Exploring The Impact Path of Artificial Intelligence Development on Income Distribution Equity

Yiran Liu *

School of Economics, Capital University of Economics and Business, Beijing, China

* Corresponding Author Email: 32022030097@cueb.edu.cn

Abstract. The rapid development of artificial intelligence has opened up an unprecedented window of opportunity, but at the same time, it has also triggered a series of complex and serious challenges. This technology is penetrating and reshaping every level of economic and social structure with unprecedented depth and breadth, profoundly changing people's production mode and life mode. This study focuses on the specific mechanisms of AI's impact on global income distribution equity and finds that it works through three core pathways: substitution and creation effects, skill bias, and capital bias. Ai is not only reshaping the employment landscape by replacing low-skilled labor jobs and creating new occupations, it is also further widening the income gap between high-skilled labor and low-skilled labor, as well as owners of labor capital, because of its inherent skill preferences and capital preferences. The interwoven effect of these mechanisms, while driving rapid economic growth, has also exacerbated income inequality within society.

Keywords: Artificial intelligence; income distribution; equity.

1. Introduction

In the context of accelerating globalization and rapid technological progress, the importance of income distribution equity as an important yardstick for measuring the healthy development of the social economy is becoming increasingly prominent. Income equity aims to ensure that the income gap among members of society remains within a reasonable range and to ensure that every member of society can benefit from economic growth, reduce the wealth gap, and thus improve the overall well-being of society. Therefore, fair income distribution is not only related to individual well-being and quality of life, but also the cornerstone of maintaining social stability and sustainable development. At the same time, artificial intelligence, as one of the most transformative technologies of the 21st century, is penetrating various fields of social economy at an unprecedented speed and breadth, and its impact on economic structure, employment patterns, and income distribution patterns is becoming increasingly significant. Therefore, an in-depth exploration of the intrinsic connection and interactive mechanism between the development of artificial intelligence and income distribution equity is of great significance for guiding policy formulation, optimizing economic structure, and promoting social harmony.

In recent years, numerous scholars both domestically and internationally have conducted extensive and in-depth research on this topic, covering multiple dimensions such as theoretical exploration, empirical analysis, policy recommendations, and technical ethics. They have achieved fruitful research results and adopted diverse research methods. However, despite significant progress in existing research, systematic and comprehensive literature review is still relatively scarce, which to some extent increases the difficulty for subsequent researchers to search for relevant literature, understand the research context, and clarify research directions.

Given this, this article aims to systematically sort out and comprehensively analyze the current research results on the development of artificial intelligence and income distribution equity. Summarize the impact mechanism of artificial intelligence development on income distribution equity from multiple dimensions and provide prospects for future research directions. This provides a more convenient reference path for future researchers and promotes the in-depth development of research in this field, contributing to the construction of a more equitable, inclusive, and sustainable socio-economic system.

2. Concept Definition and Measurement Standards

2.1. Artificial Intelligence

Broadly speaking, artificial intelligence is defined as the ability to enable agents to achieve goals in complex environments [1]. At the functional level, artificial intelligence refers to synthetic intelligence or computer system intelligence that simulates intelligent functions. It can be specifically divided into reactive AI systems, limited memory AI systems, and AI systems with self-awareness, with their application in real life decreasing in order. On the technical level, it covers key technologies such as natural language processing, machine and deep learning, artificial neural networks, human-computer interaction, and computer vision. In economic research, artificial intelligence is mostly regarded as an important tool for improving production efficiency, reducing costs, and optimizing resource allocation. Its essence is a technological advancement, manifested in various tangible (robots) and intangible (algorithms, systems, etc.) technological innovations in the process of deep integration with the industry.

The rapid development of artificial intelligence technology not only affects macro areas such as economic growth, global trade, income distribution, and industrial structure but also is closely related to the economic life of micro entities such as enterprises and residents. However, there is currently no unified consensus on the measurement standards for the development level of artificial intelligence in current research.

