Artificial Intelligence and the Transformation of China's Industrial Structure: Opportunities, Challenges, and Implications

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Abstract. In the context of rapid global economic development, artificial intelligence (AI) is significantly influencing the industrial structure of nations worldwide, particularly in China, the world's second-largest economy. This research aims to explore the impact of AI on China's industrial structure, focusing on how AI contributes to industrial upgrading, economic transformation, and the challenges it presents. The study also analyses the current issues in China's industrial structure, such as imbalances and energy constraints, and examines how AI can optimize these areas. Furthermore, it investigates the limitations of AI applications, including regional disparities and talent shortages. The findings suggest that while AI offers substantial potential for enhancing China's industrial structure, its effectiveness is hindered by uneven technological diffusion and a lack of high-end talent. The study concludes by emphasizing the need for targeted policies to harness AI's potential fully and mitigate its challenges, ensuring sustainable and balanced industrial development in China.

1 Introduction

Amidst the accelerated expansion of the global economy, artificial intelligence (AI) has emerged as a pivotal catalyst in the ongoing scientific and technological revolution, driving industrial transformation. Its profound impact is reshaping the economic structures and social development paradigms of nations worldwide. As the world's second-largest economy, China's application and promotion of AI technology is particularly crucial in the process of promoting industrial upgrading and economic transformation. As China gradually transforms from traditional manufacturing to high-tech and service industries, the potential of AI technology is being unleashed to improve productivity, optimize resource allocation and promote innovation. However, the rapid development of AI has also raised concerns about a series of issues such as employment structure, regional economic differences, and industry chain reconstruction. Therefore, studying the impact of AI on China's industrial structure not only has important academic value but also provides decision-making references for policymakers and enterprises to ensure that China occupies a favorable position in global competition and promotes high-quality economic development.

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Previous research has explored the role of artificial intelligence in promoting the optimization of the economy and industry, and it is found through combing that most of the research tends to believe that artificial intelligence is the engine of economic growth in the new era and promotes the development of integration clusters of emerging industries. The application domains of cutting-edge concepts and technologies in global artificial intelligence have grown in recent years, offering a welcoming environment for growth and garnering significant interest from the public [1]. Part of the view is that artificial intelligence has a positive effect on economic development directly according to its characteristics, especially in intelligent manufacturing and the third industry. The new developments presented by AI are mainly reflected in big data-driven knowledge learning, human-computer hybridization, group intelligence, and autonomy [2]. In the context of Industry 4.0, AI optimizes production processes and controls costs through big data analysis and identification, thus improving overall productivity [3]. Fan and Liu argue that smart technologies effectively weaken technological barriers through automation, and facilitating innovative activities can directly and positively impact regional development and promote economic growth [4]. The Economic Reference News mentioned that based on the transformation and upgrading stage of China's economic development, AI can reconstruct the links of production and distribution and other economic activities to form a new demand for intelligence from macro to micro and help innovation, triggering the reform of the economic structure, thus contributing to the supply-side structural reform [5]. As the fundamental technology of the current era of intelligence, artificial intelligence will serve as a key driver of the forthcoming industrial revolution, while profoundly reshaping the global industrial competitive landscape and significantly impacting international competitiveness [1]. However, the research results of Xia et al show that although industrial intelligence has a positive effect on industrial factor synergy and structural upgrading, it does not positively affect the rationalization of industrial structure [6].

In general, the integration of AI into industry has positively impacted the upgrading of industrial structures. However, the relationship between industrial transformation and economic growth remains inconclusive in existing literature. Some scholars argue that the restructuring of China's previously inefficient industrial system has emerged as a primary catalyst for rapid economic growth, primarily through improvements in overall economic efficiency. The promotion of economic growth mainly comes from the ‘structural dividend’ brought about by the sectoral transfer of input factors, but gradually weakened with the advancement of reforms, and the positive impact in the manufacturing industry is not significant [7]. Shi et al. observed that the relationship between industrial structure and economic growth is complex, with its impact varying significantly across different sectors and indicators [8]. They noted that the effect of industrial structure on economic performance is not uniformly substantial. Instead, the rationalization of the tertiary sector and the overall industrial structure are the primary influencing factors. In China, economic growth is largely propelled by the expansion of the tertiary sector rather than by changes in the industrial structure itself [5]. Furthermore, modifications in industrial structure have little effect on agricultural upgrading [8]. Overall, the evolution of China's industrial structure plays a role in enhancing the quality of economic development and contributes, to a degree, to the growth of green total factor productivity [5].

