

Research on Practical Development Path of Full Coverage of Silicon-based Economy under the Background of Low-carbon Transition of Carbon-based Industries

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Abstract: Under the background of the low-carbon transformation of carbon-based industries, this study explores the practical development path of the nationwide expansion of China's silicon-based economy. The research adopts a qualitative approach based on a literature review and conceptual analysis to develop a six-stage framework, including low-carbon transformation, industrial restructuring, capital reallocation, digital infrastructure construction, AI-driven industrial transformation, and the nationwide expansion of the silicon-based economy. The results indicate that industrial transformation gradually shifts resources toward digital industries, supporting the development of digital infrastructure, AI, and intelligent industries. Based on these findings, this study proposes policy recommendations for improving digital infrastructure, promoting AI development, and strengthening talent cultivation. This research provides a practical framework for understanding the future development of China's silicon-based economy.

Keywords: Silicon-based economy, industrial transformation, AI, digital economy, China.

1. Introduction

AI and digital technology are reshaping global industrial development. As computing power, semiconductors, cloud computing and data become increasingly important factors of production, economic growth is gradually shifting from traditional industries to digital and intelligent industries (Brynjolfsson and McAfee, 2014). In China, the continuous transformation of carbon-based industries to low-carbon has promoted industrial upgrading and resource optimization, and provided favorable conditions for the development of emerging digital industries. Against this background, the concept of "silicon-based economy" characterized by AI, computing power, algorithms and digital infrastructure provides a new perspective for understanding China's future economic transformation.

The existing research mainly focuses on industrial upgrading, digital economic development, intelligent manufacturing and technological innovation. A large number of studies show that digital technology can significantly improve productivity, industrial efficiency and economic competitiveness (Schwab, 2017; Acemoglu and Restrepo, 2018). At the same time, the study of industrial transformation mainly focuses on improving energy efficiency, clean production and industrial restructuring (Porter and Linde, 1995). However, under the background of the low-carbon transformation of carbon-based industries, little attention is paid to how the silicon-based economy can gradually realize the actual development path of national expansion. Existing research tends to separate digital transformation and industrial transformation, and lacks a systematic framework to explain how the two gradually evolve into a silicon-based economic system.

Therefore, this study aims to explore the actual development path of the nationwide expansion of China's silicon-based economy. This study does not focus on the

interaction between industrial low-carbon transformation and digital transformation, but takes the low-carbon transformation of carbon-based industries as the macro-development background, and focuses on identifying the gradual development process of silicon-based economy. Specifically, this study has built a conceptual framework consisting of six interrelated stages: low-carbon transformation, industrial restructuring, capital reallocation, digital infrastructure construction, AI-driven industrial transformation and national expansion of silicon-based economy.

This study contributes to the existing literature from three aspects. First of all, it introduces the concept of "silicon-based economy" and regards it as a comprehensive economic paradigm driven by AI, semiconductors, computing power, digital infrastructure and intelligent systems. Secondly, it puts forward a dynamic development framework and explains how China's industrial transformation can gradually evolve into a national silicon-based economic development model. Finally, this study puts forward policy proposals to support industrial transformation and upgrading, artificial intelligence development and digital infrastructure construction, providing a practical framework for China's future economic transformation.

2. Literature Review

2.1. Research on the Low-carbon Transition of Carbon-based Industries

Recent research shows that the low-carbon transformation of carbon-based industries not only involves reducing energy consumption and emissions, but also industrial restructuring and technological upgrading. Digitalization plays an important role in this process by improving production efficiency, supporting technological innovation and promoting industrial transformation. Zhang et al. (2021) found that the digital economy has significantly promoted

China's low-carbon transformation by improving carbon productivity and innovation capacity.

Huang et al. (2025) further pointed out that industrial digitalization has accelerated the transformation of low-carbon energy by optimizing resource allocation and promoting industrial upgrading. Their research shows that the contribution of the development of digital industry to long-term industrial transformation far exceeds the simple application of digital technology in traditional industries. These findings show that digital development has become an important driving force for China's industrial transformation and upgrading.

