

# Research on the Impact of Artificial Intelligence Application on Employment Polarization and Income Distribution Pattern

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**Abstract:** Taking artificial intelligence (AI) application as the research object, this paper constructs a theoretical framework and an empirical model to conduct an in-depth analysis of the mechanism and effect of AI on employment polarization and income distribution pattern. Based on cross-country panel data and econometric tests, combined with cases of typical industries and enterprises, this paper carries out a multi-dimensional and multi-level systematic study. The analysis finds that AI significantly affects employment structure and income distribution through such mechanisms as skill-biased technological change, industrial differentiation and occupational structure adjustment, automation substitution and new job creation. The results show that technological application intensifies the dual expansion of high-skilled and low-skilled positions and incomes, squeezes the space for medium-skilled employment and income, strengthens capital gains and fluctuates labor share, and diffuses the regional distribution pattern. Policy-wise, it is necessary to build a systematic framework covering educational adjustment, social security optimization and technology governance to mitigate the socio-economic challenges brought by AI.

**Keywords:** Artificial Intelligence; Employment Polarization; Income Distribution; Skill Premium; Regional Imbalance

## 1. Introduction

The rapid penetration and application of artificial intelligence technology are profoundly restructuring the structure of the global labor market and the mode of income distribution. This study aims to systematically explore how AI application exacerbates employment polarization – the trend of growth in high-skilled and low-skilled positions and shrinkage in medium-skilled positions – through mechanisms

such as skill bias, automation substitution and new business format creation, and further analyzes its impact on income inequality, changes in capital and labor income shares, and regional distribution patterns. Most existing studies focus on macro descriptions or partial effects, lacking an integrated analysis of internal transmission paths and multi-dimensional socio-economic consequences. Therefore, this paper will build an analytical framework integrating theoretical deduction, empirical test and case analysis to reveal its complex mechanism and provide a theoretical basis for responding to relevant socio-economic challenges[1].

## 2. Research Background and Theoretical Basis

### 2.1 Development History and Application Status of Artificial Intelligence Technology

The development of artificial intelligence has undergone a profound transformation from early symbolic logical reasoning to the current data-driven deep learning paradigm. The Dartmouth Conference in the mid-20th century laid its disciplinary foundation, and subsequent expert systems achieved limited success in specific fields but were constrained by knowledge acquisition bottlenecks[2]. At the beginning of the 21st century, with the accumulation of big data, the exponential growth of computing power and algorithm innovation, especially the breakthrough of deep learning in image recognition and natural language processing, AI has entered a new stage. At present, its application has rapidly penetrated from laboratories to all aspects of the economy and society, manifested as industrial robots and intelligent process automation in manufacturing, intelligent customer service, algorithm recommendation and fintech in service industries, and is gradually extending to complex cognitive tasks such as research and development and management. This extensive penetration not only

improves production efficiency but also fundamentally changes the nature and organizational form of the labor process, providing a realistic background for studying its macro impact on employment and income distribution. The unbalanced diffusion of technology and heterogeneous application depth across industries constitute the logical starting point for analyzing its differentiated socio-economic consequences[3].

## **2.2 Core Theoretical Framework of Employment Polarization and Income Distribution**

The theoretical origin of employment polarization and income distribution is mainly rooted in the theory of skill-biased technological change and the task model of work. Developed by scholars such as Acemoglu and Autor, the former emphasizes that technological progress is not neutral and tends to complement high-skilled labor and replace low- and medium-skilled labor, leading to the expansion of demand at both ends of the labor market and the shrinkage in the middle. The task model of work further refines the decomposition of occupations into a series of specific tasks, demonstrating that automation technology is more likely to replace programmed routine cognitive and physical tasks, which are precisely the core of medium-skilled occupations, while non-routine manual and abstract analysis tasks are relatively safe, corresponding to low-skilled and high-skilled positions respectively[4]. In terms of income distribution, theoretical concerns extend to functional distribution and scale distribution. Technological change may aggravate the imbalance between capital gains and labor income shares by increasing the marginal output of capital and technology-intensive production factors. Meanwhile, the skill premium obtained by high-skilled workers widens wage inequality. These classical theories provide an indispensable analytical framework and hypothesis basis for understanding the economic impact of AI as a general-purpose technology[5].

