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Enhancing Global Supply Chain Resilience Through Digital Economy: A China-US Perspective

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Abstract: The digital economy is significantly reshaping the structure and operational modes of global supply chains. In the context of China-US economic interactions, the mechanisms, challenges, and countermeasures of the digital economy in enhancing the resilience of global supply chains have become increasingly important areas of study. Based on a synthesis of relevant theories, three key pathways through which the digital economy impacts supply chain resilience can be identified: the enhancement of resource integration and dynamic capabilities, the reconstruction and coordination of global supply chain networks, and the reduction of transaction costs coupled with efficiency improvements. The interaction mechanisms between the digital economy and supply chain resilience are closely associated with the synergies between technological innovation and market application, as observed in both countries. However, several challenges, including geopolitical tensions and technological barriers, potentially hinder the full realization of these benefits. To address these issues, policy recommendations can be proposed from short-, medium-, and long-term perspectives. The proposed policies focus on establishing unified standards, developing intelligent risk prevention and control systems, as well as fostering a China-US digital supply chain innovation community. These findings provide both theoretical foundations and practical guidance for enterprise digital transformation and policy formulation, with the aim of contributing to the development of a more resilient and inclusive global economic system.

Keywords: Digital Economy; Supply Chain Resilience; China-US Cooperation

1. Introduction

In the era of increasingly interconnected globalization and digitalization, the digital economy is reshaping the global economic landscape at an unprecedented pace. The International Data Corporation (IDC) projects that by 2027, Worldwide spending on Digital Transformation (DX) is forecast to reach almost $4 trillion. Concurrently, recurring geopolitical conflicts, natural disasters, and public health crises have emphasized the critical importance of supply chain resilience. McKinsey calculates that

within 10 years, supply chain disruptions tally to close to half (45%) of a year's worth of profits for companies. In light of these developments, the intersection of the digital economy and supply chain resilience is emerging as a critical factor in shaping the international competitive landscape.

As the world's two largest economies, the interactions between China and the United States in the domains of digital economy and supply chains significantly influence both bilateral relations and the reconfiguration of the global economic landscape. The global supply chain system, driven by strategic competition between these two nations, is undergoing comprehensive adjustment and reconstruction. This emerging pattern should not be characterized by simplistic "de-Sinicization" or "de-Americanization," but rather by a more balanced, resilient, and inclusive system. As emphasized by Xi (2022) in his report to the 20th National Congress of the Communist Party of China, "maintaining the resilience and stability of global industrial and supply chains is a crucial guarantee for promoting world economic development." This principle not only guides China's development trajectory but also has the potential to become a shared aspiration of the international community.

Grounded in the concept of promoting China-US cooperative development, this article focuses on three core issues: (1) the mechanism through which the digital economy impacts supply chain resilience, (2) the current status and challenges of Sino-US digital supply chains, and (3) policy measures to foster Sino-US cooperation in enhancing global supply chain resilience. Through a comprehensive literature review encompassing multiple theoretical frameworks, we construct a model elucidating the digital economy's impact on supply chain resilience and propose a series of actionable policy recommendations. These findings provide valuable insights for policymakers, offer practical guidance for enterprises in constructing resilient supply chains in the digital era, and contribute to the promotion of sustainable global economic development.

2. Current Research on Global Supply Chain Resilience and Digital Economy

2.1 Global Supply Chain Resilience

Supply chain resilience was initially conceptualized as the capacity of a supply chain to rapidly recover following a disruptive event. As the field has evolved, researchers have expanded and refined this concept. Tesshu et al. (2022) proposed that supply chain resilience represents a functional network structure influencing social value. From a dynamic capabilities perspective, Sheng et al. (2022) and Fan et al. (2020) defined supply chain resilience as the ability to rapidly coordinate internal and external resources to achieve recovery in the face of external uncertainties and risks.

The formation mechanisms of supply chain resilience can be examined through resource-based and capability-based perspectives. From a resource-based standpoint, the strategic configuration of redundant resources—such as multi-source supply, strategic safety inventory, and procurement backup—is crucial for mitigating supply chain disruptions. Empirical studies by Datta (2017) demonstrated that abundant human resources significantly enhance the recovery capability of supply chains post-disruption. Research has also shown that supply chain resilience can be enhanced through

real-time information management, early warning capabilities, process restructuring, flexibility, and innovation.

The determinants of supply chain resilience encompass both external and internal dimensions. External factors include political, social, and economic environments, which directly influence supply chain stability and efficiency. Wang (2022) emphasized that political instability can induce supply chain disruptions. Wieland (2021) highlighted that sociocultural disparities may impede supply chain continuity. Chen et al. (2022) explored economic factors, such as shifts in socioeconomic structures and consumption patterns, as crucial elements affecting supply chain resilience. Internal factors comprise intra-supply chain coordination management and the robustness of relationships in adapting to changes. Soni et al. (2014) analyzed organizational resource allocation capability and collaborative response through explanatory theoretical models. Sun et al. (2020) underscored the significance of management flexibility and production recovery capability for resilience under stress. In the digital economy era, the degree of information sharing has emerged as a critical internal factor. Both Schallmo et al. (2017) and Olorunniwo and Li (2010) emphasized its role in enhancing supply chain management efficiency.

