Original Research Article

Research on the coordinated development of industrial digitalization and green transformation

Lin Wang
Anhui University of Finance and Economics, Bengbu, Anhui, 233000, China

Abstract: Against the backdrop of the "dual carbon" policy, accelerating the coordinated development of industrial digitalization and greening is a crucial pathway to achieving China's modernization. This paper explores the evolution and driving factors of coordinated industrial digitalization and greening. Key findings: 1. The coordination level between digitalization and greening has significantly improved across Chinese provinces, advancing from initial coordination to sound coordination overall, marking substantial progress in "digital-green synergy."2. China's "digital-green synergy" exhibits an "eastern leadership, western rapid development" pattern, where narrowing regional disparities is key to advancing coordinated development. 3. Regional differences remain pronounced. Beyond Beijing, Guangdong, Shanghai, and Jiangsu, most provinces lag in industrial digital-green synergy, urgently requiring accelerated synchronized development of both industrialization and green transformation.
Keywords: industrialization; digitalization; green development; coordinated development

1. Introduction

Industry serves as a vital engine for modern economic growth. Advancing high-quality development of new industrialization constitutes a core element in achieving modernization with Chinese characteristics. The report of the 20th CPC National Congress explicitly states that efforts to develop the economy should focus on the real economy, promote new industrialization, and accelerate the building of a manufacturing powerhouse. New industrialization centers on digital-intelligent industrialization, representing a deepened integration of informatization and industrialization beyond their coordinated development.By embedding digital and intelligent technologies within industrial processes, digital-intelligent industrialization achieves increasingly seamless integration with industrialization, ultimately realizing their full convergence. The White Paper on the Integrated Development of Industrial Digitalization and Green Transformation explicitly states that the path of new industrialization aims for green transformation through digital means, with both dimensions synergistically reinforcing each other. In the new round of technological revolution and industrial transformation, digital technology represents the most dynamic, widely applied, and profoundly impactful innovation.Digitalization is both a defining feature of new industrialization and a focal point for advancing it with high quality. Existing research has overly emphasized the relationship between digitalization and greening within the industrialization process. Digitalization can empower green transformation, exhibiting significant heterogeneity across industries. Digital transformation promotes green innovation by enhancing resource allocation capabilities and information transparency. Conversely, green innovation further drives corporate digital transformation by increasing R&D investment . Research on the synergistic effects between industrial digitalization and greening remains notably insufficient.

2. Literature review

Against the backdrop of information digitization, green and low-carbon challenges have become increasingly severe, prompting growing academic research on the relationship between digitalization and greening. Key areas of focus include: First, how digitalization can empower greening. Wang Hai (2023) found that during digital transformation, enterprises can "empower"green innovation development, achieving "incremental improvement"in green innovation. This enabling effect primarily stems from the application of underlying

digital technologies, which enhance greening levels by promoting digital resource investment in green R&D. Market competition and government policy support play reinforcing roles in this process. Further research by Cao Yu and Liu Chang (2023), grounded in resource dependency theory, indicates that implementing digital transformation consumes corporate financial resources, thereby influencing investment decisions and crowding out resource allocation for green innovation activities. Simultaneously, enterprises must increase investment in digital technologies such as big data platforms and artificial intelligence during digital development, inevitably leading to significant energy consumption and posing major challenges to green development. Second, the synergistic development of digitalization and greening. Achieving synergistic development between digitalization and greening has become an inevitable choice for China's high-quality development. Tian Haifeng (2023) found that digital transformation enhances resource allocation capabilities and information transparency, thereby driving green innovation. In turn, green innovation promotes further digital transformation by stimulating R&D investment. Moreover, under the concept of common prosperity, enterprises' digital and green transformations exhibit a mutually reinforcing, synergistic relationship. Both drive internal common prosperity within enterprises, achieving synergistic effects.

3. Empirical analysis

3.1. Research methodology

Industrial Green Development Level. Guided by principles of scientific rigor, data availability, and research relevance, this study builds upon the framework proposed by Wang Shaohua et al. to establish a measurement system comprising 12 evaluation indicators across four dimensions: industrial resource utilization, industrial environmental governance, and industrial growth quality.Industrial Digitalization Level. Drawing on the research methodology of Wang Shaohua and Wang Fei et al., and grounded in the fundamental essence of digitalization, this study ultimately constructed an industrial digital development measurement indicator system comprising 12 evaluation indicators across four dimensions: digital infrastructure, digital industrialization, industrial digitalization, and digital innovation capability.

