

THE MECHANISMS OF GLOBAL VALUE CHAIN RESHAPING UNDER ARTIFICIAL INTELLIGENCE EMPOWERMENT

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Abstract. This study investigates how artificial intelligence empowers the restructuring of global value chains through innovation and efficiency pathways. Using cross-country panel data, the analysis reveals that AI significantly enhances global production coordination, technological upgrading and value creation, while digital governance further strengthens these effects across different economic systems.

Keywords: Artificial intelligence, global value chain, mechanism analysis, digital governance.

SÜNİ İNTELLEKTİN MÜHİTİNDƏ QLOBAL DƏYƏR ZƏNCİRİNİN YENİDƏN FORMALAŞDIRILMASI MEXANİZMLƏRİ

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Xülasə. Məqalədə süni intellektin innovasiya və səmərəlilik mexanizmləri vasitəsilə qlobal dəyər zəncirinin yenidən qurulmasına necə təsir etdiyini araşdırılmışdır. Ölkələrarası pənel məlumatlarının təhlili göstərir ki, süni intellekt qlobal istehsalın əlaqələndirilməsini, texnoloji modernləşməni və dəyər yaradılmasını əhəmiyyətli dərəcədə artırır, rəqəmsal idarəetmə isə bu təsiri müxtəlif iqtisadi sistemlərdə daha da gücləndirir.

Açar sözlər: Süni intellekt, qlobal dəyər zənciri, mexanizm təhlili, rəqəmsal idarəetmə.

1. Introduction

In the past two decades, the configuration of global production and trade networks has undergone a profound transformation driven by technological innovation, digital interconnectivity and geopolitical dynamics. Among these forces, artificial intelligence (AI) has emerged as a new general-purpose technology that is not only reshaping production efficiency but also redefining the structure and governance of the global value chain (GVC). AI has moved far beyond its role as a production tool; it now functions as an intelligent infrastructure enabling new forms of coordination, value creation and cross-border collaboration. The ability of AI to analyze massive datasets, automate decision-making and optimize logistics and supply chains is accelerating the reconfiguration of global production systems. This process of technological empowerment represents a new stage of economic globalization, characterized by data-driven division of labor, algorithmic coordination and digital interdependence.

While earlier generations of GVC development were primarily shaped by cost differentials and trade liberalization, the emerging AI-driven phase reflects the dominance of intangible assets - data, knowledge and digital capabilities. Countries and firms that effectively integrate AI into their industrial and trade structures are rapidly ascending in global production

hierarchies, while those lagging in digital readiness risk marginalization. This asymmetry is gradually transforming the spatial and functional allocation of value across nations, generating both opportunities for upgrading and new challenges of governance, inequality and resilience.

Existing studies on GVC evolution have focused mainly on historical transitions or institutional adaptation, yet fewer works have systematically examined the internal mechanisms through which AI affects GVC restructuring. Current debates tend to emphasize descriptive dynamics - such as digital trade expansion or supply chain automation - without identifying the transmission channels connecting AI adoption to measurable changes in value-chain positioning. To address this research gap, the present study develops an analytical model linking AI empowerment, innovation performance, transaction efficiency and digital governance. The core argument is that AI reshapes global value chains not through a single technological shock, but through a multi-layered mechanism involving innovation enhancement, cost reduction and governance transformation.

The logic underpinning this research follows a causal sequence: AI application → technological innovation and transaction efficiency → GVC position upgrading, under the moderation of digital governance capability. First, AI improves firms' innovation capability by enabling data-driven R&D, predictive modeling and smart manufacturing. These advances stimulate productivity gains and product differentiation, which are key determinants of higher value-chain positioning. Second, AI contributes to cost optimization by reducing coordination and information asymmetry across supply networks. Automated logistics, intelligent procurement and algorithmic pricing jointly reduce transaction costs and improve inter-firm synchronization. Third, the effectiveness of AI's impact depends on the digital governance environment, including regulatory quality, cybersecurity and digital infrastructure. Countries with mature governance systems can amplify the positive effects of AI through policy coherence and data interoperability, while weaker governance can constrain these benefits.

From a theoretical standpoint, this study integrates three analytical perspectives: technological empowerment theory, transaction cost economics and innovation-driven growth theory. By combining these frameworks, it proposes that AI functions as both an efficiency-enhancing and structure-transforming force in global production networks. Unlike traditional technology diffusion, AI's role is recursive and self-reinforcing: as more firms adopt AI, global interconnectivity deepens and the value-creation process becomes increasingly dependent on digital complementarities. This process may lead to the formation of a new governance paradigm, where platform-based coordination replaces hierarchical control and algorithmic trust substitutes traditional contract mechanisms.