2.2 Digital Economy

The digital economy encompasses economic activities that are primarily reliant on digital computing technologies, including the utilization of digital and network technologies, as well as the accumulation and exploitation of data assets. In supply chain management, the digital economy has markedly enhanced supply chain efficiency and responsiveness through real-time data analysis, automated processing, and optimized resource allocation. As a result, global supply chains have transitioned from traditional linear operational models to networked and intelligent paradigms. By leveraging technologies such as big data, cloud computing, and the Internet of Things, companies can monitor and adjust supply chain operations in real-time on a global scale, thereby augmenting their resilience and adaptability .

Recent research on the digital economy's impact on industrial and supply chain resilience has focused on several key aspects. First, its effect on global value chain resilience: Ma et al. (2023) observed strong resilience in global digital value chains during the 2020 COVID-19 pandemic, while Yang et al. (2021) explored the positive influences of the digital economy on global value chain stability and security. Second, its impact on enterprise productivity and technological advancement: Tao et al. demonstrated that enterprise digital transformation enhances productivity by strengthening industrial and supply chain resilience. Du et al. (2022) found that the digital economy promotes digital transformation among peer enterprises, driving technological progress and output improvement. Third, its influence on industrial chain structure: Qi et al. (2021) posited that digital economy development improves enterprises' trade network positions in global value chains, while Shi et al. (2021) discovered that information technology development deepens inter-enterprise division of labor and cooperation. Qi et al. (2021) further noted that enterprise digital transformation effectively promotes industrial chain linkages and network positioning by reducing costs.

With respect to global value chain reshaping, Fernandes et al. (2019) and Wu (2019) emphasize that the cross-border fluidity of digital technologies can lower entry barriers for international trade, thereby providing more opportunities for enterprises to embed themselves in global value chains. Additionally, Zhang et al. (2022) highlight the digital economy's significant impact on the breadth and depth of global value chains, which promotes technological progress and product quality improvement.

Despite these advancements, most existing studies focus on supply chain spillover effects and enterprise position upgrades within industrial and supply chains. Research on how the digital economy directly affects the resilience of enterprises' own supply chains remains limited. Some studies differentiate between digital trade-dependent and non-digital trade-dependent production sectors but lack comprehensive analysis of entire industries. Other research, when measuring industrial and supply chain resilience, primarily focuses on changes in global value chain length without separately considering alterations in enterprises' corresponding procurement and supply relationships .

While these studies have provided valuable insights into the relationship between the digital economy and supply chain resilience, a more comprehensive theoretical framework is needed to elucidate the specific mechanisms through which digital technologies enhance supply chain resilience, particularly in the context of international cooperation. The following section will address this gap by examining the theoretical foundations and impact pathways of the digital economy's influence on global supply chain resilience.

3. Theoretical Foundations and Impact Mechanisms of Digital Economy in Empowering Supply Chain Resilience

To comprehensively understand how the digital economy empowers global supply chain resilience, particularly in the context of China-US cooperation, it is essential to examine this phenomenon through multiple theoretical lenses. This section integrates several key theories to provide a holistic explanation of the underlying mechanisms. By synthesizing resource-based theory, dynamic capability theory, global value chain theory, supply chain management theory, and transaction cost theory, we can better elucidate the multifaceted ways in which digital technologies are reshaping supply chain resilience.

3.1 Theoretical Foundations

Firstly, the resource-based theory posits that a firm's competitive advantage derives from its possession of resources that are rare, valuable, and non-substitutable. This theory was initially proposed by Wernerfelt (1984), who employed the term "resources" to delineate a firm's strengths and weaknesses. Subsequent scholars further developed this theory, contending that a firm's capabilities (such as management skills and organizational processes) should also be considered as crucial resources .

In supply chain resilience research, resource-based theory has been widely applied. Blackhurst (2011) believes that establishing human resource measures for risk management can enhance supply chain resilience. Brandon-Jones (2014) points out that supply chain visibility capability is a key resource for enhancing resilience. In the context of the digital economy, digital resources (such as data assets and

IT infrastructure) and capabilities (such as data analysis and IT management proficiencies) have become pivotal. These resources and capabilities empower firms to effectively manage and coordinate complexities and uncertainties in global supply chains, thereby enhancing their adaptability and resilience.

Secondly, building upon the resource-based theory, the dynamic capability theory addresses its limitations by emphasizing the need for firms to continuously reconfigure resources and capabilities to adapt to environmental changes. Dynamic capabilities are typically classified into sensing capability, seizing capability, and reconfiguring capability. In supply chain resilience research, dynamic capability theory has been widely applied. Lee and Rha (2016) believe that the process of cultivating dynamic capabilities is the process of enhancing supply chain resilience. Chowdhury and Quaddus (2017) view supply chain resilience as a dynamic capability and developed measurement indicators from proactive and reactive dimensions.

In the context of the digital economy, dynamic capability theory assumes heightened significance. Digital tools and platforms enable the monitoring of market and supply chain trends, facilitating firms' rapid responses to external changes such as demand fluctuations or supply disruptions. Within the China-US cooperation framework, companies can leverage advanced digital technologies to optimize resource allocation. For instance, through digital supply chain platforms, production resources can be strategically reconfigured to more effective locations or suppliers. Furthermore, the digital economy catalyzes the implementation of innovation, empowering firms to adapt to changing market demands through rapid iteration and product development, thereby enhancing the flexibility and responsiveness of their supply chains.

