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Reshaping the Global Value Chain Division of Labor under the Digital Economy

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Abstract: Based on the theoretical framework of global value chains (GVCs), this paper examines the mechanisms through which the digital economy reshapes global value chains. The study finds that the digital economy significantly alters the geographical distribution patterns of traditional GVCs by reducing transaction costs and enhancing the mobility of production factors. The application of digital technologies has increased the added value of midstream manufacturing segments, thereby transforming the "smiling curve" into a "shallow smiling curve." Moreover, the cross-border flow of data elements has given rise to new types of service-oriented value chains, offering developing countries a novel pathway to move up the value chain. This study provides a theoretical foundation for understanding the new characteristics of GVCs in the digital economy era and offers valuable insights for developing countries in formulating digital economy development strategies.

Keywords: Digital Economy, Global Value Chain, Division of Labor and Cooperation

1. Introduction

Against the backdrop of accelerated global digital transformation, the digital economy is reshaping the structure of global value chains (GVCs) with unprecedented depth and breadth. According to the Global Digital Economy White Paper (2023) published by the China Academy of Information and Communications Technology (CAICT), the digital economy now accounts for over 45% of global GDP, becoming a core engine for global economic recovery and growth. However, this 45% share primarily reflects the digital economy scale of 47 major developed countries, which, due to their technological advantages, occupy the high end of GVCs. In contrast, developing countries face the risk of further marginalization. In this context, investigating how the digital economy reshapes GVCs is of particular significance. Such inquiry not only deepens our understanding of GVCs in the digital age but also provides critical policy references for developing countries aiming to formulate digital development strategies and climb the value chain. This paper, grounded in global value chain theory, analyzes how the digital economy reshapes the GVC division system through three major pathways: transformation of factor structures, reduction of transaction costs, and optimization of value distribution. It also proposes policy recommendations for promoting inclusive development within global value chains.

The marginal contributions of this study are threefold: First, on a theoretical level, it supplements existing GVC research by incorporating the impact of the digital economy, offering a systematic analysis of the mechanisms through which digital technologies are altering international division of labor. Second, in terms of methodology, it adopts a multidimensional indicator system and employs

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quantitative analysis to explore the relationship between the level of digital economy development and a country's position in the global value chain. Third, from a policy perspective, it puts forward preliminary recommendations that serve as a reference for future research on the restructuring of GVCs in the digital era.

The remainder of the paper is structured as follows: Section 2 presents an overview of the digital economy; Section 3 analyzes the theoretical framework of global value chains; Section 4 discusses the mechanisms through which the digital economy reshapes GVCs; Section 5 examines the opportunities and challenges arising from GVC restructuring in the context of the digital economy; and Section 6 concludes the paper.

2. Overview of the digital economy

There is currently no universally accepted definition of the digital economy in academic circles, and its connotation continues to evolve dynamically. Bukht and Heeks proposed a tripartite progressive framework for understanding the digital economy. The foundational layer, termed the "Digital Sector," focuses on the manufacturing of core digital products and the provision of technology services, such as semiconductor production and software development. The intermediate layer, referred to as the "Narrow Digital Economy," extends to digital technology-driven business model innovations, encompassing emerging sectors such as e-commerce and digital finance. The outermost layer, "Digitally Transformed Economy," builds upon the previous two and includes all economic forms resulting from digital transformation, forming a complete ecosystem that integrates digital technology applications, digital factor flows, and the digitalization of traditional industries.

The modern digital economy exhibits pronounced structural characteristics and consists of three core domains. First, digital infrastructure serves as the foundational support layer, including next-generation infrastructure such as 5G networks, data centers, and the industrial internet, as well as underlying technological architectures like blockchain and cloud computing. These provide the physical foundation for the collection, transmission, storage, and processing of data as a key production factor. Second, digital industrialization refers to the process of industrializing digital technologies, covering strategic emerging industries such as integrated circuit design, artificial intelligence algorithm development, and quantum information. Third, industrial digitalization focuses on the digital transformation of traditional industries, leveraging technologies like the Internet of Things (IoT) and big data analytics to facilitate intelligent upgrades in manufacturing, digital transitions in services, and precision management in agriculture, thereby enhancing total factor productivity.