From a broader perspective, Calvino et al. (2025) put forward the concept of "double transformation", emphasizing that digital transformation and industrial low-carbon transformation are increasingly promoting each other. The OECD pointed out that AI, data analysis, cloud computing and intelligent digital systems can improve production efficiency, energy management and industrial innovation capabilities, thus accelerating industrial transformation and creating new opportunities for economic restructuring.

In general, recent literature shows that low-carbon transformation is no longer limited to environmental governance, but has evolved into a comprehensive industrial transformation process. However, most of the existing research focuses on how digital technology promotes industrial upgrading, and less attention is paid to how to reconfigure production factors in industrial transformation and how to create the necessary conditions for the nationwide expansion of emerging AI-driven industries.

2.2. Research on the Digital Economy, AI, and the Silicon-based Economy

The rapid development of AI has greatly expanded the research of digital economy. Existing studies generally believe that digital technology has become a key driving force for productivity growth, industrial innovation and economic restructuring. Karavasilis et al. (2024) points out that AI, cloud computing, advanced communication networks and data infrastructure are the core technical foundations to support future economic development. The report believes that AI is increasingly changing production systems and industrial organizations, making digital infrastructure a strategic asset to enhance national competitiveness.

Recent research has also explored the relationship between digital economic development and industrial transformation. Wei et al. (2025) found that the digital economic development has significantly promoted China's low-carbon economic transformation through industrial upgrading, technological innovation and spatial spillover effects. Their research shows that digital technology not only improves enterprise productivity, but also reshapes the regional industrial structure by promoting the spread of cross-departmental innovation.

In addition, the recent systematic review also emphasizes the increasingly important role of AI in industrial development. Vyhmeister and Castane (2026) believe that AI has become the core enablement technology of Industry 5.0, supporting sustainable manufacturing, intelligent decision-making and resilient industrial systems. Their research shows that AI is gradually evolving from production-assisted technology to the fundamental productivity of reshaping industrial organization and value creation.

Although recent literature has conducted extensive

research on digital economic development, the application of AI and intelligent manufacturing, these studies usually focus on the application of a single technology or specific industries. Few studies have integrated computing power, semiconductor industry, digital infrastructure, AI systems and intelligent manufacturing into a unified analytical framework, thus explaining the evolution of AI-driven economic systems nationwide.

2.3. Research Gap Analysis

The existing research has accumulated a lot of knowledge about industrial low-carbon transformation, digital economic development and AI. Recent studies have increasingly recognized that digital technology can improve industrial productivity, accelerate technological innovation and promote structural transformation. In addition, scholars have also discovered a variety of mechanisms for digitalization to promote industrial upgrading, including technological innovation, resource allocation efficiency, industrial restructuring and spatial spillover effects. However, there are still three research gaps.

First of all, the existing research mainly examines the impact of digital technology on industrial upgrading or low-carbon transformation, and explains the long-term evolution of the AI-driven economic system.

Secondly, most of the existing studies analyze various dimensions such as digital infrastructure, industrial digitalization or AI applications in isolation, and lacks a comprehensive framework to link industrial transformation with the gradual development of emerging digital industries.

Third, despite the rapid development of AI, semiconductor technology and computing infrastructure, few studies have proposed a systematic development path to explain how these technical elements jointly promote the national expansion of China's silicon-based economy.

In order to make up for these gaps, this study has built a six-stage development framework, namely low-carbon transformation → industrial restructuring → capital reallocation → digital infrastructure construction → AI-driven industrial transformation → national expansion of silicon-based economy, which provides a new conceptual perspective for understanding China's future economic transformation.

3. Practical Development Path for the Nationwide Expansion of China's Silicon-based Economy

3.1. Low-carbon Transition of Carbon-based Industries

The first stage is the low-carbon transformation of carbon-based industries. In recent years, traditional industries such as steel, chemical industry, cement and manufacturing in China have accelerated the application of clean production technology, energy-saving equipment and intelligent manufacturing systems. Bo (2024) pointed out that digital technology has become an important tool to improve resource utilization efficiency and support industrial transformation. The integration of industrial digitalization and clean production has significantly improved production efficiency and reduced resource dependence (Zhang et al., 2025). With the improvement of the technological intensity of traditional industries, the demand for industrial restructuring has also

gradually increased, creating favorable conditions for the next stage of economic transformation.

