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Is "Intelligence" More Capable of Promoting the Development of the Tertiary Industry? — Analysis of the Impact of Artificial Intelligence on Different Categories of Industries

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Abstract: In the new scientific and technological revolution round, artificial intelligence (AI) technology has become a key leading force for industrial change. Research shows that AI not only promoted technical transformation and industry upgrades but also played a significant role in the rapid development of emerging industries. Based on the installed number of industrial robots and the industrial data by the National Bureau of Statistics, this study establishes a theoretical framework with the econometric model and compares the impact of AI on different categories of industries through empirical analysis. Our results show that AI not only promotes economic growth but also plays a key role in promoting the tertiary industry. Hence, optimization of industrial structure and economic upgrade can be induced.

Keywords: Artificial intelligence; Tertiary industry; Industrial upgrade; Economic growth

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1. Introduction

Artificial Intelligence (AI) is a new technical science that applies theories, methods, technologies, and application systems to simulate, extend, and expand human intelligence. It attempts to understand the essence of intelligence and produce a new intelligent machine that can respond like human intelligence. In the new round of technological revolution, AI technology has become a key force to lead our industrial changes. As a result, research on AI has increased dramatically in recent years, and become mainstream in academic and professional explorations.

According to the data, artificial intelligence has a significant role in promoting the transformation of traditional industries. For example, in the past, heavy scientific and engineering calculations were to be

undertaken by the human brain. However, computers can be a substitution nowadays, as they can not only complete such calculations but also perform faster and more accurately than human beings. On the other hand, for the development of emerging industries, AI has also played a significant role. Driven by interaction among the Internet, big data, super-computing, and cognition-related technologies, artificial intelligence has accelerated its own development, especially in the paradigm of "Intelligence +" which is widely used in manufacturing, transportation, medical research, and so on. Some factories process highly automatically, greatly improving the efficiency of manufacture.

AI has induced changes in the socio-economy, industrial structure, and production methods. However, literature analyzing and comparing the industrial data of AI is rather limited. From the perspective of labor force structure, analyzing the impact of AI on different industries helps us to introduce employment-related policies so that we can guide the use of AI to promote the process of industrial development. Additionally, to make use of our rapid development of AI in recent years, the relevant mechanism for the changes in the labor market and enterprise structure needs to be further explored. Therefore, our study focuses on the impact of artificial intelligence on different industries in China to fill this research gap with empirical evidence.

In general, this paper focuses on whether AI has different impacts on different industries in China, and which industry recorded a more significant impact. This exploration not only helps to grasp the development trend of the employment market in different industries but also has essential significance in the subsequent optimization of labor resource allocation. Compared with previous studies, this paper focuses on the analysis of the impact of AI technology on different categories of industries in China, aiming to reveal the deep implication of how technology reforms the labor market, what kinds of employment opportunities and challenges it brings, whether employment opportunities exist for new positions, etc. Meanwhile, the study also discusses the problems encountered by AI during the development of different industries with our results in empirical study.

2. Literature review

With the continuous breakthrough of new technologies, the acceleration of artificial intelligence has expanded the innovative applications in different industries, improved productivity for enterprises, reduced operating costs, and given rise to new industries with innovation. Such technical changes also promoted the transformation and upgrade of traditional industries. Therefore, as an important driving force of the current scientific and technological revolution, AI has attracted extensive attention from many scholars and professionals. The impacts and opportunities it brings to the industry have been widely discussed in recent years. Crevier summarized the history of the development of AI and pointed out that AI will lead to the development of science and technology [1]. Peres *et al.* conducted a systematic review of the industrial AI literature, focusing on its application in real manufacturing environments, and propose that AI can assist entrepreneurs in decision-making through its data-driven predictive analytics, and help companies to meet the challenges encountered in digital transformation [2]. Long pointed out that the development of AI promotes the improvement of labor productivity as it improves working efficiency [3]. It also creates additional jobs as it increases the number of technical labor employment due to the development of emerging industries. In sum, AI creates new career fields such as machine learning engineers, data scientists, and AI strategy consultants. These positions require a higher level of skills and innovation.

Generally, AI not only improves productivity but also plays an important role in creating new industrial

structures. However, the impact of AI on the economy and industry is not entirely positive, but rather two-sided. Despite the many positive effects of AI, its negative impact on traditional employment cannot be ignored. Wang *et al.* have shown that AI technology has a "two-sided" effect on labor employment, i.e., a positive creation effect and a negative substitution effect [4]. Spitz-Oener mentioned that the development of information technology has a significant substitution effect on the employment of middle-skilled laborers, whose work tends to be more repetitive [5]. This substitution is mainly significant for those highly repetitive and standardized jobs, for example, in the manufacturing industry. Moreover, the empirical analysis of Cai and Huang showed that when the productivity growth driven by AI technology is lower than 0.0282, every 1% increase in the use of AI technology will correspondingly reduce the share of manufacturing employment by 0.124% [6].