Using the "Four-Dimensional Framework" as a measurement system (see Table 1), this study constructs an evaluation system comprising four dimensions and 17 indicators. Weights are assigned using the Entropy Weight Method to calculate the digital economy index for each province. The data analysis reveals significant regional disparities. Provinces such as Tibet, Ningxia, Qinghai, Guizhou, and Hainan experienced rapid early-stage growth, in some cases exceeding 100%. In contrast, provinces like Liaoning, Heilongjiang, Jilin, and Tianjin witnessed relatively slower growth in the early stages, generally around 30%. Furthermore, economically advanced regions, such as Guangdong, Jiangsu, Zhejiang, Beijing, and Shanghai, consistently maintain high levels of digital economy development and stable growth trajectories. Conversely, less-developed regions—such as Tibet, Qinghai, Ningxia, Gansu, and Guizhou—continue to rank at the lower end nationally despite occasional high growth rates due to their low starting base.

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Table 1: Provincial digital economy index

Province	2011	2014	2017	2020	2023
Anhui Province	0.0384	0.0724	0.1200	0.2022	0.2092
Beijing Municipality	0.1363	0.2298	0.3382	0.4611	0.4919
Fujian Province	0.0588	0.0912	0.2098	0.2488	0.2402
Gansu Province	0.0145	0.0332	0.0586	0.1199	0.0882
Guangdong Province	0.1542	0.2644	0.3945	0.6458	0.7466
Guangxi Zhuang A.R.	0.0271	0.0474	0.0778	0.1520	0.1271
Guizhou Province	0.0188	0.0381	0.0667	0.1462	0.1120
Hainan Province	0.0177	0.0432	0.0693	0.1283	0.0964
Hebei Province	0.0421	0.0734	0.1199	0.2005	0.1999
Henan Province	0.0434	0.0768	0.1312	0.2358	0.2313
Heilongjiang Province	0.0305	0.0571	0.0765	0.1182	0.0997
Hubei Province	0.0417	0.0745	0.1213	0.2008	0.2179
Hunan Province	0.0374	0.0647	0.1071	0.1839	0.1760
Jilin Province	0.0272	0.0455	0.0680	0.1152	0.0883
Jiangsu Province	0.1445	0.1984	0.2789	0.4356	0.4644
Jiangxi Province	0.0223	0.0473	0.0834	0.1567	0.1458
Liaoning Province	0.0478	0.0737	0.1002	0.1571	0.1450
Inner Mongolia A.R.	0.0331	0.0536	0.0776	0.1339	0.1079
Ningxia Hui A.R.	0.0150	0.0333	0.0582	0.1208	0.0805
Qinghai Province	0.0166	0.0337	0.0589	0.1250	0.0766
Shandong Province	0.0836	0.1484	0.1994	0.2937	0.3576
Shanxi Province	0.0277	0.0503	0.0740	0.1405	0.1227
Shaanxi Province	0.0359	0.0619	0.0951	0.1682	0.1540
Shanghai Municipality	0.0795	0.1430	0.2008	0.2922	0.3196

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Table 1: (continued)

Sichuan Province	0.0502	0.0876	0.1412	0.2341	0.2264
Tianjin Municipality	0.0380	0.0656	0.0900	0.1646	0.1335
Tibet Autonomous R.	0.0072	0.0329	0.0503	0.1127	0.0752
Xinjiang Uygur A.R.	0.0237	0.0428	0.0585	0.1279	0.0996
Yunnan Province	0.0244	0.0500	0.0787	0.1544	0.1160
Zhejiang Province	0.1186	0.1847	0.2915	0.4430	0.4816
Chongqing Municipality	0.0266	0.0561	0.0925	0.1638	0.1467

The digital economy is reshaping the paradigm of economic activity across all processes and factors. In the production domain, digital technologies are bringing about disruptive changes in production methods. Data is increasingly emerging as a core factor of production, gradually replacing traditional physical resources as a unique input material. This transformation is accelerating the shift of sectors dependent on traditional means of production. In terms of distribution and exchange, the digital economy enhances resource allocation efficiency and reduces transaction costs, thereby reconfiguring the operational mechanisms of the economy. The integration of online and offline channels has given rise to new transaction models such as disintermediation and intelligent matching, leading to a steep decline in traditional marketing costs. Driven by digital technologies, market boundaries continue to expand, fostering a globalized and integrated digital market system. At the consumption level, the digital economy is profoundly reshaping consumption habits. The convenience of digital shopping continues to be amplified through expanded application scenarios, while personalized recommendation algorithms precisely stimulate consumer demand based on user preferences, significantly enhancing the stickiness of online shopping. Meanwhile, online payment technologies simplify transaction processes while ensuring security, thereby improving the overall consumption experience and satisfaction.

