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Data-Real Integration and Logistics Enterprise Resilience: A Literature Review

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Abstract: ***With the deep integration of the digital economy and the real economy becoming a national strategy, how this integration affects the resilience of logistics enterprises has become a crucial issue in understanding the economic consequences of digital technology and supply chain security. This paper focuses on the resilience of logistics enterprises, systematically reviewing the connotation and research progress of digital-real-relationship integration, the conceptual evolution and measurement methods of enterprise resilience, as well as the direct evidence, mechanisms, and boundary conditions of its impact on enterprise resilience. The study finds that existing literature has confirmed the significant economic empowerment effect of digital-real-relationship integration at the macro, meso, and micro levels, and has initially revealed the logic of how digital transformation enhances enterprise resilience through dual innovation, dynamic capabilities, information transparency, and efficiency improvement. However, existing research still suffers from limitations such as insufficient industry-specificity, the need to improve the accuracy of enterprise resilience measurement, and a lack of empirical evidence based on large-sample panel data from the logistics industry. Future research should focus on key industries such as logistics, adopt more theoretically grounded objective resilience indicators, strengthen causal identification, mechanism testing, and heterogeneity analysis to deepen the understanding of how digital-real-relationship integration empowers the resilience of logistics enterprises.***

Keywords: Data-Real Integration, Logistics Enterprise Resilience, Digital Transformation, Financial Resilience, Literature Review.

1. Introduction

With the rapid development and deep penetration of digital technology, the integration of the digital economy and the real economy has become a core force driving the reshaping of the global economic landscape and the transformation of social production and lifestyles. This integration process has not only spawned new industries, new business formats, and new models, but has also profoundly changed the resource base, capability structure, and competitive paradigm of enterprises. At the same time, the uncertainty of the global political and economic environment, sudden public crises, and increasingly fierce market competition have made "resilience" a key capability for the survival and sustainable development of enterprises. Against this backdrop, exploring how the integration of digital and real economies can empower enterprises, especially logistics companies as the artery of the national economy, to build and enhance their resilience in the face of complex and ever-changing environments has both significant theoretical value and practical urgency.

From a policy perspective, the report of the 20th National Congress of the Communist Party of China explicitly proposed "accelerating the development of the digital economy and promoting the deep integration of the digital economy and the real economy." The 2025 Government Work Report further emphasized "deepening the innovative development of the digital economy and empowering the transformation and upgrading of traditional industries." Related policy documents jointly issued by the Ministry of Finance and the Ministry of Industry and Information Technology in 2024 also proposed promoting the deep integration of digital technology and the real economy, and driving the optimization and upgrading of the industrial chain and supply chain. As a key link connecting production and consumption and bridging the upstream and downstream of the industrial chain, the digital upgrading of the logistics industry is not only an inevitable requirement in response to national strategies, but also an important path to improve supply chain collaboration efficiency and enhance the resilience of the industrial chain.

From an academic perspective, existing research has extensively discussed the economic and social effects of data-real integration, the concept and measurement of corporate resilience, and the relationship between digital transformation and corporate performance. However, overall, research directly linking data-real integration with corporate resilience, focusing on the logistics industry, and conducting systematic testing based on large-sample panel data from listed companies remains relatively scarce. This paper focuses on the resilience of logistics companies, but given the limited literature specifically addressing logistics companies, the scope of the review is appropriately expanded to include general research on data-real integration and corporate resilience, extracting insights for the digital transformation and resilience building of logistics companies. This paper aims to systematically review relevant literature, clarify the contributions and limitations of existing research, and point out future research directions.

2. The Connotation and Research Progress of Data-Real Integration

2.1 The Concept and Connotation of Data-Real Integration

Since its inception in the 1990s, the concept of the digital economy has undergone continuous enrichment in both its connotation and extension. Early research focused primarily on the scale and growth of the digital industry itself, i.e., "digital industrialization." With the widespread penetration of digital technologies such as big data, cloud computing, artificial intelligence, and the Internet of Things into traditional industries, "industrial digitalization" has become a core issue. In recent years, academia has further developed a collaborative framework encompassing "four modernizations": digital industrialization, industrial

digitalization, digital governance, and data valorization. This indicates that the understanding of the digital economy has risen from a mere tool of productivity to a strategic level involving the systematic restructuring of production relations, factor values, and social structures.