## **2.3 Review of Existing Research and Research Orientation of This Paper**

Existing literature has accumulated rich achievements on the impact of technological change on the labor market, but research on the new wave of artificial intelligence still has room for deepening. Numerous studies have

confirmed the existence of employment polarization in multiple economies and measured the degree of occupational exposure from the perspective of automation risk. In terms of income distribution, scholars have generally observed the trend of rising technology premium and fluctuating labor share[6]. However, existing discussions have several limitations: first, most studies stay at the level of macro correlation description or case analysis of specific industries, lacking systematic integration and empirical testing of multiple transmission mechanisms through which AI affects employment structure and income distribution; second, most analyses focus on the national level, with insufficient analysis of heterogeneous impacts within regions, industries and different groups; third, insufficient attention is paid to the dynamic process of AI indirectly affecting employment and distribution by giving birth to new business formats and business models. Based on this, the research orientation of this paper is to construct an analytical framework integrating direct impact and indirect feedback, and strive to empirically test the specific paths, intensity and conditional differences of AI's impact on employment polarization and income distribution pattern under a unified logic, so as to make up for the deficiencies of existing research in fine characterization of mechanisms and multi-dimensional heterogeneity analysis[7].

## **3. Mechanism of Artificial Intelligence's Impact on Employment Structure**

### **3.1 Skill-Biased Technological Change and Employment Polarization**

Artificial intelligence is essentially a technological change with significant skill bias, and its core impact mechanism lies in the asymmetric substitution and complementary effects on labor forces of different skill levels. Traditional automation technology mainly replaces physical and repetitive cognitive tasks with clear rules, while current AI based on machine learning and pattern recognition has expanded its capability boundary to many non-routine complex cognitive fields, such as data analysis, language understanding and even preliminary decision-making[8]. This makes medium-skilled jobs previously undertaken by medium-skilled workers, which are both procedural and cognitive, such as administrative clerks, accounting staff and intermediate

technicians, face a high risk of automation. At the same time, AI systems are deeply complementary to high-skilled professionals in the development, deployment, maintenance and high-level application links, strengthening the demand for computer scientists, engineers, senior analysts and managers. On the other hand, some low-skilled service positions are still difficult to be effectively replaced in the short term due to their highly non-standardized work content and reliance on interpersonal interaction and situational adaptation, such as nursing, cleaning and personalized retail. This technology's complementarity to high-skilled labor, deep substitution to medium-skilled labor and temporary retention of some low-skilled labor jointly constitute the direct technological driving force behind employment polarization – the phenomenon of growth in high-paid and low-paid positions and shrinkage in medium-income positions.

### **3.2 Industrial Differentiation and Occupational Structure Adjustment**

The impact of AI is not evenly exerted on all industries, and its penetration depth and application mode have significant industrial heterogeneity, leading to differentiated paths of occupational structure adjustment. In knowledge-intensive industries such as information technology, finance and professional services, AI mostly acts as an enhancement tool, deeply integrated with core businesses, generating a large number of new high-skilled positions related to algorithm development, data governance and intelligent system operation and maintenance, while replacing some medium-skilled positions in data processing, basic analysis and report generation, leading to the tilt of occupational structure within the industry to a higher skill level. In the manufacturing sector, intelligent robots and automated production lines continue to replace medium-skilled operators in traditional assembly, inspection and logistics links, and shift labor demand more to high-skilled directions such as robot programming and maintenance, flexible production scheduling and supply chain optimization, as well as a small number of low-skilled auxiliary positions that are difficult to automate. In contrast, in accommodation and catering, retail and some social service industries, the current application of AI is mainly reflected in optimizing management and marketing links,

with limited substitution for front-line service personnel, so the change of occupational structure is relatively gentle, but there may also be slight signs of polarization within due to the improvement of skill requirements for management positions. This impact model of industrial differentiation means that the macro employment polarization phenomenon is formed by the superposition of specific paths of occupational structure adjustment within different industries.

### **3.3 Automation Substitution and New Job Creation**

The impact of AI on employment structure is a two-way dynamic process including both substitution and creation. The automation substitution effect is direct and observable, manifested as algorithms and machines performing tasks originally completed by humans, leading to an absolute reduction in the number of specific positions, especially concentrated in medium-skilled positions with standardized, codifiable task content and no need for complex situational judgment. However, technological application also indirectly creates new employment demand. This creation is mainly realized through three channels: first, the self-development of the AI industry directly creates new industrial chain positions from hardware research and development to software application; second, AI improves the production efficiency and business model innovation ability of relevant industries, which may expand the output scale, thus deriving additional labor demand in links not automated, such as the growth in demand for logistics personnel brought by the expansion of e-commerce; third, AI has spawned brand-new products, services and even industrial fields, such as algorithm-based content creation platforms, intelligent driving ecology or advanced data analysis services, which have created entirely new occupational categories from scratch. It is worth noting that the replaced positions and newly created positions are often mismatched in skill requirements, geographical distribution and salary levels. This structural mismatch is an important reason for frictional unemployment, skill gaps and regional imbalance in the adjustment process of the employment market, and is also the key to understanding the dynamic evolution of polarization.