3. Theoretical framework of global value chains

3.1. Evolution of the value chain

The concept of the value chain refers to a value-creation system in which different specialized departments undertake distinct stages of a product or service's lifecycle—from design, raw material procurement, and manufacturing to distribution and final consumption—with the goal of maximizing efficiency. The global value chain (GVC) represents the transnational extension of this system, wherein multinational corporations or outsourcing networks allocate different segments of production to countries with comparative advantages. These advantages may lie in local labor costs, marketing capabilities, or product design, thereby optimizing the entire value creation process from concept development to market promotion across national borders.

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3.2. Mechanisms influencing division of labor

The core factors determining patterns of labor division within GVCs include institutional linkages among countries and the characteristics of intermediate goods trade. First, political relations serve as a critical foundation for collaborative division of labor; strong political trust can facilitate policy coordination and reduce trade barriers, directly promoting value chain integration. Second, differences in economic scale reflect market capacity and production capability—larger economies are more likely to emerge as core nodes in GVCs or attract value chain positioning. Third, disparities in factor endowments, such as labor, capital, natural resources, and institutional quality, determine comparative advantages and shape the international division of labor. Fourth, economic distance—rooted in geographical fixity but measured through dynamic indicators such as transportation capacity, logistics efficiency, and information connectivity—reflects the cost and complexity of international trade and GVC collaboration.

3.3. Imbalanced features of traditional division of labor

Traditional GVCs exhibit pronounced inequalities in benefit distribution. Developed countries dominate high–value-added segments such as R&D, design, and brand operations, while developing countries are often locked into low–value-added activities like assembly and processing. High entry barriers in key areas such as technology patents and brand loyalty further reinforce the monopolistic advantages of developed economies. Factor endowment differences allow developed countries to leverage scarce resources such as capital, technology, and knowledge to earn excess profits. In contrast, developing countries, reliant on easily substitutable factors such as low-cost labor and land, possess limited bargaining power. Moreover, multinational corporations frequently adopt transfer pricing strategies to compress the profit margins of developing economies.

3.4. Digital transformation and value chain restructuring

The digital economy is reshaping global value chains in terms of spatial distribution, participation models, and value creation logic. The deep integration of digital technologies into the real economy enhances efficiency in production, R&D, logistics, and other segments, thereby promoting both value-added levels and overall productivity. The development of digital infrastructure and industrial digitalization reduces the cost of international trade, lowers the entry barriers for small and medium-sized enterprises (SMEs) to engage in GVCs, and enables a broader range of countries to participate in the global division of labor more effectively.

4. Mechanism pathways of the digital economy reshaping global value chains

4.1. Mechanism of factor structure transformation

The digital economy reshapes the foundation of global value chain division by restructuring the factor endowment system: digital technologies reduce the relative importance of labor costs and enhance the marginal contribution of digital capital, driving the transformation of factor structures. First, the widespread application of automation technologies reduces labor intensity in manufacturing; the proliferation of industrial robots diminishes dependence on low-skilled labor, prompting a shift in outsourcing models from "offshoring" to "nearshoring." Second, the digital economy fosters new forms of trade in services. Developing countries can enhance their participation in global value chains by leveraging remote services such as IT services, digital outsourcing, and telecommuting. Third, the skill premium effect is intensified—income growth for high-skilled workers accelerates while the

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substitutability of low-skilled jobs increases, exacerbating the skill-based stratification of labor divisions within global value chains.

4.2. Mechanism of trade cost compression

The digital economy empowers the reduction of economic distance and trade costs through technological enablement: network effects, intelligent matching mechanisms, and the near-zero marginal cost characteristics of digital services significantly lower transaction costs and enhance SME participation. First, the widespread adoption of smart logistics systems reduces transportation losses and time costs, enabling firms to dynamically adjust their outsourcing strategies. Second, the digital platform economy shortens economic distance; cross-border e-commerce bypasses traditional distribution hierarchies and connects directly with end consumers, effectively lowering the barriers for SMEs to engage in international trade. Finally, virtual service platforms enable zero marginal cost service delivery. Online services such as Zoom and Tencent Meeting overcome geographic constraints and digitally substitute face-to-face services, reshaping the spatial structure of trade in services.