Under this consensus, "digital-real integration" has become a core term describing the deep interaction and mutual promotion between digital technology and the real economy. Its essence is the expansion of key production factors driving economic development from traditional land, labor, and capital to data, a new factor, and the leap in total factor productivity achieved through the driving force of data. At the enterprise level, digital-real integration is typically manifested as digital transformation, that is, using digital technology to systematically transform products, processes, organizations, and business models to create new value and gain a competitive advantage.

2.2 Macroeconomic Empowerment Effect

The academic community has conducted research on the economic and social empowering effects of digital-real integration from three dimensions: macro, meso, and micro. At the macro level, numerous studies have confirmed that digital-real integration is a key engine for promoting economic growth and improving the quality and competitiveness of regional development. Jing Wenjun et al. (2019) theoretically analyzed the dual mechanism by which the digital economy affects economic growth: at the micro level, digital technology improves the level of economic equilibrium by increasing information efficiency, optimizing decision-making, and reducing transaction costs; at the macro level, it drives long-term growth by introducing new production factors, improving resource allocation efficiency, and increasing total factor productivity. Zhao Tao et al. (2020) used panel data from Chinese cities to find that the digital economy can significantly empower high-quality economic development by stimulating regional entrepreneurial vitality.

Furthermore, the spatial spillover effect of digital-physical integration has been widely verified. Research by Yang Huimei et al. (2021) shows that the development of the digital economy not only improves the total factor productivity of the region but also generates significant positive spillover effects on neighboring regions. This effect is achieved through pathways such as technology diffusion, knowledge spillover, and industrial chain synergy. Studies by Liang Qi et al. (2021) and Chen Tang et al. (2021) have also confirmed the existence of the cross-regional radiation and driving effect of the digital economy from the perspectives of improving regional innovation quality and upgrading industrial structure, respectively.

2.3 Transformation and Upgrading Effects at the Meso-level of Industry

At the meso-level of industry, research focuses on the empowering paths and effects of digital-real integration on the transformation and upgrading of different industries. Manufacturing, as the foundation of the real economy, has received the most attention. Early research by Manyika et al. (2011) pointed out that the embedding of digital technologies can significantly promote the transformation of manufacturing towards intelligence and service orientation. Jiao Yong (2020) further emphasized that the impact of the digital economy on manufacturing has transcended short-term efficiency improvements and is evolving into a long-term value creation model transformation, empowering manufacturing to build new competitive advantages by reshaping the entire chain of R&D, production, marketing, and services. Wang Dexiang (2022) and Ma Zhongdong et al. (2020) have deeply analyzed the internal mechanisms by which the digital economy empowers manufacturing from the perspective of data-driven and factor allocation optimization.

Meanwhile, the integration and application of digital technology in agriculture and the service sector has also attracted much attention. Wen Tao et al. (2020) systematically reviewed global practices of integrating digital technology with the agricultural and rural economy, arguing that such integration can effectively promote intelligent agricultural production, modernize rural governance, and facilitate farmers' lives. Cao Xiaoyong et al. (2021), from the perspective of the new development pattern of domestic and international dual circulation, proposed that the digital economy can comprehensively empower the service industry to improve quality and efficiency through four paths: promoting innovation and upgrading, promoting industrial integration, improving operational efficiency, and achieving precise matching of supply and demand.

For the logistics industry, the application of digital technologies such as the Internet of Things, big data, artificial intelligence, and blockchain is becoming increasingly widespread, driving the rise of new models and business forms such as smart logistics, supply chain collaboration platforms, and online freight. As a crucial link connecting production and consumption and bridging the upstream and downstream of the industrial chain, the digital upgrade of the logistics industry involves not only the intelligent transformation of transportation, warehousing, and distribution, but also information sharing and collaborative decision-making across the entire supply chain. Therefore, the integration of data and reality in the logistics industry shares commonalities with general industrial digitalization, but also possesses distinct industry characteristics such as high requirements for network collaboration, sensitivity to timeliness and cost, and critical resilience to disruptions.

