

Study on the Path of Enhancing the Toughness of Heilongjiang Manufacturing Industry Chain Driven by Digital Economy

Huiyan Zhang*, Shuang Zhang, Jia Liu, Yuhao Wu
Harbin Finance University, Harbin, Heilongjiang, China
*Corresponding Author.

Abstract: In Heilongjiang Province's pursuit of high-quality economic development, strengthening and upgrading its production chain has become a top priority. As a key force for future economic growth, the digital economy has great potential to enhance the resilience of the production chain. In order to explore how the digital economy can enhance the resilience of the production chain and promote the development of high-end manufacturing in Heilongjiang Province, the challenges faced by the traditional manufacturing industry in the province will be studied in depth, and a theoretical framework for improving the resilience of the production chain will be established through a literature review and case studies. The results of the study show that the digital economy can stabilize the industrial chain, improve the productivity of the manufacturing industry, and lay a solid foundation for the upgrading and transformation of the manufacturing industry. To achieve this goal, it is necessary to strengthen the construction of digital infrastructure, give full play to the synergistic effect of multi-factors, cultivate digital talents, foster digital industry clusters, and optimize the digital pattern of the industrial chain. By implementing these strategies, Heilongjiang Province can significantly enhance the resilience of its production chain and pave the way for the dynamic development of its high-end manufacturing industry.

Keywords: Digital Economy; Manufacturing; Industry Chain Resilience; Digital Transformation

1. Introduction

In the fast-paced digital era, strengthening the resilience of industrial chains has become a

pivotal strategy for driving sustainable and robust economic growth. To this end, it is imperative to optimize the operational efficiency of manufacturing supply chains, broaden their labor specialization, and fortify their risk mitigation capabilities. Unfortunately, the lagging digital infrastructure and technological innovation have hampered the digital economy's ability to fully bolster this resilience. To overcome these obstacles, we must adopt a proactive policy approach that is open, inclusive, and forward-thinking. This includes fostering breakthroughs in information and communication technologies, as well as intensifying international collaborations and knowledge exchanges. By doing so, we can steer the industrial chain towards a more robust, resilient, and comprehensive path, ultimately laying the groundwork for China's economy to achieve unparalleled levels of high-quality development [1].

The digital economy is gradually emerging as a key driving force to lead the industrial structure to a higher level. At present, the manufacturing industry is facing unprecedented changes in the environment and pattern, in which enhancing the resilience of the industrial chain has become a task that cannot be delayed. After in-depth research, it is found that the digital economy is a powerful tool to strengthen the resilience of the industrial chain, especially in the eastern, western and northern regions, and its driving role is particularly significant. Therefore, in order to promote the balanced and coordinated development of regional economies, there is an urgent need to promote the prosperity of the digital economy in a comprehensive manner, optimize its regional layout, and ensure that all regions can share the dividends it brings in a balanced manner [2].

Cross-border cooperation and innovation will

inject new vitality into the transformation of the traditional manufacturing industry. To ensure the cutting-edge sophistication and popularization and integration of digital technology, it is also necessary to step up efforts to cultivate digital technology talents, build a talent team with innovative spirit and professional skills, and strengthen policy support to provide solid backing and guarantee for the digital and intellectual transformation of the manufacturing industry [3].

Digitalization is a key driver for enterprises to modernize and transform, improve competitiveness, innovate business models, optimize operational processes, and enhance customer experience. Its impact is not only directly reflected in facilitating transformation, but also provides an indirect boost to manufacturing upgrading by enhancing innovation capacity. Based on this finding, it is suggested that the governments of Heilongjiang Province and its prefectural-level cities should increase their support for the digital economy, including policy support and financial investment, while focusing on the cultivation and introduction of innovative talents and the active development of emerging technologies, in order to accelerate the digitalization and intelligent transformation of the manufacturing industry [4].

To examine the effects of the digital economy on bolstering the resilience of the manufacturing industry chain in Heilongjiang Province, a comprehensive evaluation framework was designed using relevant data, and a visual scatter plot was produced to illustrate the interplay between the digital economy and the resilience of the manufacturing chain. The findings indicate that the digital economy not only solidifies the industrial chain, enhancing production efficiency, but it also enables precise market demand forecasting, drives industrial transformation, and breaks down the limitations of traditional manufacturing modalities, thereby spurring ongoing technological innovation in the industrial chain. Therefore, Heilongjiang Province should capitalize on the robust potential of the digital economy and augment its support for digitally enhancing the manufacturing sector to foster its high-quality and sustainable

growth [5].