4.3. Mechanism of value distribution restructuring

The digital economy reconfigures the distribution of added value in global value chains, leading to the evolution of the "smiling curve" toward a "shallow smiling curve": data has become a core competitive element in upstream R&D activities, while AI accelerates technological innovation. Open-source technology systems reduce entry barriers for R&D, enabling SMEs to participate in high-value-added innovation activities. Digital technologies enhance the efficiency of midstream manufacturing; the industrial internet optimizes resource allocation on production lines, and 3D printing alters traditional manufacturing logic, reducing supply chain geographic dependency and improving profit margins. In downstream marketing, digital technologies enable precision and disintermediation: real-time data capture identifies consumption trends, while algorithmic marketing replaces traditional advertising, increasing input-output efficiency and helping small businesses directly reach global consumers.

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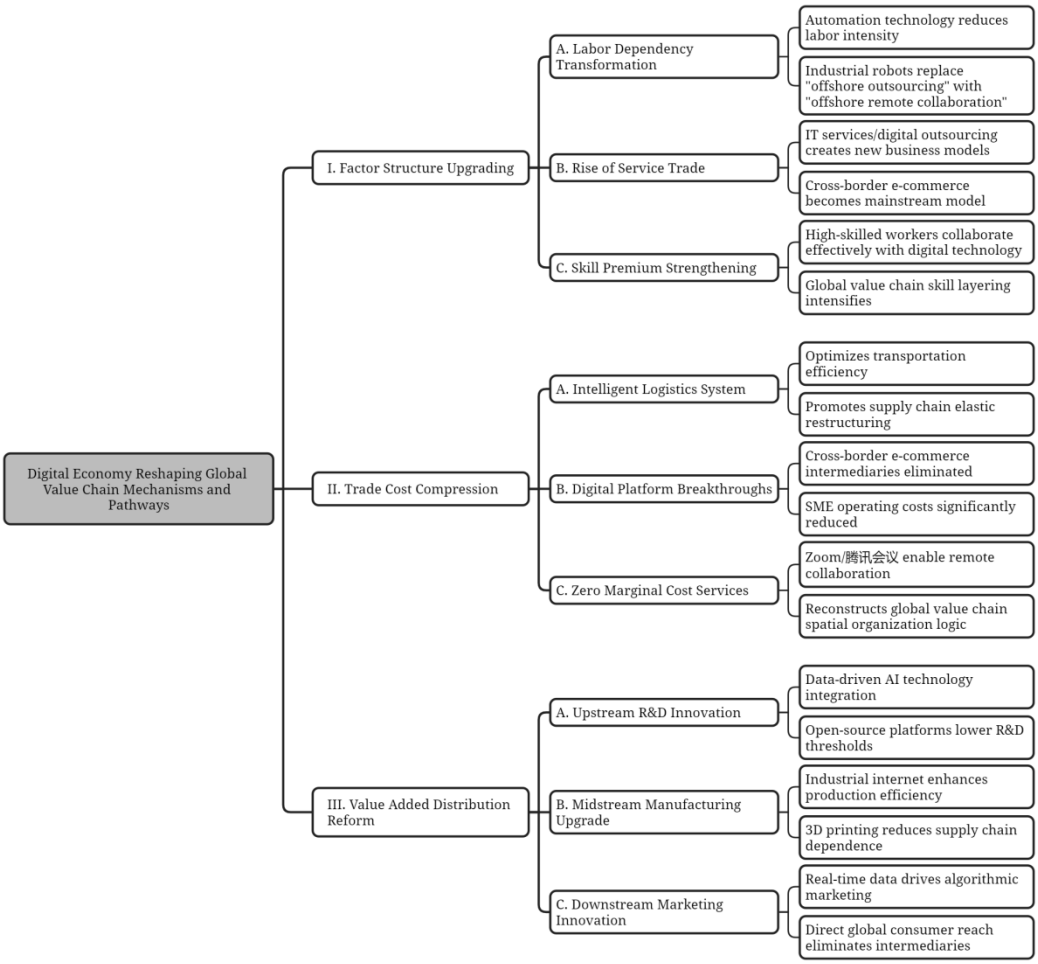

Figure 1: Mechanism pathways of the digital economy reshaping global value chains