In preliminary research, researchers generally tend to use the progress of a specific branch of artificial intelligence as an alternative indicator to indirectly reflect and evaluate the impact of the overall development of artificial intelligence technology on the economy. If there is a viewpoint that the number of patent applications and authorizations in the field of artificial intelligence can serve as key indicators, intuitively reflecting the quality of the technology at the innovation level and its actual penetration and application breadth in various industries, and thus becoming an important basis for evaluating the overall development level of artificial intelligence [2]. Some argue that the net capital stock of computers, software, and electronic devices can represent the degree of technology introduction, indirectly reflecting the level of development of artificial intelligence [3].

Although a single evaluation indicator has the characteristics of clear meaning and easy data acquisition, its inherent limitations and one-sidedness in dealing with complex situations cannot be ignored. Therefore, through research and development, researchers have constructed a multi-index evaluation system from multiple dimensions such as technological innovation capability, enterprise development level, investment scale and financing capability, industrial chain development level, development environment status, and international influence to more accurately measure the development level of artificial intelligence. Stanford professor Shoham divided artificial intelligence activities into two categories based on their scale: research and industry and constructed an artificial intelligence index from dimensions such as technological performance, government support, and AI performance milestones. Some scholars also use indicators such as market capacity and employment-population, propensity score matching method to construct virtual variables, and digital index calculated by the World Competitiveness Center to measure the level of artificial intelligence development [4].

In summary, researchers' research on measuring the level of development of artificial intelligence has evolved from a single dimension to a multidimensional evaluation system and has continued to deepen, providing important support for the healthy development of artificial intelligence and research results in related fields.

2.2. Fair Income Distribution

The theory of income distribution equity focuses on the distribution of economic output between individuals or groups, as well as the impact of this distribution on socio-economic development. This theory covers multiple branches such as welfare economics and contract theory, and balances the relationship between fairness and efficiency in the policy-making process. This fairness is not only

reflected in the initial distribution process where the owners of production factors receive income according to their contributions, but also in the government's regulation of income through taxation, social security, and other means during the redistribution process. From an economic perspective, income distribution equity aims to ensure relative income equality among members of society, so that everyone can share the fruits of economic and social development. It can not only stimulate the enthusiasm and innovation of social members but also ensure the stable operation of society.

In existing academic research, researchers have proposed methods to measure income distribution fairness from various perspectives. Among them, the Gini coefficient and Theil index are the most used methods. However, some researchers have improved the commonly used methods to address their inapplicability and shortcomings in certain countries or scenarios, thus proposing new methods. Guo Ping, Peng Niya, and Hou Dun proposed an average growth point method based on the equal Gini coefficient line in "Measuring Income Distribution Equity: A Study on the Average Growth Point Method Based on the Equal Gini Coefficient Line". They believe that under the condition of an equal Gini coefficient line, the larger the horizontal axis value of the average growth point (not exceeding 0.8), the more ideal the income distribution it represents [5]. This method has demonstrated its effectiveness through empirical analysis of the fair distribution of urban residents' income in Hunan Province in 1998 and 2005, as well as in China in 2005 and 2007. Wang Wulei and Wang Mengjia also proposed in their 2012 book "Statistical Inference on Measuring Income Distribution Inequality" the limitations of using the Theil index to evaluate macro distribution fairness, and conducted reliability tests on it using Monte Carlo simulations, verifying that the asymptotic distribution method is still applicable in small sample situations. Secondly, they proposed Bootstrap and permutation testing methods suitable for small samples [6].

Meanwhile, some researchers may also propose completely innovative measurement methods. For example, Varian proposed a definition of fairness based on individual utility and welfare in his 1976 paper "Fairness, Jealousy, and Efficiency". He believes that a fair distribution state should eliminate jealousy towards others for everyone [7]. Varian's definition of fairness relies on the comparison and judgment of utility or welfare between individuals, which, although subjective, provides a theoretical basis for comparing the degree of fairness in different distribution states. Foley emphasizes in his definition that the sufficient and necessary condition for fair distribution is that each person in the society prefers their own consumption bundle over that of any other person in the society [7]. This definition also relies on an individual's subjective utility evaluation, but introducing the concept of 'jealousy', makes fair judgments more specific and actionable.