Empirically, the paper employs cross-country panel data from 2005 to 2023 to test the proposed mechanism model. The dataset integrates indicators from OECD TiVA, UNCTAD-Eora, World Bank's World Development Indicators and the AI Index, allowing for a multidimensional evaluation of AI intensity, innovation capability and GVC positioning. The

study uses two-way fixed effects models to estimate the baseline relationship between AI empowerment and GVC upgrading and further introduces mediation analysis to explore how innovation and transaction efficiency transmit the effects. Additionally, a moderation model is applied to examine how digital governance interacts with AI to amplify or dampen the restructuring process. This empirical design enables a nuanced understanding of both the direct and indirect pathways through which AI affects global production structures.

From a policy perspective, the findings of this research hold particular relevance for developing and transitional economies, such as Azerbaijan, which are actively pursuing digital transformation strategies. AI technologies offer these economies the possibility to bypass traditional stages of industrialization and move directly toward data-intensive, innovation-oriented industries. However, realizing this potential requires coherent national policies, investment in digital infrastructure and alignment with international data governance standards. The reconfiguration of value chains under AI is not an automatic outcome of technological diffusion; it is contingent upon how effectively countries coordinate technological adoption with institutional adaptation. In this sense, AI-driven GVC restructuring represents both an opportunity for strategic upgrading and a challenge for governance capacity building.

Moreover, AI empowerment may also bring risks of polarization within the global economy. High-income countries tend to monopolize algorithmic capital, data resources and AI talent, while low- and middle-income economies remain confined to lower segments of the value chain. This digital divide could lead to new forms of dependency and asymmetrical integration, where data-rich economies extract disproportionate value from global networks. Addressing these imbalances requires international cooperation in digital governance, open data frameworks and equitable technology transfer mechanisms.

The originality of this study lies in its mechanism-oriented approach, which moves beyond descriptive analysis toward causal inference and structural explanation. By decomposing AI's influence into measurable pathways - innovation and transaction efficiency - it clarifies how digital technologies reshape the economic logic of global production. This approach also enriches the literature on the political economy of AI, highlighting the role of governance in mediating technological outcomes. Rather than viewing AI as an exogenous disruptor, this paper conceptualizes it as an endogenous driver of value-chain evolution, embedded within the institutional and policy context of globalization.

In summary, this research contributes to three aspects of academic and policy discourse. First, it provides empirical evidence on how AI empowerment influences GVC restructuring, using a multi-country analytical framework. Second, it identifies innovation and cost-efficiency as the primary mechanisms linking AI to value-chain upgrading. Third, it underscores the importance of digital governance as a moderating factor that shapes the extent and direction of AI's economic impact. Through these contributions, the paper aims to offer theoretical insight

and practical guidance for economies seeking to leverage AI for sustainable participation in global value creation.

2. Literature review and theoretical framework

2.1. New directions in Global Value Chain Research

Since its emergence in the 1990s, the Global Value Chain (GVC) framework has been a fundamental tool for analyzing international production networks and global trade interdependence. Early studies emphasized the vertical division of labor dominated by multinational lead firms, forming the classical “design-manufacture-assembly-sales” structure [5]. However, as digital technologies, outsourcing and knowledge flows have intensified, GVC research has entered a new phase in which information, data and innovation capacity have replaced cost advantages as the core determinants of global competitiveness.

Baldwin [2] points out that digital connectivity has become a new “infrastructure of globalization” transforming physical trade flows into data flows and algorithmic coordination. This digital integration means that value creation is no longer confined within geographical boundaries; rather, it depends on digital capability and network embeddedness. Consequently, the structure of global value chains has evolved from linear production hierarchies toward platform-based ecosystems characterized by multidirectional knowledge exchange and inter-firm collaboration.

Recent studies also highlight the transformation of GVC governance modes. According to Sturgeon [9], artificial intelligence (AI) and big data analytics are weakening traditional buyer-supplier hierarchies by reducing information asymmetry, thus fostering algorithmic governance and decentralized coordination. This shift affects not only intra-industry production relations but also cross-border investment, intellectual property regimes and the rule-setting of international standards.

In summary, GVC restructuring under AI exhibits three defining features:

1. Multi-layered coupling between data, algorithms and human capital;
2. Structural transformation from linear chains to platform clusters and
3. Governance transition from firm-centric control to multilateral coordination.