2.4 Empowering Effect at the Micro-enterprise Level

At the micro-enterprise level, research on the enabling effects of data-driven integration is most active, mainly focusing on enterprise performance, innovation activities, organizational change, and risk response capabilities. Enterprise digital transformation is considered a strategic process that utilizes digital technologies to systematically transform products, processes, organization, and business models to create new value and gain competitive advantage (Vial, 2019). Numerous empirical studies have shown that digital transformation can significantly improve enterprise innovation output (Wu Fei et al., 2021), total factor productivity (Zhao Chenyu et al., 2021), and market value. Its mechanism lies in the fact that digital technologies enhance information processing and connectivity, reducing information asymmetry within

enterprises and across the supply chain, thus optimizing resource allocation efficiency; simultaneously, data-driven decision-making models improve the scientific rigor and precision of management.

More importantly, scholars are beginning to move beyond short-term economic performance and focus on the role of digital-physical convergence in shaping an organization's long-term dynamic capabilities. Warner and Wager (2019) point out that successful digital transformation helps companies build dynamic capabilities for the digital age—the ability to perceive market changes, seize digital opportunities, and update their strategies. This dynamic capability is the core of a company's ability to adapt to an uncertain environment. Recently, some cutting-edge research has begun to directly link digital-physical convergence with a company's ability to cope with crises and withstand risks—"corporate resilience" — attempting to open the "black box" of how digital technology empowers an organization's long-term sustainable development.

3. Evolution and Measurement of Enterprise Resilience

3.1 From Regional Resilience to Corporate Resilience

The concept of "resilience" originated in physics, referring to the ability of materials to return to their original shape after deformation. It was later widely adopted by ecology, psychology, and sociology. Reggiani (2002) was the first to introduce it into economics to describe the response characteristics of regional economic systems to external shocks. Since then, research on "economic resilience" has developed into two main perspectives: equilibrium theory and evolutionary theory. The equilibrium theory perspective emphasizes the speed and extent of a system's recovery after deviating from equilibrium, aiming to return to its original stable state; while "ecological resilience" acknowledges the existence of multiple equilibria and focuses on the amount of shock a system can absorb before a state transition.

However, economic systems are inherently complex, non-equilibrium, and continuously evolving systems. Therefore, the perspective of "evolutionary resilience" based on evolutionary economics has gained wider acceptance. Martin's (2012) evolutionary resilience analysis framework is the most influential, deconstructing economic resilience into four dimensions: first, resistance, i.e., the system's ability to withstand shocks and avoid severe damage; second, resilience, i.e., the speed at which it rebounds to its original growth path or level after being shocked; third, reorganization and adaptation, i.e., the system's ability to adjust its internal structure and learn new knowledge to adapt to new environments; and fourth, renewal and transformation, i.e., the system's ability to use crises to create new development paths and achieve transformation and upgrading. This multidimensional and dynamic view of resilience has been widely accepted and has become the basic framework for studying the resilience of various systems.

When the research perspective shifts from regional economic systems to micro-level corporate organizations, the concept of "corporate resilience" emerges. Corporate resilience can be defined as: a dynamic combination of capabilities that enable a company to effectively predict, resist, absorb the impact of significant, sudden external shocks or long-term, gradual pressures, and to quickly recover, adapt, and even achieve leapfrog development (Duchek, 2020). It transcends traditional risk management and crisis response, emphasizing an organization's ability to learn, adapt, and fundamentally change.

3.2 Methods for Measuring Corporate Resilience

Currently, there is no unified standard for measuring corporate resilience, and existing research methods can be mainly divided into two categories.

The first category is the single-indicator measurement method, which selects a proxy variable that can corely reflect a company's impact and recovery. Commonly used indicators include: indicators based on financial performance, such as the volatility and recovery of sales, profits, and cash flow (Buyl et al., 2019); indicators based on market reaction, such as stock price volatility and the risk of stock price crashes (Albuquerque et al., 2020); or indicators based on operations, such as changes in employment. This method is direct, objective, and theoretically clear. Especially in financial resilience research, cash holding levels are often used as a key indicator to measure a company's precautionary motives and financial buffering capacity, and it has a strong theoretical foundation in finance.

The second category is the multi-indicator comprehensive evaluation method, which involves constructing an indicator system encompassing multiple dimensions. This type of research typically draws upon the multidimensional framework of evolutionary resilience, selecting a series of financial and non-financial indicators from dimensions such as resistance, resilience, adaptability, and innovation, and conducting comprehensive calculations using methods such as entropy weighting and principal component analysis (Briguglio et al., 2006; Cui Gengrui, 2021). This method can more comprehensively characterize the complex connotations of resilience, but the subjectivity of indicator selection, data availability, and potential measurement errors arising from strategic behaviors such as "greenwashing" are issues that require attention.