5. Challenges and opportunities in the digital economy's reshaping of global value chain division

In the process of reshaping global value chains, the digital economy continues to encounter multiple structural challenges. The uneven pace of digitalization across countries further reinforces the dominance of developed nations. First, developed countries seize technological advantages through systematic strategic deployments, building industrial ecosystems centered around leading firms, which constrain the value chain upgrading of developing economies. Cross-border data flow rules, where data has become a key factor of production, are predominantly shaped by industry giants, exposing SMEs in developing countries to risks of weakened data sovereignty and digital colonialism. Second, a dual suppression mechanism—comprising technological monopolies and regulatory dominance—has emerged. Developed nations impose export control regimes and patent barriers to hinder technology diffusion, forcing developing countries to bear high licensing costs. Simultaneously, they reinforce their rule-making authority through high-standard digital trade agreements, creating institutional pressures on late-developing countries to conform. Finally, developing countries face a triple bottleneck of technology, capital, and infrastructure. Traditional enterprises in these regions are typically entrenched in low value-added segments of global value chains, characterized by a heavy reliance on intermediate goods, thus trapped in a "low-end lock-in"

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dilemma. Their transformation toward digitalization is hindered by high thresholds, as their asset-heavy operational models conflict with the capital-intensive demands of digital investment, leading to a persistent erosion of market competitiveness. Against this backdrop, global value chains are increasingly concentrated around digital-leading firms, further exacerbating the marginalization of small and medium-sized enterprises (SMEs).

While the digital economy gives rise to new production factors, it also creates multidimensional development opportunities for restructuring global value chains. First, the evolution toward a data-driven economic model significantly increases the technological density of industries. The penetration of technologies such as cloud computing and big data has spawned a plethora of emerging occupations, leading to structural growth in demand for digital talent and continuously expanding the employment landscape. Second, the application of digital technologies lowers market entry barriers. Enhanced access to and processing efficiency of massive data resources has catalyzed the rapid emergence of innovative SMEs. Empowered by digitally enabled precision in production and service delivery, such firms are better positioned to overcome traditional entry barriers to value chains. Finally, platform-based data ecosystems break the limitations of geographic space. Through digital service model innovation, firms can access global markets and form "micro-globalization" development pathways, providing strategic opportunities for upgrading the service value chain.

6. Conclusion and policy recommendations

As a new driving force of global economic development, the digital economy is systematically reshaping the division of labor and value creation logic within global value chains. A multidimensional analysis of the digital economy reveals that its core lies in the synergistic advancement of three pillars: the systematic construction of digital infrastructure, the in-depth development of digital industries, and the digital transformation of traditional industries. Empirical research shows that the development of the digital economy across China’s provincial-level administrative regions displays significant gradient differences. While more developed provinces continue to lead, less developed regions, despite catching up in some areas, remain at a relatively low level overall—highlighting the spatial imbalance in digital factor allocation. From the perspective of global value chain evolution, the digital economy is driving the transformation of the traditional "smiling curve" into a digital "shallow smiling curve" through three key mechanisms: restructuring of factor endowments, compression of transaction costs, and optimization of value distribution. This transformation is manifested in several ways: automation technologies weaken the comparative advantage of low-skilled labor; digital platforms empower SMEs to break through market entry barriers; data factors reshape the competitiveness of R&D and manufacturing processes; and digital marketing enables the disintermediation and precision of value transmission. However, structural contradictions—such as technological monopolies, delayed digital transformation in developing countries, and conflicts in cross-border data regulation—continue to constrain the inclusive development of global value chains.

To address the ongoing restructuring of global value chains driven by the digital economy, a three-dimensional response strategy is recommended: For policymakers, strategic coordination should be strengthened to lower participation thresholds through digital infrastructure development and institutional innovation, with a focus on cultivating indigenous digital innovation capacities to overcome technological dependency. For enterprises, the current digital transformation window should be seized to fully explore the multiplier effects of data factors. Through integrated innovation that combines digital technologies with core business operations, firms can achieve an upward shift in their value chain positioning. For the international community, there is an urgent need to establish mechanisms for technological cooperation and frameworks for digital governance. These should aim to safeguard data sovereignty while advancing mutual recognition of cross-border digital rules,

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ultimately fostering an inclusive digital economy development ecosystem. Research confirms that only through collaborative innovation across multiple stakeholders can the digital economy truly drive efficiency improvements and sustainable development in global value chains.

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