

Research on the Impact Effect of Artificial Intelligence on the Position of China's Manufacturing Value Chain

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Abstract

Artificial intelligence (AI), central to the Fourth Industrial Revolution, is key to global competition. For China, integrating AI with manufacturing is vital to overcoming "low-end lock-in" and boosting its global value chain (GVC) position. This study analyzes data from 37 countries (2008-2021), showing AI enhances China's GVC standing via productivity and innovation. It recommends leveraging AI leadership, adopting tailored strategies, building advanced manufacturing clusters, and promoting innovation to drive GVC advancement.

Keywords

Value Chain Location; Artificial Intelligence; Manufacturing; The Value Chain Climbs.

1. Introduction

In the wave of industrial revolutions, artificial intelligence (AI) has emerged as a pivotal force driving industrial transformation, upgrading, and the division of labor in the global value chain (GVC). It not only promotes the advancement of the GVC towards higher-end and regionalized development but also provides new competitive strengths and opportunities for countries to reshape their positions within the GVC. Since the reform and opening-up, China has leveraged its labor and resource advantages to participate in GVC division of labor, achieving steady economic growth. However, as China's integration into the GVC deepens, the "two ends abroad" processing model has led to a "low-end lock-in" in its manufacturing sector, gradually eroding its traditional cost advantages. Meanwhile, Southeast Asian and African countries have actively integrated into the GVC with their low-cost advantages, further weakening the competitiveness of China's manufacturing industry.

2. Analysis of the Influence Mechanism

Existing research on AI remains in the exploratory stage, lacking unified quantitative methods, and systematic studies integrating AI with the GVC are scarce. This paper explores the mechanisms through which AI influences the position of manufacturing in the GVC from both theoretical modeling and empirical analysis perspectives, aiming to enrich existing research and provide theoretical support for China to enhance its GVC position in the context of the Fourth Industrial Revolution.

This study focuses on the impact of AI on the participation and position of China's manufacturing sector in the GVC and its underlying mechanisms. First, it clarifies the concepts of AI and GVC, identifies factors influencing GVC upgrading, and outlines measurement methods. Statistical analysis is conducted on manufacturing export data, and the GVC status at the national level is calculated. Next, theoretical analysis and econometric models are used to empirically examine the mechanisms through which AI drives GVC upgrading. Finally, based on the findings, policy recommendations are proposed to leverage AI for promoting GVC upgrading in manufacturing, including advancing technological innovation and optimizing industrial structure.

To empirically examine the impact of artificial intelligence (AI) development on the global value chain (GVC) position of the manufacturing sector, this paper sets the level of AI development as the explanatory variable and the GVC participation and position index of the manufacturing sector as the explained variables. Control variables are also incorporated into the model, establishing the following model:

$$GVC_{it} = \alpha_0 + \alpha_1 AI_{it} + \sum_{it} control_{it} + \varepsilon_{it}$$

In the model above, “i” represents the region, “t” the year, GVC_{it} the GVC participation and position index of region “i” in year “t”, AI_{it} the AI level in region “i” in year “t”, “control” other control variables, and “ ε ” the random error term.

3. Empirical Analysis

Table 1. Three Scheme comparing

Variable	(1) GVC_participation	(2) GVC_position	(3) GVC_participation	(4) GVC_position
rob	0.0175*** (0.004)	0.0093*** (0.003)	0.0262*** (0.004)	0.0077*** (0.004)
lnpgdp	-	-	-0.0344*** (0.010)	-0.0193** (0.009)
open	-	-	0.0198 (0.042)	0.1345*** (0.037)
hc	-	-	0.0315 (0.053)	0.0113 (0.046)
gov	-	-	0.2568 (0.237)	-0.3297 (0.182)
Inpop	-	-	0.2174*** (0.084)	0.2352*** (0.073)
_cons	0.5370*** (0.024)	0.0732*** (0.021)	-2.9891** (1.442)	4.1082*** (1.254)
Year fixed effects	Y	Y	Y	Y
Country fixed effects	Y	Y	Y	Y
N	518	518	518	518
R ²	0.153	0.249	0.215	0.358