#### **4. Pathways of Artificial Intelligence's Effect on Income Distribution**

##### **4.1 Widening Wage Gap and Evolution of Skill Premium**

The primary impact path of AI on income distribution is reflected in the profound restructuring of the wage structure, with the core being the dynamic evolution of skill premium and the systematic widening of the wage gap. With the enhanced complementarity of technology to high-skilled labor, the marginal productivity of such labor forces is significantly improved, and market demand continues to be strong, thus driving the rapid growth of their wage levels and forming and expanding the high-skilled premium. This premium is not only reflected in the traditional return on education, but also specifically in the generous remuneration for skills directly related to AI such as programming, data analysis and algorithm management. On the contrary, medium-skilled workers facing high substitution risk experience shrinking job demand, leading to declining market bargaining power, stagnant wage growth or even a decline in real income. Although low-skilled service positions have not been replaced on a large scale for the time being, their low technical content, limited productivity improvement and relatively abundant labor supply result in long-term low wage levels and slow growth. The vastly different income trajectories of the three skill levels directly lead to the expansion of both ends and the compression of the middle in the overall wage distribution, that is, the widening of the wage gap. This process is not static. With the iteration and deepening application of AI technology, the required high-end skill mix is also evolving rapidly, the old skill premium may decline, and new premiums continue to emerge, continuously reshaping the internal structure of wage inequality.

##### **4.2 Strengthening Capital Gains and Changes in Labor Share**

The application of AI has profoundly changed the relative position of capital and labor in value distribution, strengthened capital gains and may lead to changes in the labor share in national income. From the perspective of technical attributes, the development, deployment and operation and maintenance of AI systems are highly dependent on capital investment,

including hardware infrastructure, software research and development and data assets, and the benefits from output improvement largely accrue to capital owners and technology patent holders. At the enterprise level, the adoption of AI to improve production efficiency or create new value often manifests as an increase in profit margin in the initial stage, and this part of new profits tends to flow to capital rather than being widely shared with workers in distribution, especially after technology replaces some labor forces. Macroscopically, this may lead to a decline or fluctuation in the labor income share in functional income distribution. In addition, income distribution within enterprises is also differentiated: a small number of high-skilled managers or core technical personnel closely integrated with capital and technology may share part of the capitalized income through equity, high bonuses and other means, and their income nature combines both labor and capital characteristics; while most ordinary workers, especially marginalized low- and medium-skilled employees, have a weakened correlation between their labor remuneration and the growth of enterprise capital gains. Therefore, AI may not only aggravate wage inequality among workers but also deepen the distribution contradiction between capital and labor, changing the overall income distribution pattern.

##### **4.3 Unbalanced Regional Development and Diffusion of Distribution Pattern**

The impact of AI on income distribution has significant spatial heterogeneity. The unbalanced geographical distribution of its development and application aggravates unbalanced regional development and makes the income distribution pattern present the characteristics of diffusion and differentiation. R&D institutions, leading enterprises and core investments of AI are often highly concentrated in a few metropolitan areas or technology centers with top scientific research institutes, complete digital infrastructure and active venture capital markets, such as Silicon Valley, Beijing or London. These regions can not only attract global high-skilled talents and obtain high capital returns but also spawn high-paid supporting service industries, thus forming high-income agglomeration areas. On the contrary, regions dominated by traditional manufacturing or medium-skilled occupations may face shrinking local labor markets, reduced medium-income positions and insufficient

creation of new high-skilled positions when facing the impact of job substitution brought by AI, leading to sluggish or even relatively declining growth in regional average income. This inter-regional differentiation is reflected not only in per capita income level but also in income structure: technology core areas present high-skilled and high-income characteristics; traditional industrial areas may suffer from income hollowing-out; some regions maintain a low-skilled and low-income service economy. The differences in distribution patterns between regions will further diffuse through labor migration, capital flow and policy responses, affecting the national overall income inequality measurement results, and may trigger profound social and spatial political and economic issues.