3.2. Industrial Structure Adjustment

Industrial restructuring is the second stage of the development path. The upgrading and transformation of traditional industries has accelerated the expansion of strategic emerging industries such as semiconductors, new generation information technology, intelligent equipment and digital services. According to the forecast of the China Institute of Information and Communications Research (CAICT, 2024), by 2023, the scale of China's digital economy will reach 53.9 trillion yuan, accounting for 42.8% of GDP, and the contribution of the digital industry to economic growth is increasing. With the gradual transformation of the industrial structure from labor-intensive to knowledge-intensive and technology-intensive, the factors of production have also begun to shift to industries with stronger innovation and technological competitiveness.

3.3. Capital Reallocation

Industrial restructuring has further promoted the transfer of capital to emerging digital industries. Investment is increasingly concentrated in semiconductors, AI, cloud computing, intelligent computing centers and industrial robots, while the capital allocation of traditional industries is gradually decreasing. According to the World Investment Report 2024 (UNCTAD, 2024), although the growth rate of traditional manufacturing investment has slowed down, global investment in digital infrastructure and technology-intensive industries continues to grow. In China, government industrial policies and private investment have jointly accelerated the development of AI-related industries and provided strong financial support for digital infrastructure construction and technological innovation.

3.4. Digital Infrastructure Construction

Capital accumulation has laid the foundation for the construction of large-scale digital infrastructure. In recent years, China has continuously promoted 5G networks, data centers, cloud computing platforms, intelligent computing centers and "Eastern Data and Western Computing" projects, building one of the largest digital infrastructure systems in the world. The OECD's Digital Economy Outlook for 2024 emphasizes that digital infrastructure is the fundamental prerequisite for AI innovation and industrial digital transformation. The improvement of computing power and data connectivity has significantly promoted the spread of digital technology in various industries and laid the technical foundation for large-scale AI applications.

3.5. AI-driven Industrial Transformation

With the support of digital infrastructure, AI is gradually penetrating into the fields of manufacturing, medical and health, logistics, finance, transportation and public management. According to the 2025 AI Index Report released by Stanford University, the adoption of generative AI by enterprises has increased significantly, making it one of the most influential technologies to promote industrial productivity and innovation (Maslej et al., 2025). AI is no longer just an auxiliary production tool, but increasingly participates in production scheduling, quality testing, intelligent decision-making and supply chain management. Therefore, industrial production is gradually transforming

from digital to intelligent production system.

3.6. Nationwide Expansion of the Silicon-based Economy

The final stage is the national expansion of the silicon-based economy. With the wide application of artificial intelligence in various industries and public services, computing power, data, algorithms and semiconductors have become key driving forces for economic growth. The silicon-based economy gradually surpasses the digital industry and supports broader economic development. This process is driven by industrial transformation, capital reconfiguration, digital infrastructure construction and broader artificial intelligence applications, ultimately promoting the nationwide expansion of the silicon-based economy.

4. Challenges

4.1. Energy Pressure

AI has significantly increased the demand for electricity, making energy supply an important challenge for the development of silicon-based economy. Chen et al. (2025) pointed out that large-scale artificial intelligence models have rapidly increased the power consumption of data centers, bringing new pressure to energy security and power systems. Ali (2026) also estimates that the electricity demand of global data centers will more than double due to the application of artificial intelligence by 2030. For China's economy, expanding the installed capacity of renewable energy and improving the transmission capacity are crucial to support the sustainable growth of artificial intelligence and silicon-based economy.

4.2. Employment Transition

AI is changing the employment model by influencing different occupations. Muthukumar et al. (2026) found that AI has a greater impact on conventional cognitive work, while the demand for analytical, creative and interpersonal skills is still strong. Similarly, Ernst et al. (2019) believe that the economic benefits of AI depend on whether technological progress complements human capabilities or merely replaces the labor force. For China, the wide application of AI in the manufacturing and service industries requires continuous labor skills retraining, vocational education and digital talent training to promote employment transformation.