Thirdly, from a macro-level perspective, global value chain theory provides insights into how digital technologies reshape the structure and spatial configuration of global production networks. This theory has undergone significant evolution in the digital economy era. Strange and Zucchella (2017) highlight that the digital economy-induced restructuring of global value chains encompasses not only increased domestic value-added rates in exporting countries but also alterations in value chain length and spatial reconfigurations.

Digitalization enhances the flexibility of geographical distribution across various value chain components, consequently altering value distribution patterns. This transformation has significant implications for supply chain resilience. A notable illustration is in the design phase, where the pervasive adoption of computer-aided design (CAD) and 3D printing technologies facilitates global collaborative product design, transcending traditional geographical limitations.

What's more, supply chain management theory, which originated from the concept of integrating various business functions to meet customer needs , has progressed from early linear chain management to intermediate network management, and now to ecosystem management. In the digital economy context, supply chain management theory increasingly emphasizes the optimization of network relationships. This perspective aligns with the theoretical developments proposed by Mentzer et al.

(2001), who posited that supply chain management is evolving from traditional linear models towards paradigms centered on network relationship coordination.

Digital communication and collaboration platforms mitigate geographical and temporal constraints, facilitating more effective global supply network management. The implementation of Enterprise Resource Planning (ERP) systems and cloud services enables real-time, cross-border information sharing, thereby enhancing decision-making efficiency and response agility. Furthermore, digital tools facilitate collaboration between Chinese and American enterprises, fostering innovation capabilities and supply chain competitiveness through joint research and development initiatives and knowledge exchange.

Finally, transaction cost theory, explains how firms exist primarily to minimize market transaction costs, offers a micro-foundational framework for understanding how digital technologies mitigate transaction costs across various supply chain components. This theory was further developed to emphasize that firms choose governance structures to minimize transaction costs, which include not only production costs but also the costs of managing economic exchanges, encompassing search, negotiation, and monitoring expenses, among others.

In the digital economy era, transaction cost theory has found novel applications. Digital technologies substantially reduce costs associated with information search, transaction matching, and contract execution, among other aspects. This cost reduction not only redefines enterprise boundaries but also significantly influences supply chain structures and operations. For instance, the proliferation of digital platforms has significantly diminished search and matching costs between suppliers and buyers. Concurrently, blockchain technology has enhanced transaction transparency and traceability, thereby reducing monitoring costs. The resultant reduction in transaction costs is likely to foster enhanced cooperation between Chinese and American enterprises, facilitating the joint creation of efficient, reliable, and resilient global supply chain networks.

The aforementioned theories collectively constitute a comprehensive theoretical framework for analyzing the empowerment of global supply chain resilience through the digital economy.

3.2 Impact Pathways

3.2.1 Resource Integration and Dynamic Capability Enhancement

Digital technologies provide enterprises with novel information resources and data assets, thereby reinforcing the formative mechanisms of supply chain resilience through enhanced redundant resource configuration, improved early warning systems, and advanced process restructuring capabilities. The digital economy fundamentally alters the nature and utilization of resources. By leveraging big data analytics, artificial intelligence, and other cutting-edge technologies, enterprises can achieve dynamic integration and optimal allocation of resources, significantly improving resource utilization efficiency. Concurrently, digital technologies augment enterprises' dynamic capabilities, particularly in areas such as market change detection, opportunity identification, and resource reconfiguration. This enhancement

of capabilities directly strengthens the adaptability and resilience of supply chains, enabling them to respond more effectively to disruptions and market fluctuations.

3.2.2 Global Supply Chain Network Restructuring and Coordination

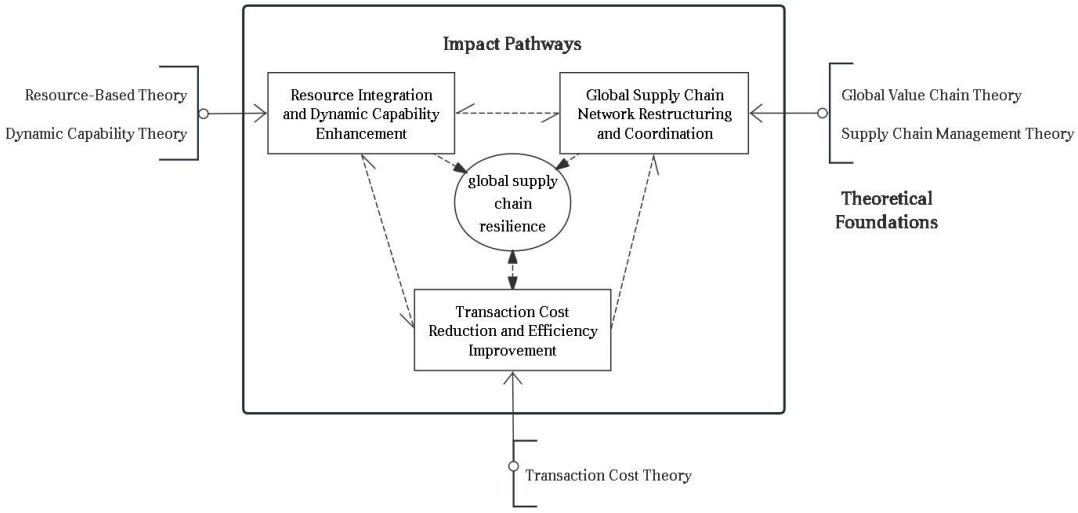
Digital technologies are fundamentally reshaping the structure and operation of global value chains, significantly enhancing "collaborative response capability" as a critical internal factor influencing supply chain resilience. Advanced digital platforms empower enterprises to more flexibly select and manage global supplier networks, facilitating dynamic adjustments to supply chain structures. Sophisticated tools, such as Computer-Aided Design (CAD) systems, enable real-time sharing of design files, substantially reducing product development cycles. Moreover, electronic market platforms significantly lower entry barriers for enterprises seeking to penetrate global markets. The synergistic effect of these restructuring mechanisms strengthens supply chain cohesion, transcending geographical and temporal limitations, thereby markedly improving the flexibility and adaptability of supply chains in the face of global challenges.