In addressing the various challenges of digital transformation of the manufacturing industry in Heilongjiang Province and strengthening its digital guidance, this paper explores in depth the close connection between the digital economy and the resilience of the manufacturing industry chain. Through meticulous literature review, case analysis and descriptive research, we clearly recognize the importance of digital industrialization for the development of the manufacturing industry, and find that the factor-driven and industry-driven effects of digitalization play a significant role in promoting the resilience of the industrial chain. Therefore, Heilongjiang Province should take digital infrastructure construction as a top priority, continuously increase investment in technological innovation, and at the same time promote multi-chain integration and the development of manufacturing clusters, so as to inject new vitality into the real economy, enhance productivity, and ultimately promote the comprehensive transformation of the manufacturing industry.

2. Difficulties Faced by the Traditional Manufacturing Industry in Heilongjiang Province

2.1 Innovation Ability is Not Strong, the Enterprise Equipment is Obsolete

First of all, weak innovation capability is one of the core challenges facing the traditional manufacturing industry in Heilongjiang Province. Numerous enterprises have long relied excessively on traditional production modes and technologies, resulting in weak independent innovation capabilities and difficulties in adapting to rapidly changing market demands. This is mainly manifested in two aspects: first, insufficient investment in research and development, many enterprises lack sufficient funds and resources for the research and development of new technologies and new processes, resulting in slow product upgrading, and it is difficult to maintain an advantage in the fierce competition in the market; secondly, the innovation environment is poor, there is a lack of effective innovation and cooperation mechanisms between enterprises, and the combination of industry, academia, research

and utilization is not close enough, which makes the transformation of scientific and technological achievements inefficient, and fails to form an effective The second is that the innovation environment is not good [6].

Secondly, enterprise equipment obsolescence is also an important factor restricting the development of traditional manufacturing industry in Heilongjiang Province. Many enterprises due to capital, technology and other reasons, failed to timely upgrade manufacturing equipment, resulting in aging equipment, low efficiency, seriously restricting the production capacity of enterprises and product quality. More seriously, some enterprises are overly dependent on foreign technology, making it difficult to get rid of the dependence on foreign technology in the process of equipment upgrading and remodeling, further weakening the market competitiveness of enterprises [7].

2.2 Outdated Enterprise Management Concepts, Lack of Competitiveness of Products

In the current market economic environment, the management concepts of many enterprises are still old-fashioned and lack of innovation and flexibility, which to a certain extent restricts the development of enterprises. First of all, the enterprise management experience lacks innovation. Some enterprises still follow the traditional family management model, this model, although to a certain extent to ensure the stability and inheritance of the enterprise, but in the face of rapid changes in the market environment, its limitations are increasingly prominent. Family management often lacks scientific decision-making mechanism and supervision mechanism, which easily leads to corporate decision-making errors and internal corruption. Secondly, some enterprises often need to face all kinds of restrictions and interventions from the government in the process of operation, which makes it difficult for enterprises to give full play to their advantages in the market competition, resulting in the lack of autonomy and flexibility of enterprises, and difficult to adapt to the changes in the market. In addition, some enterprises lack competitiveness of their products in the market due to outdated technology and obsolete design. Enterprises

also need to pay close attention to market dynamics and changes in consumer demand, and promptly adjust their product structure and market strategies to adapt to market changes.

2.3 Enterprises Still Face the Problem of Difficult and Expensive Financing

In the traditional manufacturing industry in Heilongjiang Province, financing difficulty and financing expensive has been an important problem plaguing the development of enterprises. Banks and other financial institutions, as the main financing channels for traditional manufacturing enterprises, have a strict loan approval process and require enterprises to provide sufficient collateral or guarantees. However, for many small and medium-sized enterprises, due to their small size and limited assets, it is often difficult to provide collateral or guarantee that meets the requirements of the bank, resulting in increased financing difficulties. Even if some enterprises are able to obtain financial support by way of credit loans, the amount applied for is usually low, which is far from being able to meet the financial needs of production and operation as well as transformation and upgrading of enterprises.

In addition, enterprises that choose to issue their own bonds for financing also face many constraints. First, bond issuance needs to go through a strict approval and supervision process, the progress is slow, it is difficult to quickly solve the enterprise's capital problems. Secondly, the scale of bond issuance is usually limited by the size of the enterprise, credit rating and other factors, making it difficult for small and medium-sized enterprises to obtain sufficient financial support through the issuance of bonds. All these factors increase the difficulty of enterprise transformation and upgrading and limit the development potential of enterprises.