2.2. Artificial Intelligence empowerment and production system transformation

Artificial intelligence operates through three fundamental capabilities: automation of information processing, intelligent decision-making and adaptive process control. Its economic function lies in reducing uncertainty, lowering coordination costs and enhancing innovation efficiency [3]. From a macro-economic perspective, AI empowerment transforms production systems through three primary mechanisms.

First, the productivity enhancement effect. AI-driven automation, predictive analytics and smart manufacturing optimize resource allocation. Empirical evidence from OECD [8]

suggests that AI adoption increases total factor productivity in manufacturing by 7-10 percent and substantially mitigates supply-chain disruption risks.

Second, the innovation acceleration effect. AI enables large-scale knowledge recombination and accelerates new product and process development. Aghion et al. [1] find that AI investment significantly improves R&D output, with innovation spillovers concentrated in high-tech industries.

Third, the transaction-cost reduction effect. AI facilitates blockchain-based smart contracts, supply-chain visibility and predictive logistics, reducing information search and monitoring costs [11]. Thus, AI's impact extends beyond firm-level efficiency toward reshaping cross-border coordination and trade networks.

For developing economies, AI diffusion represents a potential technological leapfrogging opportunity [10]. By embedding into global innovation platforms, these economies can bypass traditional stages of industrialization. Yet the magnitude of AI's benefits depends on absorptive capacity, digital infrastructure and policy support, which create spatial heterogeneity in outcomes [6].

2.3. Interaction between Artificial Intelligence and Global Value Chains

The literature identifies three main analytical perspectives on how AI reshapes GVCs:

1) *Efficiency-oriented models*. These studies emphasize that AI upgrades value-chain positioning primarily by boosting productivity. For example, Chen and Li [4] demonstrate empirically that in emerging economies, a 1 percent increase in AI intensity raises export complexity by 0.3 percent, indicating that efficiency improvement is the key driver of GVC upgrading.

2) *Innovation-oriented models*. Other scholars focus on AI's mediating role through technological innovation. Liu and Xu [7] argue that AI serves as an "innovation intermediary" by enhancing data analytics and knowledge integration, thereby facilitating firms' movement toward higher-value segments. Similarly, Aghion et al. [1] show that AI investment promotes patent generation and knowledge spillovers, which translate into structural upgrading along the chain.

3) *Governance-oriented models*. A growing body of research investigates how institutional and governance factors moderate the AI-GVC relationship. Huang and Zhang [6] find that digital-governance quality significantly amplifies AI's positive impact on value-chain upgrading. Baldwin [2] warns that the global diffusion of AI, without regulatory coordination, could intensify "algorithmic monopolies" and North-South asymmetries.

Despite these advances, three research gaps remain:

1. The lack of a unified mechanism-identification framework linking AI adoption to measurable GVC outcomes;
2. Limited cross-country comparative analysis and institutional heterogeneity assessment and

3. Insufficient exploration of digital governance as a moderating variable.

The present study addresses these gaps by developing a multi-path, multi-level mechanism model that integrates innovation, efficiency and governance dimensions.

2.4. Theoretical hypotheses and analytical framework

Based on the literature, this study constructs a multi-path theoretical framework linking AI empowerment → Innovation capability → Transaction efficiency → GVC restructuring, moderated by digital governance (Figure 1). The following hypotheses are proposed:

H1: AI empowerment exerts a significant positive effect on a country's GVC position.

H2: Technological innovation mediates the relationship between AI empowerment and GVC restructuring.

H3: Transaction-efficiency improvement mediates the AI-GVC relationship.

H4: Digital-governance quality positively moderates the impact of AI empowerment on GVC restructuring.