3.2.3 Transaction Cost Reduction and Efficiency Improvement

Digitalization reduces various transaction costs in supply chain operations, such as information search, transaction matching, and contract execution, improving transaction efficiency and security. For example, technologies like blockchain provide secure transaction platforms without intermediaries, increasing transparency. Electronic contracts and digital payment systems simplify cross-border transaction processes. The reduction in costs directly promotes closer, more efficient business cooperation, creating conditions for building highly resilient global supply chain networks. These technologies improve the transparency and traceability of transactions, enhancing the synergistic effects and risk resistance capabilities in the capability perspective of supply chain resilience.

The relationship between the theoretical foundations and impact pathways is illustrated in Figure 1. These three pathways are interconnected and mutually reinforcing. Initially, digital technologies equip enterprises with novel resource endowments and enhanced capability reserves. Leveraging this foundation, enterprises can strategically restructure their global production networks to achieve more efficient collaboration. Concurrently, the reduction in transaction costs facilitates increased cross-border cooperation, establishing a virtuous cycle of improvement. In the specific context of China-US supply chain cooperation, this digital transformation not only enables enterprises to optimize resource utilization and enhance operational efficiency but also fosters cross-cultural collaboration and knowledge exchange. Consequently, this synergy elevates global supply chain management to new levels of sophistication and resilience.

Figure 1: Theoretical Foundations and Impact Pathways



3.3 Current Research Limitations and Future Implications

Despite significant advancements in understanding global supply chain resilience and the impact of the digital economy, current research exhibits several limitations that warrant attention. There is a notable lack of studies examining the direct impact of the digital economy on enterprise-level supply chain resilience, with most existing research focusing on spillover effects and positional upgrades within industrial and supply chains. This gap limits our understanding of how digital technologies directly influence individual firms' resilience capabilities. Furthermore, existing studies often rely on singular theoretical perspectives, such as resource-based or dynamic capability theories, without attempting to integrate multiple theoretical frameworks. This approach constrains our ability to comprehensively understand how the digital economy empowers supply chain resilience across various dimensions.

To address these limitations and advance our understanding of global supply chain resilience in the digital era, future research should focus on several key areas. Scholars should conduct more enterprise-level studies to examine how digital technologies directly impact supply chain resilience at the firm level. There is also a need to develop integrated theoretical frameworks that combine multiple perspectives to provide a more comprehensive understanding of supply chain resilience in the digital economy. Moreover, a critical analysis of the potential risks and challenges associated with increased digitalization, such as cybersecurity threats, data privacy concerns, and digital divide issues, would provide a more balanced view of the digital economy's impact on supply chain resilience. Such research would not only contribute to academic discourse but also inform policy-making and industry practices in the rapidly evolving landscape of global supply chain management.

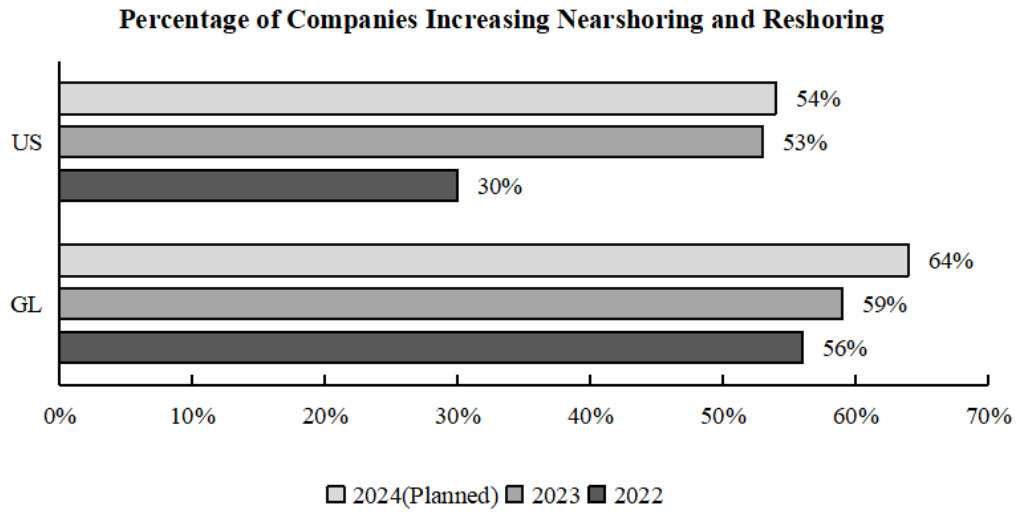
4. Current Situation and Challenges

4.1 Emerging Trends in Global Supply Chains

Global supply chains have recently demonstrated three significant trends: regionalization, diversification, and sustainable development.