2.4 Environmental Factors and Low Awareness of Transformation

Since 2020, the economic environment on a global scale has experienced unprecedented changes, and traditional manufacturing enterprises in Heilongjiang Province have also been affected, facing not only the direct impact of unfavorable factors such as the rising cost of raw materials and the economic

downturn, but also the indirect challenges of production stagnation and supply chain disruption. In this environment, many small and medium-sized enterprises have to devote most of their resources and energy to maintaining basic operations in order to protect themselves, making it difficult for them to have extra energy and time to consider the transformation and upgrading of their enterprises. Especially in Heilongjiang Province, most of the manufacturing enterprises have a large proportion of traditional industries, such as machinery processing and manufacturing, primary agricultural products and food processing, chemical industry and other traditional industries are still the main force supporting economic development. At the same time, some enterprises are worried about the uncertainties and risks associated with transformation and upgrading, and are afraid of losing their existing market share and Competitive Advantages. As A Result, Despite the huge development potential of emerging industries such as digital economy, bio-economy, ice and snow economy, these enterprises can often only trade time for space and gradually explore the road of transformation. This conservative attitude and approach may cause enterprises to miss out on good opportunities for transformation and upgrading.

2.5 Decline in Willingness to Invest and Lack of Confidence in Development

Traditional manufacturing enterprises in Heilongjiang Province are generally facing the plight of declining willingness to invest and lack of confidence in development. This situation not only restricts the innovation ability and market competitiveness of enterprises, but also poses a serious obstacle to the advancement of enterprise transformation and upgrading.

According to the international standard, a competitive enterprise usually invests more than 5% of its sales revenue in research and development (R&D). However, in the Mudanjiang region, for example, according to a visit and survey of more than 100 key manufacturing enterprises in the region in 2023, it was found that these enterprises were far from meeting this standard in terms of investment in R&D, and only 18 of them had

scientific research activities, which also reflected a serious lack of confidence in innovation investment.

The decline in willingness to invest and the lack of confidence in development make enterprises hesitant in the face of opportunities for transformation and upgrading. They are worried about the uncertainty and risk brought by transformation and upgrading, and are afraid that they will not be able to get the expected return after investment. Therefore, many enterprises have chosen the conservative strategy of "not daring to invest, not willing to invest", which not only limits the development of the enterprise itself, but also affects the transformation and upgrading process of the whole industry.

3. Theoretical Analysis Framework of the Digital Economy on the Improvement of Manufacturing Industry Chain Toughness

3.1 The Direct Impact of the Digital Economy on the Resilience of the Manufacturing Industry Chain

The digital economy, as a representative of the frontiers of the current scientific and technological revolution, is deeply changing the social production structure and becoming a core force for promoting high-quality economic growth. Based on new elements, new modes, new industries and new business forms, this new economic form is leading a profound change in the manufacturing industry chain through the wide application of digital technology.

First, the construction of digital infrastructure, with its innovation, integration, universality and interconnectivity, has provided a standardized path for information circulation in the manufacturing industry chain [8]. Secondly, the rise of digital industry has not only given rise to numerous new business forms and new models, but also accelerated the independent innovation transformation of the manufacturing industry chain. The development of emerging industries has greatly promoted the progress of the technology-intensive manufacturing industry chain, and also strengthened the in-depth integration of digital technology and the manufacturing industry chain, further releasing the huge potential of the digital

economy in the development of the manufacturing industry chain [9]. Finally, the continuous improvement of the digital environment optimizes the process of resource sharing and interconnection in the manufacturing industry chain, providing strong support for the innovation and efficiency of the industry chain. Through the digital platform, innovative resources and innovative talents can be efficiently gathered and synergistically developed, breaking the information silo and promoting the innovation and upgrading of the whole manufacturing industry chain.

3.2 The Indirect Impact of the Digital Economy on the Resilience of the Manufacturing Industry Chain

When analyzing the impact of the digital economy on the manufacturing industry chain in depth, it is necessary to comprehensively consider the multiple effects it brings. From the internal viewpoint of the industry chain, the rapid rise of the digital economy has become a powerful engine for the transformation and upgrading of the manufacturing industry, which has greatly promoted the digital transformation of the industry chain, optimized the industrial structure, and significantly enhanced the resilience of the industry chain [10]. This transformation not only accelerates the updating and iteration of technology, but also strengthens the synergistic innovation between the various links of the industry chain and improves the overall efficiency. However, from the external environment, the impact of the digital economy is more complex and variable. Although it promotes the development of new technologies and high-quality economic growth, it may also have a certain "crowding out" effect on the real economy, leading to the reduction of jobs in traditional industries. In particular, with the deepening of the degree of financialization, excessive financial tendency may have a negative impact on the allocation of capital in the real economy, triggering the concern of capital "deconcentration", thus posing a challenge to the sound development of the manufacturing industry chain. Therefore, while grasping the opportunities brought by the digital economy, it is also necessary to recognize its potential risks, and take

corresponding policy measures to guide the healthy development of the digital economy, to ensure its benign interaction with the real economy, and jointly promote the upgrading and transformation of the manufacturing industry chain.