Overall, research on corporate resilience is still in its developmental stage, and in-depth empirical analysis targeting specific industry scenarios and selecting precise proxy variables based on solid theory needs further strengthening. For logistics companies, which face frequent capital turnover, liquidity sensitivity, and high supply chain disruption risks, financial buffer indicators such as cash holding levels are particularly effective in reflecting their ability to cope with uncertainty and maintain operational continuity.

4. Research Progress on the Impact of Data-Real Integration on Enterprise Resilience

4.1 Direct Evidence and Mechanism of Action

In recent years, a few cutting-edge studies have begun to directly explore the causal relationship and mechanism of action between digital-physical integration and corporate resilience, providing direct reference for this study. Jiang et al. (2022), based on questionnaire survey data from 339 enterprises in Guangdong and Jiangsu, China, empirically examined the positive impact of digital transformation on corporate resilience and its transmission path from the perspective of dual innovation. Their study found that digital transformation not only directly enhances corporate resilience but also indirectly plays a role by promoting dual innovation activities. This indicates that digital-physical integration can both solidify the business foundation and enhance resilience and recovery by optimizing existing business processes, and open up new growth paths and enhance adaptability and innovation by exploring new products and markets.

Chen et al. (2023) further deepened this research using data from Chinese A-share listed companies from 2011 to 2020. They not only confirmed the positive impact of digital transformation on corporate resilience but also introduced "bankruptcy risk" as a key contextual factor, finding that bankruptcy risk plays a positive moderating role between the two. Particularly insightful is their distinction between "potential bankruptcy risk" and "proximate bankruptcy risk," finding that high potential risk is more incentivizing companies to enhance resilience through precise risk control via digital transformation, while high proximate risk may lead to conservative corporate behavior, thus limiting the resilience-enhancing effect of digital transformation. This study suggests that the impact of digital-real integration on corporate resilience is not a simple linear relationship but is subject to complex moderating effects from both the company's internal state and external environment.

From a mechanistic perspective, existing literature mainly summarizes the following paths: First, efficiency improvement and information transparency. Digital technologies optimize operational processes, strengthen supply chain collaboration, reduce information asymmetry and transaction costs, and enhance corporate financial resilience. Second, dynamic capability building. Digital transformation helps companies perceive market changes, capture digital opportunities, and update their strategies, thereby improving their adaptability and transformation capabilities. Third, dual-innovation drive. Utilization-based innovation solidifies existing businesses, while exploratory innovation opens up new growth paths; both jointly enhance corporate resilience. Fourth, relief from financing constraints and improved risk warning capabilities. Data-driven decision-making helps companies identify risks earlier and allocate resources more accurately, thereby enhancing their risk resistance capabilities.

4.2 Boundary Conditions and Heterogeneity

The impact of digital-physical integration on corporate resilience is not homogeneous across all enterprises. Existing research suggests that enterprise size, ownership structure, geographical location, bankruptcy risk, and industry characteristics may all moderate this relationship. For example, Chen et al. (2023) found that differences in the stage of bankruptcy risk significantly affect the resilience-enhancing effect of digital transformation. Enterprises of different sizes differ in their capacity for digital technology investment, data integration capabilities, and speed of organizational change, and their resilience enhancement effects may also vary. State-owned enterprises and non-state-owned enterprises differ in resource access, policy support, and market pressures, and regional digital infrastructure and institutional environment also affect the implementation effect of digital-physical integration.

For logistics companies, characteristics such as network layout, transportation organization methods, customer structure, asset specificity, and supply chain location can all make the resilience-enabling effect of data-physical integration exhibit industry-specific characteristics. For example, platform-based logistics companies may find it easier to improve network resilience through data collaboration, while asset-heavy logistics companies may rely more on digital scheduling and warehouse optimization to enhance operational resilience. Therefore, future research needs to strengthen heterogeneity analysis and moderating effect testing.

5. Research Review and Outlook

5.1 Contributions of Existing Research

Overall, existing literature has made significant contributions in the following aspects: First, it has confirmed the economic empowerment effect of digital-real economy integration at multiple levels, including macro, meso, and micro, providing rich evidence for understanding the deep integration of the digital economy and the real economy. Second, it has preliminarily revealed the direct effects and some mechanisms by which digital transformation impacts corporate resilience, particularly pathways such as dual innovation, dynamic capabilities, information transparency, and efficiency improvement. Third, it has begun to focus on the measurement of corporate resilience, developing two types of methods: single-indicator and multi-indicator methods, providing a methodological foundation for subsequent empirical research. Fourth, policy research and academic research have interacted, providing practical references for the digital transformation and supply chain resilience building in industries such as logistics.