Firstly, the intensification of geopolitical risks and trade frictions has propelled the trend towards supply chain regionalization. Companies have gradually realized the potential risks of concentrating supply chain layouts in a single region and have begun to shift production and procurement activities to neighboring areas. According to QIMA (2024) data, 54% of US respondents plan to increase procurement from domestic and nearby regional suppliers in 2024 (Figure 2) , aiming to reduce risks and improve supply chain responsiveness and flexibility.

Figure 2: Percentage of Companies Increasing Nearshoring and Reshoring



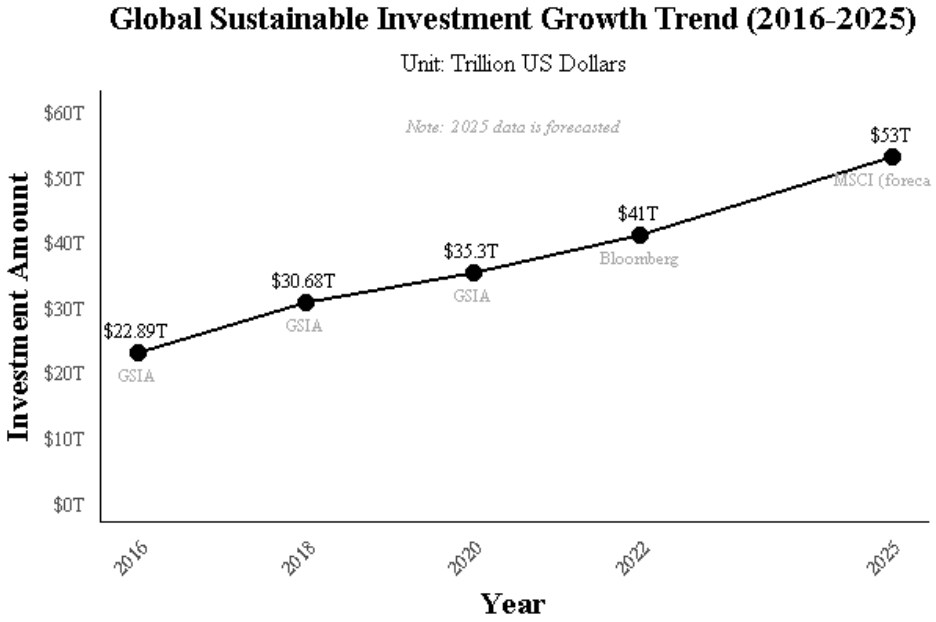
Source: QIMA Blog (2024).

Secondly, diversified supplier strategies are increasingly valued. Companies recognize the potential vulnerabilities arising from over-reliance on a single supply source and are actively seeking diversified supply channels. Research conducted by the Supplier Data Platform (2023) shows that global supplier diversification has increased to 20% . While this strategy may increase management complexity and costs, it significantly enhances the supply chain's risk resistance capability, enabling companies to more effectively address potential supply disruptions.

Thirdly, sustainable development has become a key factor in shaping modern supply chains. Companies no longer focus solely on short-term benefits but incorporate long-term sustainability into their core strategic considerations. PwC's (2022) survey results indicate that 78% of companies have integrated sustainability principles into their supply chain strategies . Global sustainable investment has been growing steadily in recent years (Figure 3), reflecting companies' increasing emphasis on

Environmental, Social, and Governance (ESG) factors, while also responding to stakeholders' expectations for sustainable business practices.

Figure 3: Global Sustainable Investment Growth Trend(2016-2025)

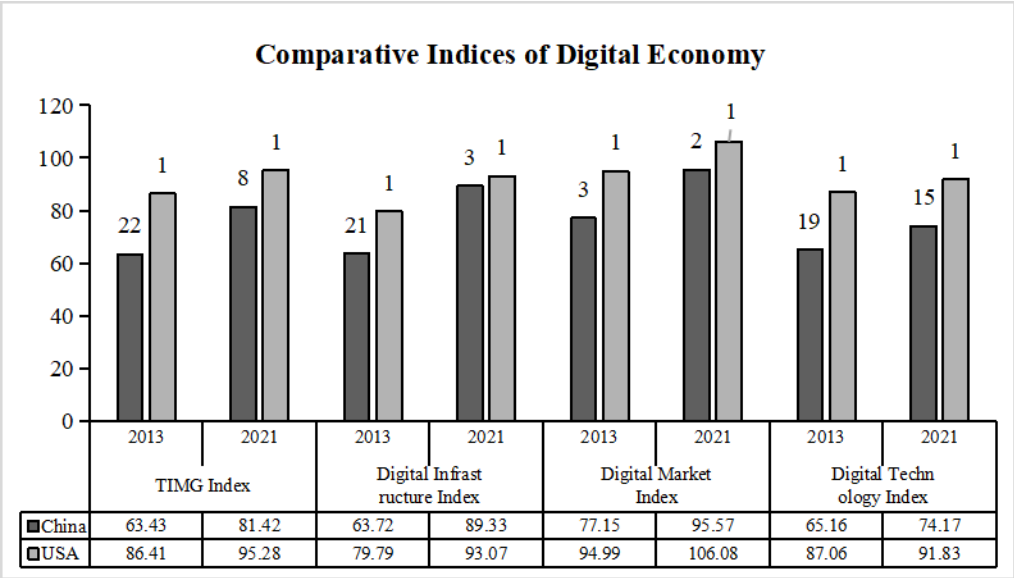


Source: World Investment Report (2023), Bloomberg Intelligence.