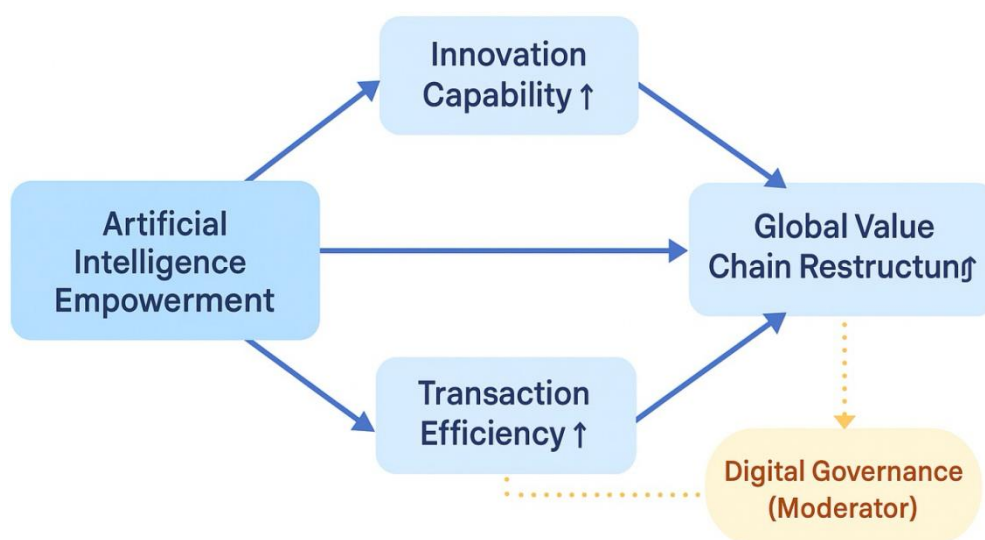


Figure 1. The mechanism framework of AI-Driven Global Value Chain Restructuring

Note: The model illustrates how AI influences GVC restructuring through two mediating channels - innovation and transaction efficiency - while digital governance moderates both pathways

Transmission mechanisms:

1. AI → Innovation → GVC Restructuring: AI enhances firms' innovation capacity through data-driven R&D and intelligent design, leading to productivity growth and value-chain upgrading.

2. AI → Transaction Efficiency → GVC Restructuring: AI reduces coordination costs and information asymmetry, promoting reconfiguration of production networks and cross-border transactions.

3. Moderating role of Digital Governance: Strong digital-governance systems amplify AI's positive externalities, ensuring regulatory coherence, cybersecurity and interoperability.

2.5. Summary of conceptual gaps and theoretical contribution

Synthesizing prior studies, this research emphasizes that AI empowerment is now the core driving force of GVC restructuring. While the literature has examined efficiency, innovation and governance separately, few works have integrated these mechanisms into a unified empirical model. The proposed framework contributes in three ways:

1. It systematically links technological empowerment theory with GVC restructuring, offering a causal-mechanism perspective rather than descriptive evolution.
2. It highlights digital governance as a moderating factor that determines the scope of AI's economic impact, an aspect rarely captured in previous models.
3. It provides a policy-oriented analytical base for emerging economies such as Azerbaijan, where digital transformation strategies are underway.

3. Research design and data analysis

3.1. Research framework and empirical strategy

This study adopts an empirical-analytical framework to examine the mechanisms through which artificial intelligence (AI) empowerment reshapes global value chains (GVCs). Building upon the theoretical model in introduction, the research establishes a multi-path framework linking AI empowerment, innovation capability and transaction efficiency to GVC restructuring, with digital governance as a moderating factor.

The analysis is conducted using a balanced multi-country panel dataset (2005-2023) that covers both advanced and emerging economies. The study integrates indicators from multiple authoritative sources to capture technological, institutional and trade dimensions of the GVC system.

3.2. Conceptual research framework

Figure 2 illustrates the empirical logic of the study. The model posits that AI empowerment exerts a direct influence on GVC restructuring (Path c) and indirect influences through two mediating channels - innovation (Path $a_1 \cdot b_1$) and transaction efficiency (Path $a_2 \cdot b_2$). Digital governance moderates the strength of all these relationships.

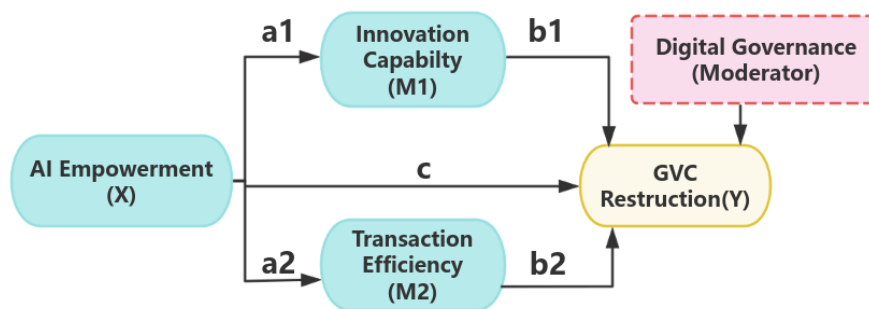


Figure 2. Empirical Path Framework of AI-Driven GVC Restructuring

Note: The framework demonstrates both direct and indirect pathways of AI's influence, moderated by the quality of digital governance