3.3 Spatial Spillover Effect of Digital Economy on the Resilience of Manufacturing Industry Chain

The digital economy is deeply embedded in and drives the development of the manufacturing industry chain with its excellent high permeability, wide coverage, high innovativeness and significant value-addedness. These qualities not only fully demonstrate the strong potential of the digital economy in terms of empowerment, but also highlight the significant impact of its spatial spillover effect. The chain-network layout of the manufacturing industry chain provides fertile soil for the diffusion and application of digital technology through the closely linked nodes and the inherent mechanism of synergistic cooperation [11].

The digital economy shows its spatial effect in many dimensions such as economic growth and industrial structure. The development of the manufacturing industry chain has a close economic connection between neighboring regions, and the spatial effect of the digital economy further strengthens this connection and improves the accessibility of information and resources of each link of the industry chain. The spatial effect promotes the overflow of innovation and technological efficacy, so that the digital economy has a significant spillover effect on the development of the manufacturing industry chain in the neighboring regions, and also makes the layout of the manufacturing industry chain present the characteristics of spatial networking, i.e., the nodes of the industry chain are in an interconnected network space. The network space structure can greatly improve the efficiency of information transmission and resource interchange, making the knowledge and technology spillover of the digital economy more extensive [12]. Through this side effect, the digital economy has a greater radiating effect and influence on the neighboring regions.

4. The Realization Path of Digital Economy

Driving the Toughness Improvement of Heilongjiang Manufacturing Industry Chain

4.1 Strengthen the Digital Infrastructure, Access to Value Information

In order to realize the all-round and in-depth empowerment of digital technology to the manufacturing industry, manufacturing enterprises need to take a series of forward-looking and strategic initiatives. First of all, strengthening the digital infrastructure is the first task. Enterprises should not only improve the data acquisition mechanism to ensure the accuracy, real-time and completeness of the data, but also strengthen the data analysis and application capabilities, so that the data become an important basis for corporate decision-making. Through the introduction of advanced data analysis tools and technologies, enterprises can integrate and utilize data resources more efficiently and promote the innovation and development of business models. Second, build a digital industrial ecological model. Enterprises should rely on the industrial Internet platform and use digital technology throughout all aspects of product design, manufacturing, sales and service to realize the digital transformation of the entire process. At the same time, the digital industrial ecological model will promote close cooperation between upstream and downstream enterprises in the industrial chain, forming synergies and jointly promoting the development of the entire manufacturing industry. Finally, the application of digital technology will give manufacturing enterprises stronger market perception and flexible production capacity. Through the support of big data, artificial intelligence and other technologies, enterprises can gain real-time insight into market dynamics and changes in user demand, and adjust production plans and product strategies in a timely manner. This ability to respond quickly and adjust flexibly will enable enterprises to occupy a more favorable position in the market competition. At the same time, digital technology will also promote the manufacturing industry to customization, personalization direction, to meet the increasingly diverse needs of users.

4.2 Unleashing the Powerful Drivers of the Elements of the Digital Economy Across Multiple Dimensions

Data elements have unique properties, such as non-competitiveness, open source and zero marginal cost. These attributes make the dissemination and replication of data in the industrial chain exceptionally efficient, effectively avoiding the imbalance in the industrial chain caused by the shortage of resources. In order to give full play to the role of data elements, it is necessary to strengthen the acquisition and cultivation of data. In the production and consumption links of the manufacturing industry chain, it is necessary to capture and store the data generated in real time, and use advanced technologies such as big data and artificial intelligence to deeply mine and analyze the data. This helps break down the information barriers between various links in the industry chain, reduce the cost of data use, and realize the efficient aggregation and sharing of data in the industry chain. At the same time, it is also necessary to promote the in-depth integration of data elements and traditional production factors. Through data-driven, the optimal allocation and efficient use of traditional production factors such as labor, capital and raw materials can be realized. Finally, the establishment of a sound data factor standard system is an important guarantee for improving the resilience of the manufacturing industry chain. The formulation of unified standards and specifications for data resource property rights, infrastructure equipment, data information security, etc., provides a solid foundation for the development and utilization of industrial chain data resources.