With respect to the current state of digital economy applications in China and the United States, both nations demonstrate robust development momentum while exhibiting disparities in developmental focus and areas of comparative advantages. Their contrasting approaches and unique strengths in digital economy development not only shape their domestic markets but also significantly influence global supply chain dynamics.

China's digital economy has experienced rapid growth, propelled by robust government support and an expansive market. According to the Global Digital Economy Development Index Report (Figure 4), China rose from 63.43 (ranked 22nd) in 2013 to 81.42 (ranked 8th) in 2021, while the United States maintained its lead, rising from 86.41 to 95.28, consistently ranking first. This growth reflects resource integration and dynamic capability enhancement, especially in digital infrastructure, where China's index improved from 63.72 (ranked 21st) to 89.33 (ranked 3rd), approaching the US's 93.07. In the digital market domain, China's performance is particularly outstanding, with the index rising from 77.15 to 95.57, second only to the US's 106.08. In contrast, the US's advantages are more evident in enterprise-level digital solutions and automation in high-end manufacturing. Its digital technology index in 2021 was 91.83, compared to China's 74.17. These high-end technology and innovation advantages promote transaction cost reduction and efficiency improvement, helping US companies maintain advantageous positions in high value-added segments of global supply chains.

Figure 4: Comparison of China-US Digital Economy Related Indices



Source: Global Digital Economy Development Index Report (TIMG2023).

Note: The numbers above the bars in the graph represent the ranking order. A smaller number indicates a higher rank.

Comparatively, China leads in consumer-end digitalization and large-scale smart logistics network construction, while the US holds advantages in enterprise digital transformation and high-end manufacturing automation. This difference reflects the distinct economic structures and development stages of the two countries: China is leveraging its vast consumer market to drive digital economy development, while the US relies on its technological innovation capabilities and mature industrial base to advance digital transformation. However, in key technology areas such as 5G and artificial intelligence, both countries are actively promoting their own technical standards, a competition that is poised to exert influence on the developmental trajectory of global digital supply chains. China is making rapid progress in 5G network construction and application, while the US maintains a lead in AI basic research and enterprise-level applications. This competition may lead to technological divergence in certain areas of global digital supply chains, increasing the complexity faced by multinational corporations in supply chain management.

Despite these differences, there is both cooperation and competition between China and the US in the digital supply chain field. In cross-border e-commerce, there is enormous potential for cooperation between the two sides. According to a report by the US-China Business Council published in 2023, bilateral trade in goods between the United States and China reached $690.6 billion in 2022, setting a new record. Furthermore, 95% of the surveyed US companies reported that their China operations were profitable in 2022, demonstrating the continued importance of the Chinese market for American businesses. This indicates that despite geopolitical tensions, the interdependence between the two countries in the digital economy remains high. Within the theoretical framework of global supply chain network reconstruction and collaboration, China's advantages in large-scale application and market

promotion, combined with the US's strengths in core technology R&D and innovation, provide ample space for potential cooperation between the two countries. However, how to seek cooperation amid competition and balance national interests with the healthy development of global supply chains will be a significant challenge facing both countries.

4.2 Major Existing Challenges

Despite theoretical propositions in digital economy suggesting enhanced supply chain resilience through resource integration, network reconstruction, and transaction cost reduction, significant practical challenges persist. This article categorizes these challenges into two core issues: geopolitical factors and imbalanced global value chain structures, and the uneven application of digital technologies and the emergence of new risks.

4.2.1 Geopolitical Tensions and Global Value Chain Imbalances

Geopolitical factors and imbalanced global value chain structures jointly constrain the full application of digital technologies in cross-border supply chains. For instance, US government restrictions on Chinese tech companies have not only impacted these companies' positions in global supply chains but also hindered the application of related digital technologies in supply chain management. In this context, the view emphasized in the resource-based theory, which posits digital resources as key competitive advantages, faces challenges in practice. Enterprises find it difficult to fully utilize cross-border data flows and cloud computing technologies to optimize global resource allocation, consequently impeding the full realization of theoretical expectations regarding resource integration and dynamic capability enhancement.

Simultaneously, the imbalance in global value chain structures further exacerbates this issue. Although China's position in global value chains has been rising steadily, with its GVC participation rate reaching 62% in 2017, a 2.5-fold increase from 1995 , its position in the value chain remains relatively low. China's global value chain position index was 0.04 in 2018, far below the US's 0.29 for the same period. This structural imbalance makes it difficult for emerging economy enterprises to fully leverage the advantages brought by digital technologies, especially in upstream resource integration and network reconstruction.

At a deeper level, this imbalance in value chain structures reflects a trend of reversal in the globalization process. UN COMTRADE data shows that the intensity of global intermediate goods trade has been declining since 2007, dropping to 22% by 2020. This trend contradicts the expected global resource optimization configuration in the global value chain theory, limiting the effectiveness of digital technologies in global supply chains. According to the transaction cost theory, digital technologies should significantly reduce cross-border transaction costs and promote global supply chain integration. However, trade barriers and policy uncertainties resulting from the reversal of globalization offset some of the cost advantages brought by digital technologies.