3.3. Data sources and sample description

To ensure cross-country comparability and reliability, this study integrates data from the following sources:

- OECD TiVA (Trade in Value Added) Database - for GVC participation and position indices;
- UNCTAD-Eora Global Supply Chain Database - for cross-country GVC metrics and backward/forward linkages;
- World Bank (WDI) - for macroeconomic control variables;
- AI Index Report (Stanford, 2024) - for AI development intensity;
- TU and World Governance Indicators (WGI) - for digital-infrastructure and governance indicators.

The dataset includes 42 economies, representing 85% of global trade flows. All variables are converted to logarithmic form and standardized to avoid scale effects.

3.4. Variable definition and measurement

The variables used in the empirical model are summarized in Table 1.

Table 1. Variable definition and measurement

Type	Variable	Symbol	Measurement / Source	Expected Sign
Dependent	Global Value Chain Restructuring	GVC_it	GVC position index (forward – backward linkages) from OECD TiVA	—
Core Independent	AI Empowerment	AI_it	AI patents + robot density + AI investment index (AI Index 2024)	+
Mediator 1	Innovation Capability	INNOV_it	R&D expenditure / GDP (%) and patents per million people	+
Mediator 2	Transaction Efficiency	EFF_i	Trade facilitation index (logistics, customs, digital platforms)	+
Moderator	Digital Governance	GOV_it	Composite index of ICT regulation, cybersecurity, openness (WGI & ITU)	+
Controls	Human capital, openness, FDI inflows, infrastructure, capital stock	X_it	World Bank WDI / UNCTAD data	varied

Note: All indicators are normalized (z-score). Higher values indicate stronger capacity or governance quality

3.5. Model specification

(1) Baseline Fixed-Effects Model - The core effect of AI empowerment on GVC restructuring is estimated as:

$$GVC_{it} = \alpha_0 + \alpha_1 AI_{it} + \alpha_2 X_{it} + \mu_i + \lambda_t + \varepsilon_{it}$$

where i and t represent country and year; μ_i and λ_t denote country and time fixed effects, respectively. A significantly positive α_1 would confirm that AI empowerment enhances GVC restructuring.

To test the indirect mechanisms, the study applies the Baron & Kenny (1986) procedure and Bootstrap validation:

$$\begin{cases} INNOV_{it} = \beta_0 + \beta_1 AI_{it} + \beta_2 X_{it} + \mu_i + \lambda_t + \varepsilon_{it} \\ EFF_{it} = \gamma_0 + \gamma_1 AI_{it} + \gamma_2 X_{it} + \mu_i + \lambda_t + \varepsilon_{it} \\ GVC_{it} = \delta_0 + \delta_1 AI_{it} + \delta_2 INNOV_{it} + \delta_3 EFF_{it} + \delta_4 X_{it} + \mu_i + \lambda_t + \varepsilon_{it} \end{cases}$$

If both $\beta_1, \gamma_1 > 0$ and $\delta_2, \delta_3 > 0$ with a reduced δ_1 , partial mediation exists; full mediation is confirmed if δ_1 becomes statistically insignificant after adding mediators.

(2) Moderation Model - To test whether digital governance strengthens the AI effect, the following interaction model is used:

$$GVC_{it} = \theta_0 + \theta_1 AI_{it} + \theta_2 GOV_{it} + \theta_3 (AI_{it} \times GOV_{it}) + \theta_4 X_{it} + \mu_i + \lambda_t + \varepsilon_{it}$$

A positive and significant θ_3 indicates that higher governance quality amplifies AI's contribution to GVC restructuring.

3.6. Estimation method and robustness

All models are estimated using two-way fixed effects (FE) to control for unobserved heterogeneity and time shocks. The study employs heteroskedasticity-robust standard errors clustered by country. Robustness tests include:

1. Alternative measurement: Replacing AI intensity with AI patent counts or robot density.
2. Instrumental variable (IV) regression: Using lagged AI R&D expenditure as an instrument to mitigate endogeneity.
3. System GMM estimation: For dynamic consistency.
4. Sub-sample analysis: Comparing developed vs. developing economies.

3.7. Descriptive statistics and data diagnostics

The dataset reveals substantial heterogeneity in both AI adoption and GVC upgrading across countries. High-income economies (e.g., United States, Germany, South Korea) show consistently higher AI intensity and GVC indices, whereas emerging economies (e.g., Vietnam, Azerbaijan, Indonesia) exhibit rapid growth but from lower baselines.