In summary, researchers have proposed various methods to measure income distribution equity, ranging from the Gini coefficient and Theil index to Varian and Frey's utility comparison method, then to the average growth point method based on equal Gini coefficient lines, and finally to the asymptotic distribution method of Theil index. These studies have continuously promoted people's understanding and evaluation of income distribution equity. Although each method has its limitations, they collectively provide an important reference for policymakers to promote more equitable income distribution.

3. The Impact Mechanism of Artificial Intelligence Development on Income Distribution Equity

3.1. Substitution Effect and Creation Effect

Artificial intelligence has reshaped the job structure through both substitution and creation effects. On the one hand, the substitution effect of artificial intelligence is reflected in the differences in the risks of different types of positions being replaced. Specifically, low-income traditional positions with repetitive work content and no need for deep thinking are more susceptible to being replaced by the impact of artificial intelligence technology. Deng Zhou and Huang Yana found that artificial intelligence has a more significant substitution effect on employment in three fields. The first is the employment position of simple and repetitive mental labor; The second is moderately complex and

repetitive mental labor employment positions; The third is employment positions that combine physical and mental abilities [8]. Fan Runhua believes that there is a risk of being replaced by artificial intelligence in routine and procedural jobs that require a single skill, such as data processing, copywriting, legal contract review, auditing, medical image inspection, and other positions, which generally have low-income levels [9]. On the contrary, high-income positions that emphasize social and innovative skills are more likely to be retained [10], such as high-tech industries and high-end service industries.

On the other hand, the development of artificial intelligence has also created new job opportunities and expanded the workload of existing positions. The emergence of new tasks will increase the demand for labor, thereby offsetting the substitution effect to some extent and expanding the scale of employment. The World Economic Forum held in 2020 predicted that by 2022, the number of jobs in the field of artificial intelligence will nearly double, with high-skilled and managerial positions being the majority, and these positions also have higher income levels. Existing domestic data also show that China's AI industry is developing rapidly at this stage, and the demand for talent in the field of AI is surging in a short time. At present, the effective talent gap in China's AI industry is 300000. It can be seen that the creative effect of artificial intelligence has begun to play a role in China's job market, which indirectly reflects the substitution effect of artificial intelligence on low-income traditional positions.

From this, it can be seen that artificial intelligence has created more high-income jobs while replacing single and repetitive low-income positions, thereby changing the employment structure of the labor market and affecting income distribution fairness.

3.2. Skill Bias

The history of economic development in developed countries shows that technological progress is skill-biased. Compared to low-skilled and unskilled labor, technological progress tends to favor high-skilled labor [11]. This trend not only increases the demand for high-skilled labor in the job market but also drives the wages of high-skilled labor to continue to rise relative to those of non-high-skilled labor, resulting in a sustained skill premium.

According to the theory of skill-biased technological progress, artificial intelligence, as a form of technological advancement, has increased the demand for highly skilled labor, resulting in a skill wage premium and thus increasing the skill income gap. Yin Zhenyu and Wu Chuanqi believe that machines have higher production efficiency and lower production costs, and in the future, personnel engaged in simple, low-skilled production and services will be completely replaced by robots [12]. Feng Xueying also pointed out that the widespread application of artificial intelligence technology has promoted the development of high-skilled and high-value-added industries, where workers and business owners can obtain more technological dividends and enjoy higher income growth. In contrast, low-skilled workers and traditional industry practitioners find it difficult to share technological dividends, and their income growth rate is relatively slow, even facing the risk of income reduction [13]. Jiang Qi, Li Jizhi, and others conducted theoretical explanations and empirical analysis to deeply explore the reasons why the skill bias of artificial intelligence affects wages. The conclusion is that the application of artificial intelligence generally improves the wage level of labor, but due to the existence of skill bias, knowledge intensity, and the "dual" nature of capital-labor, the employment creation effect of artificial intelligence is more inclined towards the highly educated group, leading to an imbalance in the income share between high and low educated labor, and further exacerbating the gap between education and wages [14]. Although artificial intelligence can achieve scale expansion by promoting current capital accumulation, it also reduces the relative marginal output level of low skilled labor, resulting in a lower proportion of low skilled labor employment in enterprises that utilize AI technology. As companies use artificial intelligence technology for a longer period, the proportion of low-skilled employment decreases, and their salary levels will gradually decrease [15].