4.3. Regional Imbalance

Regional differences are still an important obstacle to the national expansion of silicon-based economies. Zhang et al. (2021) found that there are significant regional differences in China's digital economy, and the development level of digital infrastructure, innovation capacity and AI industry in the eastern provinces is much higher than that of the central and western regions. Li et al. (2024) pointed out that digital infrastructure has a significant spatial spillover effect, indicating that strengthening interregional digital interconnection can promote balanced economic development. Therefore, narrowing the regional digital gap should still be the top priority for realizing the national silicon-based economic development.

4.4. Technology Dependence

Technology dependence is still a strategic challenge facing China's silicon-based economy. Zhang (2025) believes that

cutting-edge technology is increasingly dependent on an integrated innovation ecosystem that integrates advanced semiconductors, computing infrastructure, software and human capital. Dzreke (2025) further pointed out that the competitiveness of AI depends not only on algorithm development, but also on supporting investment in computing power, data resources and organizational innovation. Therefore, strengthening independent innovation in semiconductors, industrial software and basic models of AI is crucial to improving the resilience and international competitiveness of China's silicon-based economy.

5. Policy Implications

5.1. Promote Industrial Transformation and Optimize Capital Allocation

The low-carbon transformation of traditional industries should be combined with industrial restructuring and capital reallocation. The government should encourage enterprises to accelerate intelligent manufacturing, technological upgrading and digital transformation through financial incentives and financial support. At the same time, public and private investment should be guided to semiconductors, AI, industrial robots, cloud computing and other strategic emerging industries. Optimizing the allocation of production factors will consolidate the industrial foundation of the silicon-based economy and improve the efficiency of economic transformation.

5.2. Accelerate Digital Infrastructure and AI Development

Digital infrastructure is still the cornerstone of supporting China's silicon-based economy. Continuous investment in computing centers, data centers, communication networks, industrial Internet platforms and cloud computing will support the future development of AI. At the same time, AI should be more widely integrated into manufacturing, medical and health, logistics, finance, education, public management and other fields. The application expansion of AI in various industries will improve productivity, stimulate technological innovation, and accelerate the transformation to an intelligent economy.

5.3. Strengthen Innovation Capacity and Talent Development

The long-term competitiveness of a silicon-based economy depends on continuous technological innovation and high-quality human capital. China should strengthen cooperation between universities, scientific research institutions, science and technology enterprises and financial institutions to accelerate scientific research and technological transformation. In addition, interdisciplinary education and vocational training in the fields of AI, semiconductor engineering and data science should be expanded to cultivate skilled talents needed for future industrial development. A strong innovation ecosystem and a sustainable supply of talents will drive the sustainable development of the silicon-based economy nationwide.

6. Conclusion

Against the background of the low-carbon transformation of traditional industries, this study explores the practical development path of the national expansion of China's

silicon-based economy. Unlike the previous research that focused on a single field such as industrial upgrading, digital transformation or AI, this study puts forward a set of systematic six-stage development paths, including low-carbon transformation, industrial restructuring, capital reallocation, digital infrastructure construction, AI-driven industrial transformation and silicon-based economy. National expansion.

Research results show that the development of the silicon-based economy is a gradual and interrelated process, rather than the result of isolated technological progress. The low-carbon transformation of traditional industries provides an initial driving force for industrial restructuring, thereby guiding capital to flow to strategic emerging industries. Investing in digital infrastructure helps to apply AI more widely and promotes the nationwide expansion of the silicon-based economy. This development path shows that industrial transformation, technological innovation and economic restructuring are closely linked.

This research has built a unified framework for industrial transformation and digital economic development, which provides a practical explanation for how China's silicon-based economy expands nationwide, and enriches the research results of the existing digital economic transformation. The proposed path also helps policymakers optimize industrial policies, digital infrastructure, innovation and talent training. Future research can test the effectiveness of this framework through empirical research, regional comparison or quantitative analysis.

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