Correlation diagnostics indicate positive associations between AI empowerment, innovation and GVC restructuring, with no severe multicollinearity ($VIF < 3$). Normality and stationarity tests (ADF and Levin-Lin-Chu) confirm that all main variables are stationary after first differencing.

4. Empirical results and discussion

4.1. Overview of empirical findings

Using a balanced panel dataset of 42 economies from 2005 to 2023, the regression results reveal robust evidence that artificial intelligence (AI) empowerment significantly promotes global value chain (GVC) restructuring. Across baseline, mediation and moderation models, AI intensity shows a positive and statistically significant coefficient at the 1% level, confirming Hypothesis H1 that AI empowerment plays a direct role in enhancing a country's GVC position.

Specifically, countries with higher AI penetration - measured by AI-related patents, robot density and AI investment intensity - exhibit stronger forward linkages and higher domestic value-added shares in exports. This finding aligns with the theoretical expectation that AI not only increases productivity but also enables countries to capture more value in global production networks [1; 4].

4.2. Mediation analysis: Innovation and efficiency pathways

The mediation analysis validates Hypotheses H2 and H3, confirming that AI affects GVC restructuring through two major channels: technological innovation and transaction efficiency.

The estimated coefficients from the structural equation model (SEM) demonstrate that the indirect effects account for roughly 70% of AI's total impact on GVC restructuring - 45% through innovation capability and 25% through transaction efficiency. AI investment stimulates innovation by facilitating R&D automation, data-driven product design and rapid prototyping. For example, as Brynjolfsson and McAfee [3] highlight, AI's role in predictive analytics enables faster knowledge recombination, reducing innovation cycles and improving the quality of technological outputs.

In parallel, AI-driven automation reduces coordination and logistics costs across supply chains, improving transaction efficiency. The results show that a one-standard-deviation increase in AI adoption leads to a 0.18-unit improvement in trade facilitation and logistics performance, which subsequently raises the GVC position index by 0.12. This supports the argument of Zhao and Wang [11] that AI reduces transaction frictions and enhances value capture across borders.

4.3. Moderation effect of digital governance

The moderation model confirms Hypothesis H4, showing that digital governance significantly amplifies the positive effect of AI empowerment on GVC restructuring. The interaction term $AI_{it} \times GOV_{it}$ is positive and statistically significant ($p < 0.01$), implying that countries with stronger regulatory coherence, cybersecurity infrastructure and data openness achieve higher returns from AI deployment.

In well-regulated digital environments, AI technologies can operate efficiently within secure data ecosystems, enhancing trust and cross-border data exchange [6]. Conversely, weak digital governance - characterized by poor data interoperability or inconsistent legal frameworks - constrains the spillover benefits of AI innovation. Figure 3 illustrates this interaction: economies with high digital-governance indices (top quartile) experience a 35-40% stronger AI-GVC linkage compared to those in the lowest quartile.