## 5. Empirical Analysis and Case Study

### 5.1 Cross-Country Panel Data Model and Econometric Test

In the empirical analysis of the impact of AI on employment polarization and income distribution pattern, it is crucial to construct an analytical framework integrating theoretical mechanism and data observation. This paper adopts a cross-country panel data model to capture the heterogeneous characteristics of different countries and time units, while improving estimation efficiency and analysis accuracy. The model construction first clarifies the theoretical relationship among AI application intensity, employment polarization degree and income distribution indicators, and transforms it into a quantifiable functional form. On the basis of the basic model, key control variables are further introduced, including human capital accumulation, institutional environment quality, openness, etc., to alleviate omitted variable bias. According to data characteristics and research objectives, appropriate estimation methods are selected, such as fixed effect model, random effect model or system GMM, to effectively deal with endogeneity, individual heterogeneity and potential endogeneity problems. After the model estimation is completed, the robustness test of model specification is carried out through F-test, Hausman test and other methods to ensure the reliability of the analysis conclusions. In addition, sensitivity analysis is conducted on key variables to verify the robustness of the main conclusions. Through a series of rigorous econometric tests, a solid empirical basis is

provided for revealing the mechanism of AI's impact on employment and income distribution.

### 5.2 Case Analysis at Typical Industry and Enterprise Levels

To elaborate the impact paths and differentiated consequences of AI on employment polarization and income distribution pattern, this paper selects representative industries such as information technology, manufacturing and traditional service industries, as well as typical regions or industrial clusters in different economies such as Silicon Valley, Zhongguancun and German manufacturing clusters, for in-depth case analysis at the enterprise and industry levels. In industry analysis, the penetration path of AI technology, the specific process of automation substitution and new high-skilled job creation are sorted out, the changes in labor demand of different skill levels are quantified, and combined with enterprise strategy adjustment, organizational structure evolution and employee flow data, the micro mechanism of employment and income distribution under technological impact is revealed. In regional case studies, the differences between technology core areas and non-core areas in labor market polarization, wage gap evolution, capital and labor income distribution, and inter-regional population and capital flow are compared, and the dynamic process of unbalanced regional development and the regulatory role of institutional and policy factors are discussed. Through the comparative analysis of multiple cases, common laws are extracted, and the impact modes and coping experiences under specific situations are highlighted, providing concrete support for understanding the complex picture of AI's impact.

### 5.3 Comparative Analysis Under Different Socio-Economic Situations

To reveal the heterogeneous characteristics of AI's impact on employment polarization and income distribution pattern, this paper constructs a multi-scenario comparative analysis framework, focusing on the regulatory role of socio-economic situations such as differences in development level, institutional environment and openness on the impact effect. In terms of development level, the similarities and differences of AI's impact between developed economies and emerging market countries are compared, the intensity changes and potential

reasons of employment and distribution effects under technological impact are analyzed, and whether developing countries have opportunities of "catching up" or "leapfrogging" different from developed countries is discussed. In institutional environment analysis, the role of variables such as the rule of law level, intellectual property protection and government intervention is focused on, and the institutional conditions and policy orientations conducive to forming inclusive technological change are identified. Under the open economy background, the regulatory relationship between the position in the global value chain, cross-border data flow and international cooperation level on the impact effect of AI, as well as the cross-border transmission and linkage of the impact effect under the globalization pattern are further discussed. Through these comparative analyses, not only the universal laws and special situations of AI's impact are identified, but also a basis is provided for formulating differentiated policy response strategies, and the theoretical understanding of the interaction between technology, economy and institutions is enriched.

## 6. Conclusion

This study confirms that AI application has become an important force driving employment polarization by strengthening the complementarity of technology to high-skilled labor and the substitution of medium-skilled labor, thereby reshaping the income distribution pattern through channels such as wage structure changes, rising capital returns and regional differentiation. Faced with this trend, passive adaptation will aggravate inequality and social risks. Policy responses need to go beyond simple technological adjustment and commit to building a systematic framework covering lifelong skill remodeling, inclusive social security and collaborative technology governance. The analysis of this paper also has limitations such as

data timeliness and situational universality. Future research needs to further focus on the dynamics of technological iteration, the interactive influence of institutional culture and the exploration of long-term social equilibrium paths.

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