This study conducts panel regressions on AI development and GVC participation/position, using the Hausman test to select the fixed-effects regression model. Results in Table 6.2 show columns (1)-(2) as direct regressions and (3)-(4) as fixed-effects regressions with controls. The findings reveal that AI, particularly industrial robots, significantly boosts manufacturing participation in the GVC. AI lowers production and trade costs, enhancing efficiency and improving countries' roles in global division of labor. It also addresses information asymmetry, improving information flow and promoting flexible manufacturing. Industrial robot stock significantly impacts GVC participation and position at the 1% level, with a stronger effect on participation. This may be because some OECD countries (e.g., Austria, Belgium) use many robots but have lower GVC positions, while some developing countries (e.g., Russia, Brazil, China) have higher GVC positions due to resources or technology but rely more on traditional labor, making robots less prominent.

Control variables show that openness negatively affects GVC position, possibly due to economic instability and output fluctuations from high openness, or the transfer of low-value, polluting industries. Market size has an unstable impact: while larger markets can create economies of scale and trade advantages, they may also lead to greater reliance on domestic markets and less international trade, resulting in a negative coefficient for GVC participation.

4. Conclusion

The division of labor within the global value chain (GVC) of traditional manufacturing industries has historically been predicated on the comparative cost advantages derived from differential factor endowments across nations. Multinational enterprises have predominantly maximized economic benefits through strategies of outsourcing and contract manufacturing. However, the advent of artificial intelligence (AI) has ushered in a transformative phase for the GVC. In this new era, the limitations of previous large-scale, cost-driven production models have become increasingly evident. The singular focus on cost minimization is no longer sufficient to address the heterogeneous demands of contemporary consumers. The Fourth Industrial Revolution, propelled by AI, has supplanted traditional paradigms with more flexible, small-batch, customized, and localized production and service methodologies. This evolution not only better accommodates diverse consumer preferences but also generates significant spillover effects, such as "technological leapfrogging" and "innovation complementarity." These dynamics not only facilitate the GVC's progression towards more sophisticated and regionalized structures but also furnish nations with novel core competitive advantages and opportunities to recalibrate their positions within the GVC. Grounded in this theoretical framework, this study undertakes both theoretical and empirical investigations into the potential of AI to elevate a nation's standing within the manufacturing GVC. The principal findings are as follows:

(1) Although the GVC participation and position indices generally exhibit similar trends, they are not entirely congruent, with the GVC position index demonstrating less volatility. Over the past decade, the GVC positions of most countries have remained relatively stable, suggesting that while some nations have enhanced their capacity to engage in global division of labor through developmental strides and policy interventions, their manufacturing GVC positions have displayed a degree of continuity and are unlikely to undergo significant shifts in the near term. China's GVC position has markedly improved over the last decade, maintaining a consistent upward trajectory post-financial crisis. This underscores that China's manufacturing sector has transcended its erstwhile reliance on low-skilled processing and assembly, steadily bolstering its research and development capabilities and autonomy, thereby cultivating its own competitive edge.

(2) The stock of industrial robots across various nations has seen annual increments, indicative of the expansive global potential for AI applications. Presently, industrial robots are predominantly concentrated in OECD countries, yet the growth rate in developing nations is noteworthy. China has experienced the most substantial increase in industrial robot stock, with its AI development level now ranking among the global leaders. This attests to the widespread adoption of AI within China's manufacturing sector to drive industrial advancement, laying the groundwork for further enhancing its role in the global division of labor during the Fourth Industrial Revolution.

(3) The development of AI significantly augments a nation's participation and position within the manufacturing GVC. Both the GVC participation and position indices exhibit inertia, implying that a country's overall level of engagement in the global division of labor is unlikely to undergo significant changes in the short term. Through theoretical model analysis and mediation effect tests, this study reveals that AI exerts both direct and indirect influences on the GVC, with the latter mediated through enhancements in production efficiency and innovation effects.

(4) Owing to disparities in technological proficiency, industrial structure stability, and the specific production stages where AI is implemented, the impact of AI development on manufacturing GVC positions is more pronounced in developing countries, whereas its effect on GVC participation is more salient in developed nations. Furthermore, a comparative analysis of the periods during and after the financial crisis indicates that the crisis attenuated the positive impact of AI on GVC positions.

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