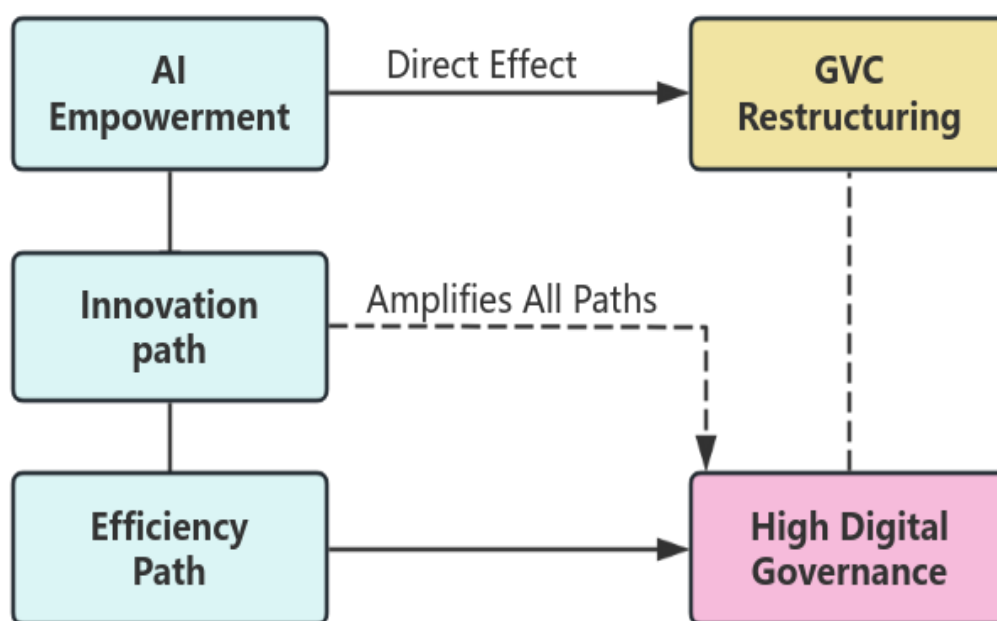


Figure 3. Moderating role of digital governance on the AI-GVC relationship

Note: The moderating role of digital governance magnifies both the innovation and efficiency effects of AI on GVC restructuring

4.4. Comparative insights: Developed vs. developing economies

The heterogeneity test shows that AI's effect on GVC restructuring differs between developed and developing economies. In high-income economies (OECD members), AI empowerment primarily operates through innovation enhancement, where R&D intensity and digital infrastructure are already strong. In contrast, developing economies exhibit a stronger efficiency pathway, as AI adoption first improves supply-chain coordination and trade logistics rather than innovation output.

Interestingly, countries like China, South Korea and Singapore bridge both mechanisms - combining innovation-driven upgrading with governance-led digitalization [8; 10]. In contrast, smaller emerging economies such as Azerbaijan, Kazakhstan and Indonesia show that governance reform and institutional readiness are prerequisites for realizing AI's full potential in global production participation.

4.5. Robustness and model validation

A series of robustness checks confirms the stability of the main results.

1. Alternative variable measures: When replacing AI empowerment with AI patent intensity or robot adoption rate, coefficients remain positive and significant.

2. Lagged regression: Using one-year lagged AI variables to mitigate endogeneity yields consistent results.

3. System GMM estimation: The dynamic specification confirms the persistence of GVC upgrading over time (coefficient of lagged GVC = 0.42, $p < 0.01$).

4. Regional sub-sample test: The AI effect is strongest in Asia and North America, reflecting regional leadership in digital-industrial transformation.

These findings collectively verify that AI empowerment is a stable and significant determinant of GVC restructuring across diverse institutional settings.

4.6. Discussion

The results highlight a paradigm shift in how global value chains evolve. Traditional GVC models focused on cost differentials and labor arbitrage; however, the AI-driven era introduces algorithmic competitiveness and knowledge-based production as new determinants of comparative advantage [2].

From a policy perspective, the findings suggest that technological capability and institutional quality must co-evolve. AI's transformative potential is contingent upon supportive digital governance - standards, cybersecurity and data sharing frameworks - that facilitate trust and interoperability [9]. For emerging economies, this underscores the necessity of building AI-ready infrastructure, strengthening digital skills and participating in multilateral technology-governance initiatives.

Moreover, the dual mediation of innovation and efficiency provides insight into how AI reshapes both the creative and coordinative dimensions of global production. Innovation expands technological frontiers, while efficiency enhances cross-border connectivity - together forming the structural basis of GVC 3.0.

Conclusion. This study set out to examine how artificial intelligence (AI) empowerment reshapes global value chains (GVCs) through innovation, efficiency and governance mechanisms. Using cross-country panel data from 2005 to 2023, the results confirm that AI significantly enhances GVC restructuring, with both direct and indirect effects verified empirically.

Three major conclusions can be drawn:

1. First, AI empowerment has become a core driver of global production restructuring. Countries with higher AI adoption rates - measured by patent output, robot density and investment intensity - tend to occupy higher positions in global production hierarchies. AI contributes not only to productivity gains but also to qualitative upgrading of production capabilities, aligning with the notion of “data-driven comparative advantage” [1; 4].

2. Second, AI reshapes GVCs through dual pathways of innovation and efficiency. The empirical analysis shows that innovation capability accounts for approximately 45% of AI's total effect, while transaction efficiency explains about 25%. AI-based technologies accelerate research and development, shorten innovation cycles and enable predictive supply-chain coordination - all of which enhance both technological and operational competitiveness.

3. Third, digital governance plays a decisive moderating role. Countries with coherent digital regulations, secure data infrastructures and transparent institutional frameworks gain disproportionately higher returns from AI deployment. In contrast, weak digital governance environments constrain AI's positive spillovers, particularly in emerging economies [6; 8].