4.2.2 Technological Disparities and Emerging Digital Risks

The application of digital technologies in supply chain management varies significantly between domestic and global contexts. While domestic or regional supply chains have seen substantial advancements, the effectiveness of digital technology applications in global cross-border supply chains remains severely constrained. This unevenness not only limits the effects of digital technologies in cross-border collaboration and resource integration but also increases supply chain vulnerability.

Furthermore, new risks introduced by digitalization further complicate the construction of supply chain resilience. The emergence of new risks such as cybersecurity threats and data privacy issues makes it difficult to fully realize the theoretically expected risk management effects in reality. According to dynamic capability theory, enterprises should be able to enhance their ability to sense and respond to risks through digital technologies. However, in a complex international environment, these new risks are often intertwined with geopolitical factors, making it difficult for enterprises to effectively manage risks solely through technological means.

Research demonstrates a positive correlation between supply chain complexity and supply chain disruption risk . The uneven application of digital technologies may further increase supply chain complexity, thereby elevating the risk of supply chain disruptions. Meanwhile, the"Triple-A Supply Chain" theory (Agility, Adaptability, and Alignment) faces new challenges in the digital era, especially in achieving these three characteristics in cross-border supply chains.

In summary, significant gaps exist between theoretical expectations and practical realities in applying digital technologies to global supply chains. Future research should focus on optimizing this application amid complex international relations, promoting balanced value chain development and cross-border digital cooperation. Additionally, exploring effective management of digitalization-induced risks to enhance supply chain resilience is crucial.

4.3 China-US Policy Responses to Digital Supply Chain Challenges

China and the United States have implemented various policy measures to address the challenges facing digital supply chains, reflecting their respective strategic priorities and economic contexts. China's approach has been characterized by a strong emphasis on self-reliance and industrial upgrading. The "dual circulation" development strategy proposed in 2020, along with the "Outline of the 14th Five-Year Plan" adopted in 2021, collectively emphasize reducing dependence on external markets and technologies while enhancing economic resilience and scientific self-reliance. In parallel, China is actively promoting industrial upgrading to elevate its position in global value chains, as evidenced by initiatives such as "Made in China 2025" and the recent "Implementation Opinions on Accelerating the Innovative Development of Supply Chains." These policies collectively aim to enhance China's innovation capability, competitiveness in manufacturing, and overall position in global value chains.

The United States, on the other hand, has focused on safeguarding its technological advantages and strengthening national security in its policy approach. Legislation such as the Foreign Investment Risk Review Modernization Act (FIRRMA) of 2018 has tightened the review of foreign investments,

particularly in critical technology areas. The CHIPS and Science Act of 2022 , with its substantial subsidies for the semiconductor industry, further demonstrates the U.S. commitment to maintaining technological leadership. Additionally, the U.S. Innovation and Competition Act of 2021 allocates significant resources to scientific research and technology development, aiming to solidify the country's leading position in global value chains.

However, while both China and the United States have implemented substantial policies to address digital supply chain challenges, these approaches often prioritize short-term national interests over long-term global cooperation. To build a resilient, inclusive, and innovative global digital supply chain, both countries need to recalibrate their strategies towards strengthening international cooperation. This shift would involve jointly exploring a more open and coordinated policy framework that balances the protection of core national interests with the imperative of global digital ecosystem development.

5. Policy Recommendations

In the highly globalized digital economy era, complete technological isolation and decoupling (such as U.S. restrictions on Chinese tech companies) are impractical. Overemphasis on self-reliance or technological blockades may protect national interests in the short term, but in the long run, it could hinder global innovation processes and even harm the long-term competitiveness of domestic enterprises, leading to the formation of "innovation islands." To effectively address the development issues of global digital supply chains, China, the United States, and other major economies need to strengthen international cooperation and jointly construct a more open and coordinated policy framework while safeguarding their respective core interests.

Based on the challenges and limitations of existing policies analyzed in the previous sections, this article proposes policy recommendations from three time dimensions: short-term (1-2 years), medium-term (3-5 years), and long-term (over 5 years). The short-term foundational work provides support for medium-term intelligent transformation, medium-term measures pave the way for long-term cultivation of innovation ecosystems, while long-term policies continuously optimize the implementation effects of short-term and medium-term policies. The progressive policies in different periods support each other, showing progressiveness and synergistic effects in the time dimension, aiming to construct a dynamically evolving and self-improving global digital supply chain policy system.

5.1 Short-term: Constructing a Unified Standard System

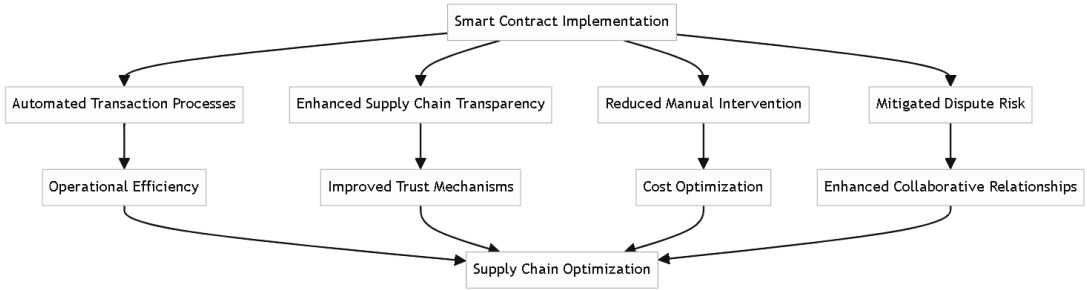
Short-term measures mainly focus on establishing basic collaboration mechanisms for cross-border digital supply chains. First, establish a China-U.S. Digital Supply Chain Standards Coordination Working Group to formulate annual standardization roadmaps and unify technical specifications and data exchange protocols for cross-border digital supply chains. There are precedents for international promotion of common standards and industrial efficiency improvement. For instance, a study of the Indonesian grocery industry revealed that adopting standardized B2B e-commerce systems significantly enhanced supply chain efficiency. Second, promote the formulation of unified data classification