5.2 Deficiencies in Existing Research

Despite the insightful results of existing research, there are still significant limitations in the current literature.

First, the research context lacks specificity. Existing empirical studies on digital-physical integration and enterprise resilience either employ cross-industry mixed samples or focus on the manufacturing sector as a whole. No research has specifically examined the "logistics industry"—a key infrastructure and core link in the national economic operation and supply chain. The logistics industry possesses unique characteristics, including connecting production and consumption, high reliance on network collaboration, and extreme sensitivity to timeliness and cost. Its digital-physical integration process and resilience building have distinct industry characteristics and crucial strategic significance.

Ignoring industry heterogeneity may cast doubt on the universality of research conclusions and fail to provide precise guidance for the digital transformation practices of logistics enterprises.

Second, the accuracy and theoretical depth of core variable measurements need improvement. Existing research on measuring corporate resilience either uses a comprehensive index method, whose indicator construction is easily influenced by subjectivity; or it uses market indicators, which, while reflecting market expectations, are easily affected by overall financial market sentiment. Few studies have taken a fundamental perspective of corporate financial security and liquidity management, using a classic proxy variable from finance—cash holding levels—that is theoretically sound and data-driven, to directly measure a company's "financial resilience." Cash holdings serve as a "financial buffer" for companies to cope with uncertainty and prevent future shocks; the decision-making process is underpinned by profound preventative motivation theories. Using this as a starting point can more purely and directly reveal how the integration of data and reality affects a company's risk prevention and survival capabilities.

Third, industry-specific empirical evidence based on large-sample panel data remains lacking. The aforementioned pioneering studies either relied on cross-sectional questionnaire surveys or failed to highlight the logistics industry within the full sample. There is a lack of rigorous econometric analysis based on panel data from listed logistics companies over a longer time span to robustly examine the causal effect of data-real-reality integration on their resilience, particularly their financial resilience.

5.3 Future Research Directions

Based on the above shortcomings, future research can be deepened in the following aspects.

First, focus on specific industries and deepen contextual research. The research sample can be strictly limited to A-share listed logistics companies in China to explore the unique patterns of how data-real integration affects corporate resilience within this specific industry context. Second, accurately measure variables and solidify theoretical dialogue. Textual analysis can be used to extract the frequency of digital transformation terms from listed companies' annual reports to construct core explanatory variables. Simultaneously, classic indicators in finance, such as cash holding levels, which measure precautionary motives, can be used as core proxy variables for corporate financial resilience, ensuring the research is grounded in solid economic theory. Third, provide novel evidence and address real-world concerns. Panel data from listed logistics companies over a longer period can be used to construct a two-way fixed-effects model to empirically test the impact of data-real integration on the financial resilience of logistics companies. This provides empirical evidence and policy insights from the micro-enterprise level for the national strategic need to "empower the development of the real economy through the digital economy and enhance the resilience of the industrial and supply chains." Fourth, strengthen mechanism testing and heterogeneity analysis. Further exploration can be conducted on mediating mechanisms such as improved operational efficiency, alleviated financing constraints, and dual innovation, and the moderating effects of contextual factors such as company size, ownership structure, and regional location can be analyzed.

6. Conclusion

The integration of digital and physical data and the resilience of logistics enterprises are important topics in organizational management and supply chain security research in the digital economy era. Existing literature has confirmed the economic empowering effect of digital-physical integration from multiple perspectives and has initially revealed the logic of how digital transformation enhances enterprise resilience through dual innovation, dynamic capabilities, information transparency, and efficiency improvement. However, existing research still has limitations such as insufficient industry-specificity, the need to improve the accuracy of enterprise resilience measurement, and a lack of large-sample panel evidence in the logistics industry. Future research should focus on key industries such as logistics, adopt more theoretically grounded objective resilience indicators, strengthen causal identification, mechanism testing, and heterogeneity analysis, thereby deepening the understanding of how digital-physical integration empowers the resilience of logistics enterprises and providing practical references for the digital transformation and supply chain resilience building of logistics enterprises.

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