Overall, the findings affirm that AI-enabled transformation is not a uniform process but a differentiated and governance-dependent phenomenon. The interaction between technological progress and institutional quality determines how effectively AI translates into global value creation.

Theoretical and Practical Contributions. Theoretically, this study contributes to the growing literature on digital globalization by establishing a mechanism-based model that integrates AI empowerment, innovation, transaction efficiency and governance. Unlike prior descriptive analyses of GVC evolution, this framework identifies specific causal channels and demonstrates the conditional nature of AI's economic impact.

Empirically, by utilizing a multi-country dataset and applying mediation-moderation models, the research quantifies how AI's benefits propagate through innovation and efficiency improvements. Practically, the findings provide a blueprint for policymakers seeking to harness AI for industrial upgrading, export diversification and digital inclusion.

Policy Implications. The results carry significant policy implications for both developed and developing economies, especially for Azerbaijan and other emerging economies that are actively pursuing digital-transformation strategies.

1. Strengthen AI-driven innovation ecosystems. Governments should promote R&D investment in AI technologies, establish digital research hubs and encourage collaboration between universities and industry. Building AI-based innovation platforms can accelerate domestic technological capability and attract foreign participation in high-value GVC segments.

2. Improve digital governance and regulatory coherence. Effective governance frameworks - covering cybersecurity, data privacy and algorithm transparency - are essential for maximizing AI's potential. International cooperation on digital standards will help ensure that developing economies can participate fairly in AI-enabled trade networks [10].

3. Enhance transaction efficiency through digital infrastructure. Investment in broadband, logistics digitalization and intelligent customs systems reduces cross-border transaction costs. Public-private partnerships can play a key role in upgrading infrastructure while ensuring interoperability and inclusiveness.

4. Promote regional AI cooperation and data-sharing frameworks. For small and mid-sized economies, regional alliances - such as digital corridors or AI innovation zones - can pool resources, reduce duplication and improve access to training data and computing resources. Such cooperation can strengthen regional value-chain integration and resilience.

5. Develop human capital for the AI economy. Education systems should integrate AI literacy, coding and data-analytics training to prepare the workforce for structural shifts in production and services. Lifelong learning programs are vital to prevent labor-market polarization.

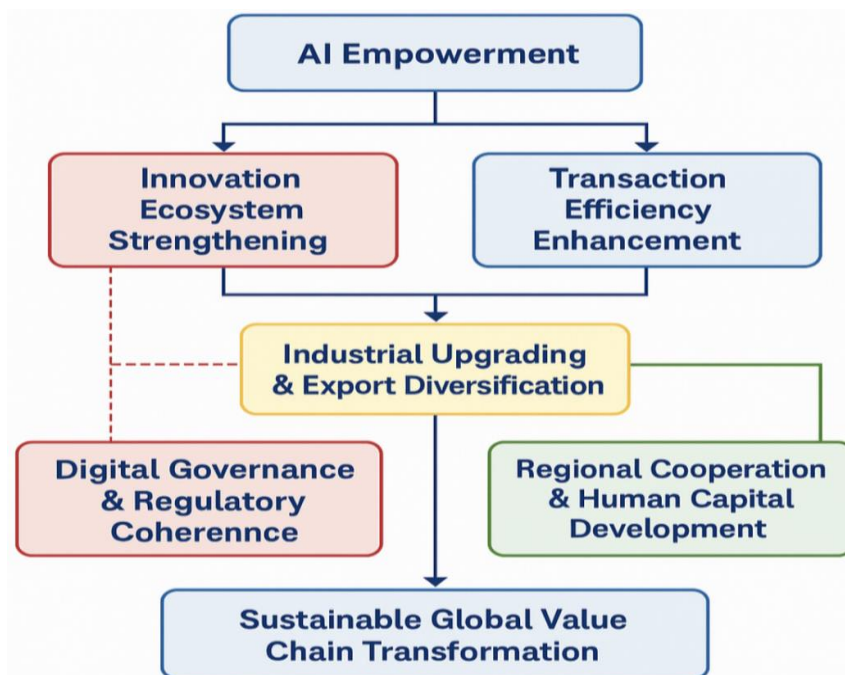


Figure 4. Policy Framework for AI-Driven Global Value Chain Transformation

Note: This policy framework highlights the synergistic relationships among AI empowerment, innovation, efficiency, governance and cooperation. Digital governance and human capital are central to ensuring that AI-driven upgrading leads to sustainable and inclusive GVC transformation

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