In summary, due to the skill bias of artificial intelligence, its widespread application has led to an increase in labor market wages, but it has also exacerbated the income share imbalance and wage gap between high and low skilled labor, thereby promoting income inequality.

3.3. Capital Bias

The capital bias of technological progress means that technological progress can significantly improve the marginal productivity of capital, thereby promoting an increase in the share of capital income and a decrease in the share of labor income. Compared with previous technological advancements, artificial intelligence technology can not only replace physical labor but also replace mental labor, thereby exacerbating the gap in the proportion of labor and capital in the initial distribution [16]. Therefore, as the latest manifestation of technological progress, artificial intelligence has the characteristic of "bidirectional substitution" for human physical and intellectual strength. In a certain sense, its capital bias is extremely strong, which will exacerbate the imbalance of labor capital distribution. Based on this, some scholars have pointed out that the capital bias and bidirectional substitutability of artificial intelligence will lead to an increase in the net unemployment rate, gradually widening the income gap between capital and labor, and affecting income distribution fairness [17]. Compared to labor, capital has become more important and its share of income has increased.

At the same time, studies have shown that the capital bias of artificial intelligence is not only reflected in its substitution of labor but also its driving effect on capital deepening [18]. Under the application of artificial intelligence technology, enterprises tend to increase their capital investment in AI-related equipment, software, and data. These capital investments often require a large amount of capital, and large or capital-strong enterprises are more likely to make such investments. For example, large manufacturing enterprises will invest huge amounts of money in purchasing equipment, developing related artificial intelligence management systems, and obtaining a large amount of data resources to introduce advanced artificial intelligence production lines. This capital investment enables these enterprises to gain an advantage in market competition and obtain higher returns. However, due to limited funds, small and medium-sized enterprises find it difficult to keep up with the capital investment competition in artificial intelligence, resulting in squeezed market share and reduced operating income. This further widens the income gap between enterprises and affects the fairness of overall income distribution.

In addition, according to relevant research, the capital bias of artificial intelligence also affects income distribution fairness at the regional level [19]. Developed regions typically have advantages in attracting investment in artificial intelligence capital, such as good infrastructure, abundant high-quality talent resources, and favorable policy environments. Enterprises in these regions can quickly and massively apply artificial intelligence technology to achieve significant improvements in production efficiency, thereby increasing the overall income level of enterprises and regions. However, underdeveloped regions are relatively lagging in the introduction and application of artificial intelligence technology, which limits the development of enterprises and slows down the growth of workers' income, leading to further widening income gaps between regions and exacerbating income inequality.

4. Conclusion

This article summarizes the research results on the impact of artificial intelligence development on income distribution equity. In terms of conceptual definition and measurement standards, the concept of artificial intelligence has multiple perspectives in terms of broad, functional, and technological aspects. The measurement of its development level has gradually evolved from a single indicator to a multidimensional evaluation system. Fair income distribution encompasses the processes of initial distribution and redistribution, with commonly used measurement methods including the Gini coefficient, Lorenz curve, and new evaluation methods based on multiple

perspectives such as individual utility and welfare. In terms of the influencing mechanism, this article focuses on exploring three dimensions: substitution effect and creation effect, skill bias, and capital bias. Specifically, the substitution effect makes repetitive and low skilled positions easily replaced by artificial intelligence, while the creation effect generates new high-skilled positions, both of which jointly change the employment structure and affect income distribution fairness. The skill bias has increased the demand for highly skilled labor, leading to a premium in skill wages and widening income gaps. Capital bias is not only reflected in the substitution of labor but also promotes the deepening of capital. In addition, at the enterprise level, large enterprises are more likely to invest in artificial intelligence-related capital to gain advantages, while small and medium-sized enterprises are even more restricted, and the income gap between enterprises is constantly increasing. At the regional level, developed regions have faster application of technology and higher income, while underdeveloped regions lag, leading to widening regional disparities.

