A Quantitative Analysis Study on the Impact of Artificial Intelligence Technology on the Labor Market

Yunxuan Zhao

University of Waterloo, Waterloo, N2L 3G1, Canada

Abstract. This study focuses on the impact of artificial intelligence (AI) technology on the labor market. By employing quantitative research methods such as panel data analysis and Ordinary Least Squares (OLS) regression model, and utilizing unbalanced panel data of 31 provincial-level administrative regions in China from 2010 to 2022, it empirically examines the associations between the level of AI technology and various indicators of the labor market. In this study, the "fixed asset investment in the information transmission, computer services, and software industry across the society" is used as an indicator to measure the development level of AI. The employment numbers (subdivided into the number of employed persons in urban units and rural enterprises) is taken as the core variable. Meanwhile, the per capita disposable income of residents (distinguished between urban and rural areas) is selected as a proxy variable for the salary level, and the regional gross domestic product is introduced as a control variable. The study finds that AI technology has, to a certain extent, promoted the overall growth of employment, but has aggravated the polarization phenomenon of the employment structure and had a substitution effect on rural labor. At the same time, AI technology has significantly raised the overall salary level of the labor force without leading to salary polarization. Based on the above findings, this study puts forward policy suggestions such as strengthening labor skills training, promoting the upgrading of industrial structure, and improving the social security system, in order to cope with the challenges and opportunities presented by technological progress.

Keywords: Artificial Intelligence (AI) Technology; Labor Market; Employment Structure; Salary Level.

1. Introduction

With the rapid development of artificial intelligence (AI) technology, its applications have been widely integrated into various fields such as smart voice assistants, autonomous driving, precision medicine, and personalized education, profoundly impacting the global economic landscape and social structure. Against this backdrop, exploring the impact of AI technology on the labor market has become a significant topic in academic research [1]. As the core of economic activities, the stability and development of the labor market are crucial to socio-economic prosperity. Current research on the impact of AI technology on the labor market mostly focuses on theoretical aspects, while systematic and quantitative empirical research in China, a rapidly developing economy, remains insufficient [2]. This study aims to fill this research gap by conducting an in-depth analysis of the specific impacts of AI technology on the employment level, the salary level, and the employment structure. By adopting quantitative research methods such as panel data analysis and Ordinary Least Squares (OLS) regression models, and utilizing unbalanced panel data from 31 provinces in China, this study constructs an econometric model to empirically test the correlation between the level of AI technology and various indicators of the labor market. This research expects to not only reveal the mechanism of AI technology's influence on the labor market but also provide a scientific basis for policy-making, promoting the healthy, stable, and sustainable development of China's labor market.

2. Overview of AI Technology and the Labor Market

2.1 Basic Concepts and Development History of AI Technology

AI technology, as a key branch of computer science, is dedicated to simulating and expanding human intelligence, enabling computer systems to perform complex tasks. Its development began with the proposal of the Turing Test in the 1950s. Early research focused on logical reasoning, search algorithms, and natural language processing, but system functionalities were relatively basic due to limited computational capabilities. In the 1970s, AI encountered technical bottlenecks and funding shortages, entering a winter period. In the 1980s, the rise of expert systems led to a revival of AI, with initial successes in medical diagnosis, financial analysis, and other fields. Entering the 21st century, advancements in computational capabilities and the emergence of big data facilitated breakthroughs in machine learning, deep learning, and neural networks, accelerating the commercialization of AI technology (see Figure 1)[3]. Currently, AI demonstrates powerful data processing capabilities, with deep convolutional neural networks achieving human-level performance in image recognition and speech recognition. Natural language processing technologies such as GPT-3 excel in text generation and translation. Significant progress has also been made in computer vision, robotics, and biometric technologies [4]. AI technology is widely applied in various industries such as autonomous driving, healthcare, finance, and education. For instance, autonomous driving technologies from Tesla and Google Waymo, as well as AI-assisted medical diagnosis, demonstrate the immense potential of AI technology, providing a rich empirical foundation for research on the labor market.