management guidelines, categorizing data into high sensitivity (such as national security-related data), medium sensitivity (such as enterprise trade secrets), and low sensitivity (such as public market data), and develop differentiated cross-border flow policies for each category. For example, allow free flow for low-sensitivity data, require review for medium-sensitivity data flow, and generally prohibit cross-border flow of high-sensitivity data. These measures will effectively reduce coordination costs, promote necessary cross-border data flow, and enhance the coordination efficiency of global supply chains.

5.2 Medium-term: Building an Intelligent Risk Prevention and Control System

Medium-term strategies aim to advance supply chain intelligence and risk management upgrades. Specifically, introduce smart contract mechanisms based on blockchain technology to automatically execute quality verification and trigger preset commercial terms based on Internet of Things data. The application of smart contracts (Figure 5) is mainly reflected in four aspects: automating transaction processes, improving supply chain transparency, reducing human intervention, and lowering dispute risks. These applications further bring advantages such as efficiency improvement, trust enhancement, cost reduction, and improved cooperative relationships, achieving overall optimization of the supply chain. Meanwhile, construct a multilateral supply chain risk information sharing platform, integrating real-time risk early warning systems and supplier evaluation tools to provide data support for the execution of smart contracts. These measures will enhance the overall digitalization level of global value chains to strengthen the risk response capability of supply chain networks.

Figure 5: Application and Advantages of Smart Contracts in Supply Chain Management



5.3 Long-term: Building a China-U.S. Digital Supply Chain Innovation Community

Long-term policies focus on cultivating a sustainable global innovation ecosystem. Currently, direct cooperation between China and the U.S. in the digital supply chain field is limited, but both countries are actively exploring international cooperation models. For example, China and Singapore launched the "China-Singapore International Internet Data Channel"[1] project in 2021, while the U.S. Department of Commerce initiated the "U.S.-EU Trade and Technology Council" (TTC) in 2021 to foster transatlantic cooperation on key global trade, economic, and technology issues. Drawing on these

[1] Infocomm Media Development Authority. "Singapore and China to Pilot Blockchain Technology for Electronic Trade Documents." IMDA, 29 Nov. 2021, www.imda.gov.sg/news-and-events/Media-Room/Media-Releases/2021/Singapore-and-China-to-Pilot-Blockchain-Technology-for-Electronic-Trade-Documents.

experiences, China and the U.S. can cooperate in the joint research and development and application of supply chain digital twin technology, such as bringing together government agencies, research institutions, and private enterprises from both countries to establish a joint research center for digital supply chains. On this basis, implement an open innovation mechanism of "announcing tasks and assigning responsibilities" to stimulate the innovation potential of researchers and enterprises. Additionally, encourage the cultivation of transnational "chain-leading enterprises" to drive technological innovation among enterprises throughout the supply chain with their core competitiveness, enhancing the overall competitiveness of the industry.

6. Conclusion

This article discusses the impact mechanism of the digital economy on global supply chain resilience, revealing that although China and the United States have competition and differences in this field, there is still enormous potential for cooperation through strengthening digital infrastructure construction, improving data security regulatory systems, and building multi-level dialogue mechanisms.

The theoretical contributions of this article are: First, it provides a more comprehensive analytical framework, deepening the understanding of how the digital economy affects supply chain resilience; Second, from the perspective of China-U.S. relations, it reveals the role and challenges of digital technology in cross-national supply chain collaboration. In terms of practical contributions, enterprises can optimize their digital transformation strategies based on the three paths proposed in this article; policymakers can refer to the recommendations to formulate more targeted and forward-looking policy measures. However, this article also has certain limitations. Given the complexity and dynamics of the world economic landscape, policy recommendations need to be dynamically adjusted according to actual situations. Moreover, the representativeness and time span of data and cases may also affect the universality of the results.

Future research could explore the application effects of digital technologies in specific industry supply chains (such as automotive, electronics, medical), the differences in digital transformation under different cultural backgrounds, and how digital technologies can help supply chains respond to sudden events (such as global pandemics). These research directions are expected to further enrich the theoretical system and provide more targeted practical guidance for policymakers and business decision-makers. Looking ahead, digital technologies will continue to profoundly change the face of global supply chains, and the cooperation between China and the United States in this process will contribute significantly to building a community with a shared future for mankind.

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Author Contributions

The author confirms sole responsibility for the following: study conception and design, data collection, analysis and interpretation of results, and manuscript preparation.

Availability of Data and Materials

All data included in this study are available upon request by contact with the corresponding author.

Conflicts of Interest

The authors declare that they have no conflicts of interest to report regarding the present study.

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