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# How Artificial Intelligence Enhances the Stability and Resilience of the Global Value Chain

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**ABSTRACT**
Artificial intelligence has emerged as a key pathway for enhancing the resilience of global value chains. The study finds that artificial intelligence promotes the improvement of industrial chain resilience; artificial intelligence technology mainly promotes the improvement of industrial chain resilience through channels such as improving productivity, reducing transaction costs, and enhancing knowledge diversity. The research results of this paper have important theoretical and practical significance for deeply understanding the upgrading of globe value chain resilience and promoting high-quality economic development.

**KEYWORDS**
Artificial intelligence; Globe value chain resilience; High-quality economic development

## 1 Introduction

The security and stability of industrial chains are not only a solid guarantee for integration into the global production system, but also core factors in mastering economic development, promoting high-quality economic growth, and fostering new forms of productivity. In recent years, the global industrial chain has faced unprecedented uncertainty and vulnerability, driven by multiple external shocks, including Sino-US trade friction, the global public health crisis, natural disasters, and geopolitical competition. Against this backdrop, enhancing the stability and resilience of industrial chains has become a strategic consensus among economies worldwide.

As the core engine of the new technological revolution and industrial transformation, artificial intelligence has become a strategic frontier that countries are eager to position themselves in. Data shows that the global AI market will exceed 279.2 billion USD by 2024, with China accounting for 60% of global AI patents, demonstrating a strong technological reserve. In the context of digital transformation, the question arises: can artificial intelligence deeply empower the global production system and act as a stabilizer for ensuring the security and resilience of the global value chain? What are the internal mechanisms through which AI strengthens the resilience of global industrial chains? Based on this, this paper explores the impact and mechanisms of artificial intelligence on the resilience of global industrial chains, which holds significant theoretical and practical value for advancing the "AI+" initiative and building a secure and controllable modern industrial system.

## 2 Literature Review and Conceptual Definitions

Currently, artificial intelligence (AI) possesses powerful capabilities in data reasoning, natural language processing, and machine learning. It is not only replacing traditional labor but also creating new employment opportunities. In essence, AI represents a type of technological progress that is driving industrial innovation across various sectors. The global value chain refers to the interlinked network structure in the global production system, where production, distribution, and value-added activities are achieved through multinational division of labor and collaboration. The resilience of the global value chain is defined as the ability of this chain to self-repair through production relationships and rapidly adjust back to an optimal state after being impacted by potential market risks and uncertainties (Hong & Wang, 2024). Related to resilience is robustness, which emphasizes the ability of a system to maintain its core functions and structure when faced with external shocks. Compared to resilience, robustness focuses more on sustaining basic operations, while resilience emphasizes the ability to return to its original state. Given that the global value chain must not only maintain basic operations but also recover to its pre-shock state, this paper emphasizes examining the stability of the global value chain from the perspective of resilience.

Existing research has explored the effects of AI on labor employment, income inequality, economic growth (Acemoglu & Restrepo, 2020), and corporate innovation (Li et al., 2024). With the development of global value chain theory, scholars have begun to investigate the role of AI as a driver of technological progress in upgrading the division of labor and positioning within the global value chain (Elliott et al., 2022). In recent years, amidst the increasingly complex external environment and potential shocks, the security, stability, and resilience of the global value chain have attracted considerable attention, with studies starting to explore AI's enabling effect on the resilience of the global value chain (Borin et al., 2021). Leveraging its intelligent and automated characteristics, AI optimizes the allocation of labor resources to respond to labor supply shocks and improves the efficiency of resource allocation in production factors (Lv & Zhang,

2024; He et al., 2024), thus enhancing the resilience of the global value chain in the face of unexpected events. Based on this, this paper investigates the transformative role of AI in reshaping the resilience of the global value chain, in light of the rapid development of AI and the accelerating restructuring of global value chains.

## 3 The Mechanisms through which Artificial Intelligence Affects the Resilience of the Global Value Chain

This paper, based on the core characteristics of artificial intelligence such as autonomous learning, predictive capabilities, decision-making ability, and logistical effects, systematically explains the intrinsic mechanisms through which AI empowers the resilience of the global value chain from three dimensions: productivity enhancement, transaction cost reduction, and the diversification of knowledge.

### 3.1 Productivity Effect and GVC Resilience

Leveraging the powerful computational foundation and logical reasoning advantages of large models, artificial intelligence (AI) has developed strong predictive insights and autonomous decision-making capabilities. First, AI's immense computational power supports the rapid processing of vast datasets across domains and enterprises. On one hand, algorithmic models significantly enhance the efficiency of data utilization, uncovering potential issues and opportunities within large databases, and generating feasible solutions. On the other hand, AI optimizes inter-departmental resource allocation efficiency, improving collaborative production capabilities across departments to address the uncertainties within global value chains. Second, AI's knowledge base and Retrieval-Augmented Generation (RAG) technology significantly enhance knowledge inference and decision-making abilities, helping to efficiently identify risks and make decisions. On one hand, AI uses algorithms to search and simulate geopolitical information, providing foresight into external risks and effectively reducing the "bullwhip effect" caused by supply chain disruptions. On the other hand, through multi-dimensional analysis of historical and real-time data such as weather and sales conditions, AI can accurately assess market supply and demand as well as changes in segmented market demands. By improving resource matching efficiency, AI reduces uncertainties within global value chains. Finally, AI's decision-making capabilities are greatly strengthened by Agent-based algorithms. These agents enable AI to automate decision-making and intelligently plan when executing complex tasks. When the global production network suffers sudden disruptions in R&D, production, or sales stages, AI can quickly identify failure points, accurately pinpoint the causes of interruptions, and calculate optimal alternative paths or global replacement suppliers in real-time. This allows for the rapid restructuring of the industrial chain to mitigate potential risks arising from sudden shocks.