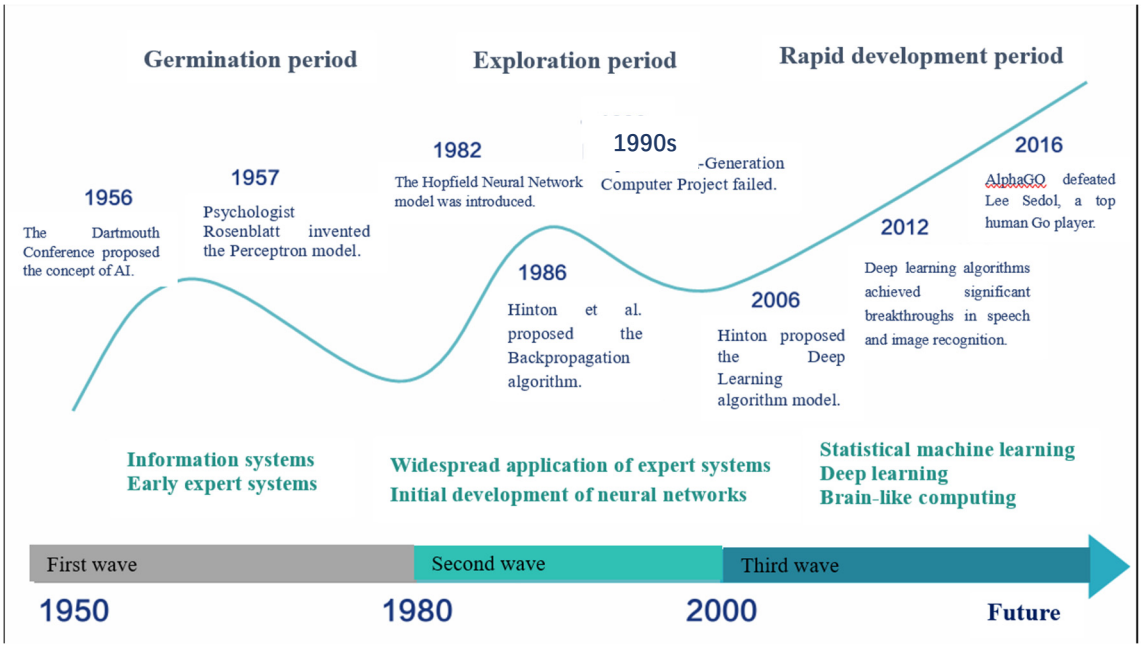

Figure 1. Timeline of the development of AI

2.2 Basic Concepts and Characteristics of the Labor Market

The labor market, as a core component of the economic system, is defined as the aggregate of transactions through which the supply and demand sides of labor effectively allocate resources through market mechanisms. This market consists of two primary elements: laborers (the supply side) and employers or enterprises (the demand side), relying on market mechanisms such as salaries and employment conditions to facilitate resource mobility. Its operational mechanisms encompass information dissemination, matching, negotiation, and contract signing, ensuring efficient allocation of labor resources. Currently, the labor market exhibits characteristics of diversification and dynamism. Technological advancements and industrial restructuring have driven an increase in labor demand in emerging industries such as information technology and artificial intelligence, while

demand in traditional manufacturing has relatively declined, triggering structural changes (see Figure 2). Globalization has accelerated international labor mobility, enhancing market diversity. However, this process has also exposed issues such as skill mismatches, employment instability, and labor discrimination, posing challenges to the healthy development of the market. Skill mismatches are particularly prominent, with a surge in demand for high-skilled talent and an excess of low-skilled or outdated-skilled laborers, leading to an imbalance between supply and demand and increasing the difficulty of employment. While flexible forms of employment such as informal employment and short-term contracts increase opportunities, they also exacerbate employment instability and risks. Governments, businesses, and laborers must work together to promote the sustained and healthy development of the labor market through measures such as vocational training, the improvement of employment policies, and the optimization of the industrial structure.[4]

