificial intelligence research and development, while small and medium-sized enterprises are benefiting from the digital spillover benefits of relying on chain leading enterprises. Proactively connect and adapt digital financial services, alleviate financial pressure, control financial risks, optimize supply chain cash flow, and comprehensively enhance the dual capabilities of chain risk resistance and rapid recovery.

Government level: Improve policy infrastructure, optimize the development environment of digital finance, increase support subsidies for digital transformation of manufacturing industry, and balance the development gap between regions, large, medium and small enterprises; Accelerate the construction of new digital infrastructure such as industrial Internet and computing network. Establish a sound regional financial regulatory system and guide digital finance to accurately serve the supply chain needs of the manufacturing industry. Relying on the leading role of the chain owner enterprise, promote the collaborative digital transformation of upstream and downstream, and create a favorable environment for industrial development.

Industry level: Unify standards and norms, jointly build a global collaborative resilience ecosystem. Develop unified evaluation standards for digital transformation and supply chain resilience in the industry, and standardize the development path of the industry; Build an industry exchange and sharing platform to promote mature experience in risk prevention and control, intelligent applications, and collaborative operations. Promote the deep integration of digital finance and supply chain platforms, leverage the driving effect of regional clusters and leading enterprises, connect the data, capital, and resource circulation of the entire industry chain, and build a highly resilient digital industrial supply chain.

5 Conclusion

This article conducts a systematic study on the relationship between digital transformation of manufacturing industry and supply chain resilience, clarifies the connotation of relevant concepts, sorts out the driving factors of transformation and resilience evaluation system, and deeply analyzes the internal mechanism of digitalization and digital finance synergistic empowerment of supply chain operation. Based on empirical results of domestic A-share enterprises, summarize multidimensional transmission paths, heterogeneity patterns between enterprises and regions, and cross link spillover effects. Research has shown that digital transformation is the core lever for breaking the fragility of traditional supply chains, and digital finance serves as an important supporting support. The synergy between the two can effectively resist various external shocks and ensure the stable and efficient operation of manufacturing supply chains. The coordinated efforts of enterprises, governments, and industries, reasonable planning of digital construction, improvement of financial support, and deepening of upstream and downstream linkage and cooperation can continuously enhance the security level and overall resilience of China's manufacturing supply chain. In the future, targeted empirical research can be conducted in conjunction with segmented manufacturing industries to continuously optimize the integration mode of digital technology and digital finance, and further strengthen the independent and controllable, safe and stable development pattern of the manufacturing industry chain.

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