Based on this, this paper proposes the following:

Proposition 1: Artificial intelligence enhances industrial chain resilience by influencing production efficiency.

### 3.2 Trade Cost Effect and GVC Resilience

Artificial intelligence (AI), relying on "embodied intelligence" and "generative algorithms," is deeply integrated into the production and transportation segments of the global value chain, significantly reducing transaction costs. First, the deep integration of humanoid robots and data empowerment. On one hand, industrial equipment such as logistics drones, industrial robotic dogs, and quadruped robots compress production, warehousing, and transportation costs within the industrial chain, improving resource allocation efficiency. On the other hand, the widespread application of intelligent voice customer service and humanoid robots in the service industry not only replaces repetitive labor and reduces communication costs but also converts these interactions into valuable data, driving large-scale data analysis and decision optimization, thus enhancing the resilience of the global value chain. Second, the continuous innovation of large language models reduces language and institutional barriers. AI software now possesses the logical capability to adapt to different linguistic environments and can process texts in multiple languages swiftly. Iterative updates of large models such as NLP, DeepSeek, ChatGPT, and Gemine have significantly reduced transaction costs in global trade. These models have strong logical reasoning and text comprehension abilities, not only greatly lowering translation and communication costs but also facilitating the understanding of complex texts such as regional trade agreements. This helps eliminate barriers to circulation and further promotes the deep integration of countries into the global value chain. Third, algorithmic optimization enables effective inventory control. First, AI training frameworks like DeepSpeak and Megatron-LM can rapidly categorize information, reducing computational and storage costs, lowering the threshold for enterprises to adopt AI, and enhancing their ability to mitigate risks. Second, using real-time inventory classification and historical data based on AI, errors from manual operations can be eliminated, enabling precise inventory control. By reducing warehousing costs, this improves the global value chain's ability to withstand risks. Based on this, this paper proposes the following:

Proposition 2: Artificial intelligence enhances industrial chain resilience by affecting trade costs.

### 3.3 Knowledge Diversity Effect and GVC Resilience

The diversification of products, partners, and supply channels within an industrial chain can generate substitution or complementary effects, enabling rapid responses to changes in the industrial chain and enhancing its stability (Freund et al., 2021). Artificial intelligence (AI), with its superior autonomous learning, data integration, and logical reasoning capabilities, efficiently processes cross-domain knowledge and drives cross-disciplinary technological innovation, thereby fostering knowledge diversity (Haefner, 2021). This is primarily manifested in the following ways: First, autonomous learning drives diversified network layout. Through efficient information search and knowledge iteration, AI constructs extensive knowledge bases and promotes disruptive technological innovations to overcome core technological barriers. This not only helps expand the scale and business scope of export products but also fosters the diversification of global value chain network layouts. Second, data mining promotes product differentiation. AI utilizes Natural Language Processing (NLP) to widely capture cross-domain knowledge and integrate large-scale market information. This allows for in-depth analysis of data and prediction of future trends, enabling the targeted development of differentiated products based on demand analysis from diversified markets. Third, network algorithms expand diversified markets. AI's neural network algorithms can accurately analyze information such as images, videos, and audio, significantly enhancing the depth and breadth of information acquisition for enterprises. Moreover, the advanced language processing capabilities of large language models support the development of diversified products tailored to different linguistic markets, effectively expanding export ranges and mitigating industrial chain risks. Fourth, intelligent collaboration fosters cross-domain cooperation. Leveraging information-sharing platforms, RAG and Agent technologies, AI enables the fusion of cross-domain knowledge and logical reasoning. This promotes cross-domain and cross-departmental collaborative innovation, opening up new markets with innovative products developed through R&D, thereby further strengthening the global value chain's ability to resist risks. Based on this, this paper proposes the following:

Proposition 3: Artificial intelligence enhances industrial chain resilience by influencing knowledge diversity.

## 4 Conclusion and Implications

This study finds that artificial intelligence (AI) significantly enhances the resilience of industrial chains. AI technologies, through their autonomous learning, predictive capabilities, decision-making abilities, and logistical effects, contribute to the improvement of global value chain resilience by boosting productivity, reducing transaction costs, and increasing product diversity. The findings of this study provide the following policy implications for the development of AI technology and the promotion of industrial chain resilience: First, Enhance the knowledge spillover and absorption capabilities of AI to inject core momentum into the enhancement of global value chain resilience. Second, Build cross-disciplinary AI collaborative innovation platforms to leverage the integration effects of data elements. Third, Implement differentiated tax policies to stimulate innovation. By using tools such as tax incentives, financial subsidies, and increased R&D expense deductions, governments should increase R&D funding for AI enterprises and provide targeted policy support for companies of different scales, promoting the development of AI technology and driving disruptive technological innovations. Fourth, Optimize the AI development environment through digital infrastructure. On one hand, accelerate the deployment of emerging infrastructures such as 6G, the Internet of Things (IoT), and cloud computing. On the other hand, improve mechanisms for cultivating and attracting innovative talent, providing a solid environmental guarantee for AI development. Fifth, Align with high-standard regional trade rules and actively participate in global digital trade governance. Promote the inclusion of more economies in high-level digital trade agreements such as DEPA, aiming to eliminate cross-border circulation barriers. Improve digital trade rules by integrating AI-related clauses, and foster a fairer and more open development environment, thereby enhancing global value chain resilience.

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