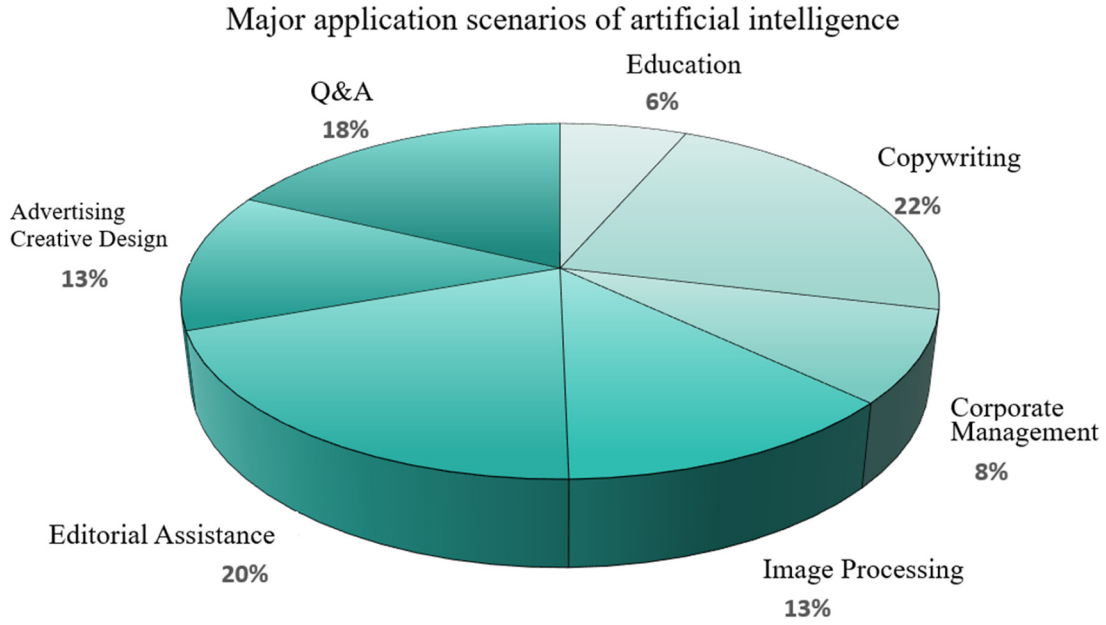

Figure 2. Major application scenarios of AI

2.3 Theoretical Basis for the Impact of AI Technology on the Labor Market

Classical economic theories, such as Ricardo's labor theory of value, have already revealed the potential impact of technological progress on the labor market. Technological advancements, while enhancing production efficiency, may also render specific labor skills obsolete, thereby triggering structural adjustments in the labor market. The neoclassical growth theory emphasizes technological progress as the core driving force of economic growth, necessitating flexibility in the labor market to address the labor demand of emerging industries [5]. In this context, constructing a theoretical framework for the impact of AI technology on the labor market is particularly significant. The rapid development of AI technology has not only significantly improved production efficiency but also profoundly reshaped the division of labor and employment structure. In manufacturing, for example, the widespread application of intelligent robots has drastically reduced low-skilled labor positions, while high-skilled positions such as data analysis and algorithm development have continuously emerged. This change necessitates rapid adaptation of the labor market, through vocational training and skill upgrading, to achieve reasonable labor mobility and efficient allocation. The widespread application of AI technology also poses new challenges, such as exacerbated skill mismatches, employment difficulties for low-skilled laborers, and a shortage of high-skilled talent, which may exacerbate polarization in the job market and increase the risk of social inequality. The construction of a theoretical framework must comprehensively consider these practical factors, deeply explore the multidimensional impact of AI technology on the labor market, and provide a solid scientific basis for policy formulation.