This study seeks to examine the effects of artificial intelligence (AI) on China's industrial structure by building upon existing research. It focuses on the ways in which AI influences economic transformation, regional disparities, and industrial upgrading. The research aims to address the imbalances in China's industrial development by optimizing resource allocation and enhancing energy efficiency. Additionally, it endeavors to explore both the potential benefits and challenges posed by AI.

2 The dilemma of China's industrial structure

2.1 Problems arising from industrial imbalance

The transformation of China's industrial structure reflects a process of adjustment and correction from the initial industrial system established at the onset of reform and opening-up, driven by economic marketization. This shift is predominantly marked by the increasing proportion of value added from the secondary and tertiary sectors in the Gross Domestic Product [9]. Initially, China's economic development was characterized by extensive resource consumption, a feature dictated by both external conditions and the country's national circumstances [10]. This is different from the regular evolution of industrial structure experienced by most Western developed countries and has certain special characteristics. Although the large-scale consumption of resources and material capital with the original reason of prioritizing the development of heavy industry has enabled China to safeguard itself in the turbulent international situation and laid the economic foundation for subsequent development, with the gradual increase in the scale of the economy, the drawbacks of the industrial system of prioritizing the development of heavy industry have gradually come to the fore. From the perspective of resources and environment, the finiteness of resources and the non-renewable environment constrain the upgrading of industrial structure, and the disadvantages of insufficient per capita resources are gradually highlighted, at the same time, it also brings about the tension of international resources, energy and the environment; from the perspective of labour force, the negligence of the labour-intensive light industry and tertiary industry leads to the problem of employment, and the opening up to the outside world and development of cheap labour force leads to the manufacturing industry to lock in the low end of the value chain [10]. From the perspective of labour, the neglect of labour-intensive light industry and tertiary industry has led to employment problems, and the development of cheap labour in opening up has resulted in the manufacturing industry being more locked in the low end of the value chain [10]. The overall disadvantages are reflected in the inability to reflect the basic requirements of the market for resource allocation and the principle of international comparative advantage of industries.

2.2 Dilemmas regarding energy

Industrial structure simultaneously affects energy efficiency and consumption structure to different degrees, which in turn constrains the further optimization of industrial structure. China's resource characteristics and the crude economic growth mode have led to a resource consumption characterized by high coal, low efficiency, and high emissions, which is not conducive to sustainable economic development [11]. Although environmentally friendly energy technologies are constantly developing, they are still in the early stage of development, the cost and technology application issues have not been perfected, and the energy structure characterized by high coal consumption has not been substantially changed. Due to the major concentration of energy consumption in the industrial sector in China, this industry-led industrial structure is not only highly dependent on traditional energy sources, but also largely determines the characteristics of the energy consumption structure, and the two form a mutually constraining relationship [11]. Due to the price advantage of coal resources and the rapid advancement of industrialization, it is difficult for China to get rid of the coal-dominated energy consumption pattern in the short term. In terms of energy efficiency, Yu's research indicates significant spatial dependence on energy efficiency across different regions, revealing pronounced regional disparities in industrial structure. Specifically, the eastern regions of China exhibit superior industrial structure quality and energy efficiency compared to the central and western regions, as well as to the national average [12]. The

initiative taken in the East to upgrade the industrial structure and the rise of high-tech industries make the effect of resource utilization efficiency improvement obvious; in the central and western parts of China, due to the differences in their own economic foundation and structural adjustment methods, the effect of energy efficiency improvement is not significant, which leads to the increase of regional differences [13]. This shows that the lagging energy structure is not only an obstacle to the optimization of industrial structure but also limits the coordinated development of the regional economy to a certain extent.

3 The impact of artificial intelligence on industrial structure

3.1 Optimising perspectives

The application of artificial intelligence provides a new path to alleviate China's industrial structure woes. Firstly, under the conditions of existing resource constraints, digital technologies such as AI, as exogenous variables, can effectively reduce production costs, improve production efficiency, and promote enterprises to achieve upgrading through the substitution effect on human resources [14]. At the same time, by improving the quality and allocation efficiency of production factors, improving the level of information technology, and promoting industrial upgrading, it can promote urban industrial agglomeration and thus enhance innovation capacity [15]. AI technology has the potential to deliver region-specific solutions for industrial upgrading, tailored to the developmental status of different areas. In the eastern regions, AI can drive the enhancement of high-tech industrial services. Conversely, in the central and western regions, AI can facilitate the digital transformation of traditional industries, thereby decreasing dependence on low-value-added sectors and advancing the optimization of the industrial structure.