4.3 Cultivate Digital Talents to Support Value Creation

In order to enhance the technological innovation and value creation ability of manufacturing enterprises, it is necessary to pay attention to the cultivation and introduction of high-end digital talents. On the one hand, colleges and universities should continue to optimize the innovative talent cultivation system, work closely with the government and manufacturing enterprises to build talent cultivation platforms, provide internships, and explore the development of high-end digital talent cultivation programs in

order to strengthen the cultivation of local digital talents. On the other hand, while cultivating local talents, they should also actively introduce high-end talents in the digital field, learn from the successful experience of other provinces, improve the talent introduction policy in accordance with the actual situation of the province, and attract and retain high-end talents by providing an attractive working environment, broad career development space and generous salaries and benefits, so as to provide strong support for the technological innovation and value creation of manufacturing enterprises.

4.4 Build Digital Industry Clusters and Realize Value Co-creation

In order to shape a digital industry cluster with a high degree of competitiveness, leading enterprises should give full play to their leading role and take the initiative to introduce and deeply apply digital technologies in order to promote the transformation of the whole industry to digitalization. In this process, large manufacturing enterprises will act as forerunners and demonstrators, taking the lead in integrating advanced digital technologies into production practices, and setting up industry benchmarks for digital transformation of manufacturing through technological innovation and model innovation. The Heilongjiang Provincial Government should actively focus on the cultivation of "specialized, special and new" enterprises. Through in-depth analysis and assessment of small and medium-sized enterprises with development potential, combined with their unique development characteristics, to determine their market segments and positioning, and provide targeted policy support and resource support, to help these small and medium-sized enterprises to grow rapidly, to become a leader in their respective segments, and thus enhance the core competitiveness of the entire industrial cluster. Heilongjiang Province should also conduct comprehensive sorting and categorization guidance for SMEs. Through undifferentiated extraction and assessment, it will help them clarify their own development plans and goals, and provide the necessary financial, technological, talent and other resource support. In addition, it is also

necessary to actively promote the construction of digital innovation bases to provide SMEs with a good innovation environment and platform, and to promote their innovation and development in the field of digitization. Through the formation of digitalization industry clusters, the entire industry will be promoted to achieve sustained innovation and development.

4.5 Improve the Digitization of the Industrial Chain and Build a Value Network

In order to effectively protect enterprise data security and strengthen data compliance management, there is an urgent need to strengthen and improve the construction of relevant regulations. First, it is necessary to develop a comprehensive and systematic set of regulatory frameworks for data openness and circulation, clarify the specific rules and standards for data sharing, and provide a clear and compliant data interaction environment for enterprises in the manufacturing industry chain, so as to eliminate information barriers and promote the efficient circulation of data. Second, in order to enhance the value and efficiency of data sharing, Heilongjiang Province needs to establish a unified data sharing standard system. This system should cover data security, data quality, data format and other aspects to ensure smooth data interoperability and integration among enterprises, so that data can become an important resource to promote the collaborative development of the industrial chain. Finally, in order to accelerate the digitization process, Heilongjiang Province should encourage and support the research, development and application of digitization technology. Especially in the field of intelligent manufacturing, the industry should be encouraged to independently research and develop intelligent equipment, such as CNC machine tools and industrial robots, in order to improve production efficiency and product quality. Simultaneously, we must hasten the profound integration and broad implementation of digital technology across the industrial chain. This will empower upstream and downstream enterprises to embark on a journey of intelligent transformation. Our objective is to cultivate a digital value network, underpinned by

intelligent manufacturing and characterized by safety and efficiency, ultimately propelling the entire industry towards transformation, upgrading, and long-term sustainability.

5. Conclusion

As the digital economy flourishes, digital technology is gradually breaking the shackles of traditional manufacturing techniques, opening up more diversified market opportunities for the manufacturing industry. It has reduced production costs, overcome technological and trade barriers, and thereby ensured the stability and resilience of manufacturing supply chains. Concurrently, the development of the digital economy has spurred new business formats and models, fueling rapid growth in emerging industries and further accelerating the technological intensification of the manufacturing industry's supply chain. In light of this, Heilongjiang Province should actively embrace this trend, strive to enhance the development of its digital economy, leverage its innovative driving force for the manufacturing sector, and reinforce the digital transformation of manufacturing supply chains. This will lay a solid foundation for the steady growth and robust development of the manufacturing industry in Heilongjiang.

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