3. Quantitative Analysis of the Impact of AI Technology on the Labor Market

3.1 Data Sources and Sample Selection

This study employs panel data from 31 inter-provincial administrative regions in China spanning from 2010 to 2022. The data sources include the *China Statistical Yearbook* and relevant industry research reports, ensuring the completeness and representativeness of the sample. The "fixed asset investment in information transmission, computer services, and software industry across the society" is selected as an indicator to measure the level of AI development, effectively revealing the investment intensity in the field of AI across regions. The core variable of the study is the employment numbers, which is subdivided into the number of employed persons in urban units and rural enterprises, to explore the impact of technology on the employment structure in different regions. Meanwhile, per capita disposable income of residents (differentiated by urban and rural areas) is chosen as an alternative variable to assess the effect of AI technology on the salary level and polarization phenomena. To control the potential influence of regional economic development levels on the results, regional gross domestic product is introduced as a control variable. This comprehensive data framework not only provides detailed support for the transformation of China's labor market in the era of AI but also, through the continuous growth of investment in the information transmission, computer services, and software industry reflected in the latest statistical data, along with changes in employment numbers and the salary level, collectively demonstrates the actual impact of AI technology on the labor market. This provides a scientific and comprehensive basis for policy formulation.

3.2 Variable Measurement and Model Construction

In studying the impact of AI on the labor market, accurate measurement of key variables is fundamental to ensuring the quality of the research. Core variables such as the level of AI development, employment numbers, and the salary level have been rigorously defined and measured. The level of AI development is indicated by "fixed asset investment in the information transmission, computer services, and software industry across the society", which effectively reflects the investment intensity and development trend of various regions in the field of AI technology. The employment numbers is subdivided into the number of employed persons in urban units and rural enterprises to comprehensively capture the potential impact of AI technology on different employment markets. The salary level employs per capita disposable income as a proxy variable, further differentiated into per capita disposable income for urban and rural residents, to deeply analyze the role of AI technology on the salary structure and income distribution patterns.

Based on the aforementioned variable measurements, the study constructs an OLS (Ordinary Least Squares) regression model to explore the specific impact of the level of AI development on employment numbers and the salary level. In the model specification, the key factor of regional gross domestic product is controlled to eliminate potential interference from regional economic development levels on the research results. The specific form of the regression model is as follows:

For employment numbers (employment): $employment=a_0+a_1AI+a_2Size+\varepsilon1$
For the salary level (Salary): $Salary=a_0+a_1AI+a_2Size+\varepsilon2$

In these equations, *AI* represents the level of artificial intelligence development; *Size* represents regional gross domestic product; a_0 is the intercept term; a_1 and a_2 are the coefficients corresponding to the respective variables, and ε1 and ε2 are the random error terms.

The choice of the OLS regression model is based on its advantage in handling linear relationships and its widespread application in economic research. Through this model, a quantitative analysis of the direct impact of the level of AI development on employment numbers and the salary level can be conducted, while taking into account the role of regional gross domestic product as a control variable, ensuring the accuracy and robustness of the research results. This model framework not only aids in

deeply understanding the specific impact mechanisms of AI technology on the labor market but also provides a scientific basis for policy-makers to make decisions.

3.3 Analysis of Empirical Results

Descriptive statistical analysis of the natural logarithms of each variable was conducted using SPSS 20.0 software, revealing the level of AI development and characteristics of the labor market in China (see Table 1).

Table 1. Descriptive statistics of variables

	N	Minimum value	Maximum value	Mean value	Standard deviation
Fixed asset investment in the information transmission, computer services, and software industry across the society	217	0. 580	661. 860	121. 488	105. 594
Total employment	217	58. 970	5595. 380	1269. 379	996. 654
Urban employment	217	17. 530	986. 470	206. 984	163. 429
Rural employment	217	3424. 700	25520. 400	9681. 671	4152. 806
Per capita disposable income of residents	217	507. 460	80854. 910	20076. 348	16130. 299
Valid N (list status)	217				

As shown in Table 1, the maximum and minimum values of “fixed asset investment in the information transmission, computer services, and software industry across the society” are 661.860 and 0.580, respectively, highlighting the uneven development of AI in China. This also confirms the necessity and feasibility of analyzing the impact of AI on the labor market across provinces. The mean value of 121.488 and the standard deviation of 105.594 indicate that the development of AI in China is not only rapid but also shows a strong momentum. The standard deviation of rural employment numbers reaches 4152.806, reflecting significant fluctuations in rural employment numbers across provinces and over time.