This study employs the entropy weight method to determine the weights of evaluation indicators, thereby overcoming the shortcomings of previous evaluation systems that relied on subjective weighting methods such as the Analytic Hierarchy Process (AHP). A coupling coordination degree model is applied to assess the coupling coordination level between industrial greening and industrial digitalization. To further identify the barrier factors affecting the level of synergistic development between industrial digitalization and greening, this paper constructs a barrier degree model based on the evaluation indicator system. A higher barrier degree indicates greater resistance of that factor to the level of synergistic development.

3.2. Empirical analysis

This paper employs the entropy method to calculate the synergy level between industrial greening and industrial digitalization. The results reveal: (1) From 2013 to 2022, both the national industrial greening level and industrial digitalization level showed an overall upward trend. However, after 2020, the industrial digitalization level first declined before resuming growth, while the synergy level between digitalization and greening followed a similar trajectory. (2) In terms of overall magnitude, industrial greening consistently surpassed industrial digitalization from 2013 to 2022. However, the development gap between the two narrowed to its minimum in 2020 before widening again. (3) Regarding growth rates, industrial greening progressed at a slower pace, while industrial digitalization advanced more rapidly. China's industrial digital-green synergy exhibits pronounced regional disparities, warranting further in-depth analysis. It is evident that spatial heterogeneity significantly influences China's industrial digital-green synergy, with more economically developed regions achieving higher levels. Across the four major regions: - Eastern, Central, Western, and Northeastern regions show broadly similar overall trends in new industrialization development, maintaining sustained growth. Development levels declined in 2020 but subsequently exhibited an upward trajectory; The eastern region consistently maintained a higher level of industrial digitalization and green development than the other three regions, exceeding the national average, largely due to its advanced economic development. The central region's level remained below the national average but aligned with its development trajectory and growth rate. The western region started with

the lowest level but demonstrated the most significant growth rate. The northeastern region exhibited the slowest growth rate, with its level of industrial digitalization and green development remaining the lowest after 2018.

The barrier degree model reveals that the key barrier factors are, in order of importance: the number of R&D institutions in industrial enterprises above designated size, total income of personnel in information transmission, computer services, and software industries, software business revenue, and corporate e-commerce sales. The trend in barrier degree across these indicators shows an overall upward trajectory, though the rate of increase is modest.

3.3. Research implications

Regarding the primary research content outlined above, this paper draws the following research implications: 1. Deepen understanding of the importance of synergistic digitalization and greening. View digitalization and greening as intrinsic requirements for high-quality economic and social development. Advancing green and low-carbon transformation necessitates robust support from digital tools, while the demands of greening will also drive digital advancement. 2. Focus on core drivers. When advancing the synergistic development of digitalization and green transformation, key factors such as digital talent, technological innovation, and energy consumption levels should be prioritized. Strengthen investment in digital technologies, accelerate talent recruitment, and establish efficient mechanisms for cultivating digital talent in the context of carbon neutrality and carbon peaking to enhance industrial digital governance capabilities. 3. Enhance regional coordination. While significant achievements have been made in digital infrastructure and green development across regions, interregional coordination remains an area for improvement. Efforts should be made to facilitate the flow of data resources, deploy green ecological networks, optimize the spatial layout of digital infrastructure, and form effective factor markets. This will promote the intensive development of industrial digitalization and green transformation, thereby accelerating the modernization process.

References

[1] Wenjia Ma, Hongzheng Zhang. The Impact of Enterprise Digital Transformation on the Selection of Green Innovation Models [J]. Science and Technology Management, 2023, 44(12): 61-70.

[2] Hai Wang, Guanyu Guo, Junya Yin. How Digital Transformation Empowers Green Innovation and Development in Enterprises [J]. Economic Dynamics, 2023(12): 76-91.

[3] Haifeng Tian, Huajun Liu. Research on the "Dual-Transformation Synergy"Mechanism of Corporate Digital Transformation and Green Innovation [J]. Industrial Economics Research, 2023(6): 29-41, 72.

[4] Jun Li, Junjiang Qiu . Current Status and Development Strategies of Business Integration in the Digital Transformation Process of Industrial Enterprises [J]. China Science and Technology Forum, 2019(7): 113-118.

[5] Liping Yu, Kuangwei Zhang, Gongxing Wu. Research on the Mechanism of Digital Transformation's Role in Corporate Innovation: A Perspective Based on Technological and Management Innovation [J]. China Soft Science, 2024(1): 24-35.

[6] REXHAUSER S,RAMMER C. Environmental innovations and firm profitability: Unmasking the Porter hypothesis[J] . Environmental and Resource Economics,2014,57(1) :145-167.

[7] Dagum C.A New approach to the decomposition of the Gini income inequaity ratio[J]. Empirical Economics. 1997,22(4): 515-531.