Furthermore, there are not many comparative studies on the impact of AI on different industrial sectors. Chen showed that AI significantly replaces production staff in primary and secondary industries, but it has a weaker replacement for some sectors in the tertiary industry, such as researchers and technicians [7]. This is one of the few studies comparing industrial differences. To summarize, most of the existing literature separately focused on the impact of AI development on the industrial economy and other aspects, and these studies are normally based on foreign data and cases. For the differences in the impact of AI on different categories of industries, there are relatively few studies. This study emphasizes this question and serves as a supplement to the gap in research.

3. Research methodology

3.1. Data sources and research hypotheses

Although Chinese artificial intelligence is still in the stage of preliminary industrialization, the development speed in the past 10 years has been rather rapid. In 2016, the stock of industrial robots in China jumped to the first place in the world, which became a milestone in industrial development. In 2019, the number of industrial robots' installations and production ranked first in the world. Based on the perspective of labor force structure, our research selected the Chinese provincial robot data from 2013-2022 on the latest Statistical Yearbook published by the National Bureau of Statistics, and those data for the development of each industry. We explore our question through the empirical model. The specific data and statistical descriptions are as follows.

Table 1. Industrial data and industry-related data, 2013-2022

Reference indicator	Industrial robot installations	Primary industry-added value	Secondary industry-added value	Tertiary industry-added value
2013	37,000	53,028.1	261,951.6	277,983.5
2014	57,000	55,626.3	277,282.8	310,654.0
2015	69,000	57,774.6	281,338.9	349,744.7
2016	97,000	60,139.2	295,427.8	390,828.1
2017	156,000	62,099.5	331,580.5	438,355.9
2018	155,000	64,745.2	364,835.2	489,700.8
2019	145,000	70,473.6	380,670.6	535,371.0
2020	176,000	78,030.9	383,562.4	551,973.7
2021	275,000	83,216.5	451,544.1	614,476
2022	290,000	88,345.1	483,164.5	638,697.6

Table 2. Statistical descriptive analysis, 2013-2022

Variable	Mean	Standard deviation	Minimum	Maximum
Industrial robot installations (units)	14.82	9.36	3.7	29.0
Gross national product, GNP (100 million yuan)	854,507.1	202,212.4	592,963.2	1,210,207.2
Primary industry added value, PI (100 million yuan)	67,377.1	13,360.4	53,028.1	88,345.1
Secondary industry added value, SI (100 million yuan)	353,535.0	75,843.5	261,951.6	483,164.5
Tertiary industry added value, TI (100 million yuan)	435,080.1	122,737.1	277,983.5	638,697.6

From the descriptive statistics, it can be seen that the number of industrial robots in China implies the level of artificial intelligence has grown significantly between 2013 and 2022. Simultaneously, the value added of the primary, secondary, and tertiary industries all showed significant growth trends, suggesting that the development of AI may have had a positive impact on the rapid growth of these industries. In addition, the added value in the tertiary industry grew the fastest, which may reflect the importance of service and information technology in promoting economic development.

3.2. Research design and empirical results

For the role of artificial intelligence, this paper puts forward the following hypotheses: Firstly, artificial intelligence has a promoting effect on all three major industries in China. Secondly, artificial intelligence has a lower impact on China's primary industry. To test the impact of artificial intelligence on different industries in China, the following linear regression model is established:

is the value added by different industries. represents the primary industry, secondary industry, and tertiary industry respectively. is the amount of industrial robots installed in China, representing the indicators related to the development of artificial intelligence. is the constant term, representing the benchmark value of Y when the installed quantity of industrial robots is zero. is the regression coefficient for the number of industrial robots, which represents the impact of each unit increase in the installation of industrial robots to the added value of the industrial outcome.

The values of the parameters from linear regression analysis are estimated using Eviews with the least squares (OLS) method, and the results are presented in the table below.

Table 3. Linear regression results of output value of different industries

Variable name	k_1 coefficient	*T*-value	*P*-value
Primary industry-added value	0.135254	9.056822	0.0000
Secondary industry-added value	0.859495	13.38029	0.0000
Tertiary industry-added value	1.402680	9.104616	0.0000

The results in **Table 3** show that Chinese artificial intelligence has a significant positive impact on the added value of output for the primary, secondary, and tertiary industries. This result indicates that the development of artificial intelligence has a positive role in promoting the overall economy. In particular,

among the three major industries, the tertiary industry is most significantly affected, as the coefficient for this industry is 1.403 which is the largest among the three.

4. Conclusion and implications

This paper utilized Chinese data from 2013 to 2022 to study the impact of AI on different industries. We find that strong positive correlations exist between industrial robots installed and the added value of different industries. Additionally, among the three major industries, the value added of the tertiary industry has the fastest growth rate and accounts for an increasing proportion of the total Gross Domestic Product (GDP), reflecting that AI not only promotes economic growth but also plays a key role in promoting the optimization of industrial structure and economic upgrade.

According to this research findings, these are the following insights. China should vigorously promote the development of artificial intelligence, and increase technological innovation and research and development (R&D) investment, focusing on industrial structure adjustment by optimizing resource allocation. Through these measures, government can improve the productivity and service quality of various industries. At the same time, government officers can also strengthen the synergistic effect of the industrial chain by making use of the development opportunities brought about by AI technology. This will help to promote the high-quality development of each industry and further enhance the GDP growth.

Disclosure statement

The authors declare no conflict of interest.

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