Further analysis of the regression results reveals the correlation between the level of AI development and employment numbers (see Table 2). AI is positively correlated with total employment and urban employment, with coefficients of 56.972 and 30.387, respectively, and both are statistically significant. However, it is negatively correlated with rural employment (-0.571), indicating that while AI technology has promoted employment overall, it has also had a substitution effect on rural labor, exacerbating polarization in the labor market.

Table 2. Regression results of the level of AI development and employment numbers

Variables	Overall effect	Urban area	Rural area
Constant term	56. 972**	30. 387***	20. 108
	(2. 111)	(3. 236)	(1. 358)
Level of AI development	0. 680**	0. 244***	- 0. 571***
	(22. 571)	(2. 649)	(-3. 935)
Regional gross domestic product	0. 056***	0. 007***	0. 015***
	(32. 504)	(12. 155)	(15. 532)
Adjusted R-squared	0. 939	0. 727	0. 672
F-value	1672. 466***	288. 334***	221. 836***

Note: *** indicates significance at the $p < 0.01$ level; ** indicates significance at the $p < 0.05$ level, and * indicates significance at the $p < 0.1$ level.

Table 3 presents the relationship between the level of AI development and salary income. The results show that AI is positively correlated with salary income (90.517), significantly increasing the overall salary level of the labor force, reflecting the positive impact of technological progress on living standards. Notably, AI not only raises the income level of urban labor but also promotes the growth of rural labor income, indicating that technological development has not led to salary polarization.

Table 3. Development level of AI and salary income

Variables	Overall effect	Urban area	Rural area
Constant term	20030. 172**	21013. 607***	6865. 952***
	(14. 006)	(29. 114)	(18. 080)
Level of AI development	90. 517**	33. 624***	18. 150***
	(6. 459)	(4. 754)	(4. 878)
Regional gross domestic product	- 0. 082	0. 052	0. 030
	(-0. 895)	(1. 130)	(1. 249)
Adjusted R-squared	0. 296	0. 291	0. 3308
F-value	46. 464***	45. 387***	49. 054***

Note: *** indicates significance at the $p < 0.01$ level; ** indicates significance at the $p < 0.05$ level, and * indicates significance at the $p < 0.1$ level.

These findings not only deepen the understanding of the relationship between AI and the labor market but also provide a scientific basis for policymakers to address the challenges and opportunities presented by technological progress.

4. Conclusion and Policy Suggestions

This study reveals the profound impact of AI technology on the labor market, finding that while technology has promoted overall employment growth to some extent, it has significantly exacerbated the polarization of the employment structure, with a surge in demand for high-skill jobs and low-skill jobs facing substitution risks. Technological innovation has driven the rise of emerging industries such as data analysis and machine learning, providing vast employment opportunities for high-skilled talent while also posing transformation or unemployment challenges for low-skilled labor in traditional industries. Overall, AI technology has raised labor salaries but also widened income disparities between urban and rural areas, industries, and skill levels. In response, this study proposes the following policy recommendations: The government should increase investment in labor skills training, especially for low-skilled labor; promote industrial structure upgrading, encourage enterprises to adopt new technologies to create high-skill jobs, and guide the transformation of traditional industries; improve the social security system to provide basic security and reemployment services for unemployed individuals. Despite the achievements of this study, there are limitations such as insufficient comprehensiveness of the data sample. Future research should broaden data sources, adopt more refined analytical methods, and continuously monitor and deeply investigate the long-term impact of AI technology on the labor market, industry and regional differences, and the effects of policy interventions, providing scientific and comprehensive evidence for policy formulation.

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