Secondly, AI technology can promote the balance of the labour market to a certain extent by changing traditional production methods. Although AI has partially replaced the labour force in automated production, AI plays a supporting role in jobs that are difficult to automate [16]. At the same time, due to the involvement of AI, the unit value of products may be increased, thus expanding the size of the market and expanding the market area, providing more production jobs for workers [17]. Therefore, AI will not necessarily reduce the overall labour demand, but rather bring more structural changes, which is conducive to stimulating the enthusiasm, initiative, and creativity of workers [16].

Thirdly, AI can optimize resource allocation and improve energy efficiency through big data analysis and machine learning. After solving the endogenous bias, AI not only releases technological dividends through direct effects but also brings significant structural dividends through industrial structure upgrading [18]. The benefits of AI technology also extend to enhancing resource allocation and energy efficiency. By improving the efficiency of resource utilization and optimizing the energy structure, AI can promote green growth and sustainable economic development. This effect is especially notable in regions characterized by minimal market distortions and higher levels of innovative human capital, where AI's impact on resource allocation and energy efficiency is markedly significant [18].

3.2 Limits

Although AI holds significant promise for advancing China's industrial structure, its effective deployment and widespread adoption are hindered by a range of constraints and challenges.

Firstly, the imbalance in technology diffusion due to regional development differences in China produces different social and economic adaptations. Eastern regions have benefited from stronger industrial intelligence capabilities and have seen significant improvements in

green development efficiency, while marginal effects have yet to fully emerge in central and western regions due to insufficient technology diffusion, especially in the western regions [19]. Regions with economic and social structures may not be flexible enough to adapt quickly to the elimination of traditional industries and the pressure to transform the labour force due to the rapid development of AI technology. In addition, the unbalanced distribution of AI resources creates gaps in efficiency and market power, allowing firms in developed regions to expand their market share by virtue of their AI advantages, further squeezing the market space of lagging regions, and exacerbating the imbalance in the regional economy [20]. These technical and socio-economic adaptability problems exacerbate the imbalance in industrial structure optimization between regions, further limiting the effect of AI on industrial structure optimization on a national scale.

On the other hand, although Chinese universities and research institutes have increased the cultivation of AI-related professions in recent years, high-end talents are still relatively scarce. Data indicate a significant shortfall in the availability of artificial intelligence (AI) talent in China, with a gap of over 5 million professionals. As of July 2021, only 50,000 individuals had received training in this field, highlighting a considerable disparity between supply and demand [21]. Additionally, a notable gap exists between China and the United States in terms of high-end AI talent. The U.S. boasts 1,146 scholars recognized as leading figures in AI research, whereas China has 232 such scholars [21]. Talent shortages not only limit the R&D and application of AI technologies but may also make it difficult for some regions to adapt to AI-driven industrial upgrades, further exacerbating regional imbalances.

4 Conclusion

This study has investigated the role of artificial intelligence (AI) in shaping China's industrial structure, particularly in relation to industrial upgrading, economic transformation, and associated challenges. The research delved into the existing issues within China's industrial framework, such as imbalances and energy inefficiencies, and evaluated the potential of AI to address these concerns. Additionally, it explored the limitations of AI applications, including regional disparities in technology adoption and the shortage of skilled AI professionals.

Key findings reveal that AI has the potential to significantly enhance China's industrial structure by increasing productivity, optimizing resource use, and driving innovation. AI can facilitate economic transformation and contribute to more balanced regional development. However, the advantages of AI are unevenly distributed, with more developed regions benefiting disproportionately due to superior infrastructure and technological capabilities. The scarcity of AI talent also poses a challenge to fully realizing AI's benefits.

Looking ahead, it is essential to develop comprehensive strategies to address these challenges and maximize AI's impact on industrial development. Policymakers should prioritize technology diffusion in less-developed regions, ensuring that all areas can benefit from AI advancements. This could involve incentivizing investments in AI infrastructure, supporting local innovation ecosystems, and promoting regional collaborations. Additionally, enhancing AI education and training programs is crucial to building a robust talent pipeline. Establishing partnerships between universities, research institutions, and industries could help bridge the skills gap and accelerate the development of AI expertise.

In the long term, China should focus on creating an inclusive and sustainable industrial ecosystem where AI not only drives economic growth but also contributes to social well-being. By addressing regional disparities, fostering talent development, and ensuring responsible AI deployment, China can position itself as a global leader in the intelligent economy, paving the way for a more resilient and equitable industrial future.

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