Looking ahead to the future, research can continue to deepen from the following aspects. Firstly, further improve the measurement system for the development level of artificial intelligence, so that it can more accurately and comprehensively reflect the degree of technological development and its comprehensive impact on the economy and society. Secondly, delves into the dynamic impact mechanism of artificial intelligence on income distribution across different industries and income groups. For example, pay attention to the income distribution changes in the early and mature stages of artificial intelligence applications in emerging industries, as well as the long-term impact path on low-income groups. Thirdly, research on strong policy guidance and institutional design. Explore how to formulate reasonable tax policies, labor market policies, and industrial policies to alleviate the problem of income inequality caused by artificial intelligence. For example, by regulating capital income through taxation, strengthening retraining and employment support for low skilled workers, guiding balanced industrial development, promoting more equitable and sustainable socio-economic development, and ensuring the fairness of income distribution while enjoying the benefits brought by advances in artificial intelligence technology.

References

[1] Russell S, Norvig P. Artificial intelligence: a modern approach (third edition). London: Pearson, 2012.

[2] Chao Xiaojing, Zhou Wenhui. Research on the impact of artificial intelligence on labor income share: theoretical explanation and empirical test from the perspective of skill bias. Research on Economics and Management, 2021, 42(02): 82-94.

[3] Jeff Borland, Michael Coelli. Are robots taking our jobs?. Australian Economic Review,2017, 50(4):377-397

[4] Chen Deyu, Tang Yonggang. Impact of artificial intelligence industry on regional economic development. Science and Technology Management Research, 2021, 41(02): 138-144.

[5] Guo Ping, Peng Niya, Hou Dun. Measurement of fair income distribution: a study on the average growth point method based on the equal gini coefficient line. The Theory and Practice of Finance and Economics, 2009, 30(05): 81-85.

[6] Wang Wulei, Wang Mengjia. Statistical inference of measuring income inequality in distribution. Statistics and Decision making, 2012, (01): 12-15.

[7] Xu Jiwang. Fair income distribution and its measurement standards. Economist,2001, (07):20-21+81.

[8] Deng Zhou, Huang Yana. Research on the employment impact of artificial intelligence development. Study＆Exploration, 2019(7): 99-106,175.

[9] Fan Runhua. A preliminary analysis of the impact of artificial intelligence development on the social employment situation. Contemporary Economy, 2018, (7): 18-19.

[10] Jiang Yonghong, Zhang Benxiu. Research on the mechanism and countermeasures of artificial intelligence's impact on income distribution. The Journal of Humanities,2021, (07):58-68.

[11] Autor D H, Dorn D. The growth of low-skill service jobs and the polarization of the US labor market. NBER,2013.

[12] Yin Zhenyu, Wu Chuanqi. The employment effect of artificial intelligence and its implications for China. Reformation & Strategy,2019,35(02): 90-97.

[13] Feng Xueying. The impact of artificial intelligence technology on the labor market and corresponding strategies. Internet Weekly,2024, (13):37-39.

[14] Jiang Qi, Li Jizhi, Ni Shuo. Will artificial intelligence exacerbate the educational and wage gap?. Financial Science,2024, (06):61-76.

[15] Xie Mengmeng, Xia Yan, Pan Jiaofeng. Artificial intelligence, technological progress, and low skill employment: an empirical study based on chinese manufacturing enterprises. Chinese Journal of Management Science, 2020, 28(12): 54-66.

[16] Chen Dong, Yao Di. Has artificial intelligence widened the wage gap between enterprises—— evidence from Chinese industrial enterprises. Economic Science, 2022, (03): 127-142.

[17] Zhao Tao, Zhang Zhi, Liang Shangkun. Digital economy, entrepreneurial activity, and high quality development: empirical evidence from Chinese cities. Managing the World,2020,36(10):65-76.

[18] Acemoglu D, Restrepo P. The race between man and machine: implications of technology for growth, factor shares, and employment. American Economic Review, 2018, 108(6): 1488–1542.

[19] Luo Changyuan, Wan Siyu. The impact of digital economy on income distribution and its response. China Opening Journal,2024,(04): 35-42.