Journal of Economics and Technology Research
ISSN 2690-3695 (Print) ISSN 2690-3709 (Online)
Vol. 5, No. 2, 2024
www.scholink.org/ojs/index.php/jetr

Original Paper

Research on the Impact of Digital Trade on the Reconstruction of Global Value Chains —An Empirical Analysis Based on Cross-national Panel Data

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Received: May 15, 2024 Accepted: May 25, 2024 Online Published: June 2, 2024

doi:10.22158/jetr.v5n2p43 URL: http://dx.doi.org/10.22158/jetr.v5n2p43

Abstract

With increasing refinement in production, advancements in information technology, and optimized transport, enterprise value chains have become global. This international division of labor based on Global Value Chains (GVCs) has driven economic growth but also caused issues like income disparity and status inequality. Developed countries aim to maintain dominance in GVCs, while developing countries seek greater participation and advancement within them. For developing nations, breaking the "low-end lock" in GVCs is crucial. This paper empirically examines the complex relationship between digital trade and global value chain reconstruction, and explores the moderating effect of institutional environmental factors on the above relationships. This enriches the research perspective and expands the research at the intersection of digital trade and value chain. Findings suggest that digital trade affects China's position and participation in global value chains, with institutional quality and economic freedom moderating these effects. This research contributes to understanding the complex dynamics of digital trade and value chain reconstruction, highlighting China's potential to ascend the global value chain through digital trade development.

Keywords

global value chain reconstruction, digital trade, institutional quality, economic freedom

1. Introduction

Since the 1990s, with the increasing refinement of production processes, the liberalization and facilitation of trade and investment, the rapid development of information technology, and the continuous optimization of transportation, production chains have gradually lengthened, and trade in intermediate goods has rapidly expanded. The national attributes of final products have become increasingly blurred, making the global value chain-based international division of labor the new normal. As one of the key participants in the global value chain, China has deeply integrated into it through comparative advantages such as its demographic dividend and low land costs. This integration has enabled China to gradually grow into the world's largest trading nation and an emerging power with one of the most comprehensive and complete industrial chains. However, within the global value chain division of labor dominated by developed economies, developing economies often find themselves in a passive position, with pronounced imbalances in the distribution of benefits. Developing countries are striving to break this imbalance and promote the restructuring of the global value chain in a direction more favorable to themselves.

Meanwhile, trade protectionism and disputes between countries and regions have never ceased, with the trend of economic de-globalization becoming evident. The level of production fragmentation has continued to decline, leading to stagnation in the development of global value chains (Miroudot & Nordström, 2020). The major powers' strategic competition has gradually politicized trade issues, driving the restructuring of global value chains in a more complex and diversified direction. Some developed countries have deepened their regional integration by establishing high-standard international trade and economic rules, attempting to continuously dominate the restructuring of global value chains and suppress the economic rise of developing countries. For instance, the global value chain restructuring advocated by the United States, particularly in trade and technology sectors, has led to the implementation of "decoupling" policies towards China. This has had a significant impact on China's import and export trade, subsequently affecting its economic development and international image. How China can seize the initiative in the restructuring of global value chains and reshape its international competitiveness is a pressing and significant practical issue that needs to be addressed.

Although external shocks have accelerated the restructuring of global value chains, the core factors influencing this trend are technological innovation and the optimization of resource allocation. A new round of technological revolution and industrial transformation is reshaping the global innovation landscape and restructuring the global economic framework, providing opportunities for developing countries to seize the initiative in global value chains. Data, as a link connecting global resources, is driving the transition of global value chains from traditional chain structures to closely linked network structures, embedding digital products deeply into the global production division system. This is becoming a new engine for China's foreign trade. The report of the 20th National Congress of the

Communist Party of China proposed that China should "develop digital trade and accelerate the construction of a trade power". In 2022, China's exports of services that can be digitally delivered amounted to USD 210.54 billion, an increase of 7.6% year-on-year. Customs data shows that in 2022, the scale of China's cross-border e-commerce imports and exports reached RMB 2.11 trillion, an increase of 9.8%, of which exports amounted to RMB 1.55 trillion, growing by 11.7%. It is evident that digital trade has become a new driver for the high-quality development of China's foreign trade, a "golden key" to seizing opportunities in the digital era in global value chains.

Based on this, this paper intends to explore whether digital trade, supported by digital technology, can effectively promote China's proactive restructuring of global value chains. What are the specific mechanisms and pathways of its impact? By developing digital trade, the aim is to help China proactively restructure global value chains and the international distribution of benefits, escape the "mid-low end lock-in" dilemma, ascend to the high end of global value chains, and promote a higher level of opening-up, thus holding significant practical value.

2. Literature Review

In contrast to the expectations of developed economies, which focus on restructuring global value chains, this paper emphasizes the relevant literature on developing countries driving the reconstruction of global value chains. It explores the relationship between digital trade, supported by digital technology, and the restructuring of global value chains led by developing countries, as well as the intrinsic mechanisms at play.

There is some controversy in existing research on how digital technology impacts the restructuring of global value chains. Some scholars argue that the new wave of digital information revolution represents a significant opportunity for developing countries to restructure global value chains. Huang Liangxiong et al. (2023) found that the application of industrial robots significantly reduced the technological gap between developing and developed economies, helping developing economies to achieve leapfrogging development and promoting the restructuring of global value chains in a manner favorable to developing economies. Conversely, some scholars believe that digital technology will shorten global value chains, resulting in faster changes in consumer preferences and rapidly increasing capital intensity, which could exert greater pressure on developing economies. Alternatively, the impact of data elements on the restructuring of global value chains may have a dual nature, with a trend towards blockization under the leadership of European and American countries (Yi Ziyu et al., 2023), resulting in a stagnation of the overall global value chain.

Although the academic community pays significant attention to how digital technology impacts the restructuring of global value chains, an effective consensus has not yet been reached. Moreover, current research mainly proposes relevant research topics, largely remaining at the theoretical level, lacking

systematic theoretical frameworks, and empirical verification. Loonama and O'Regan (2022), through a review of literature, discussed the development strategies of digital trade platforms and global value chains. Dilyard et al. (2021) discussed the potential value of digital trade in enhancing the resilience of global value chains. Only a few scholars have empirically explored the issues related to digital trade and the restructuring of global value chains. For example, Zhu Qin and Zhou Xiangxiang (2024) confirmed that the significant development of urban digital trade has promoted the elevation of global value chain status.

Overall, scholars have not yet reached a consensus on the research questions related to digital technology and the restructuring of global value chains, and there has been limited empirical testing of the relationship and intrinsic mechanisms between the two. There is significant room for expansion in related research. Regarding the restructuring of global value chains, scholars have studied it alongside themes such as trade friction and high-quality development. Regarding digital trade, scholars have focused on issues such as digital trade barriers and digital service exports. However, there is insufficient empirical testing of the impact of digital trade on the restructuring of global value chains, which requires further exploration.

3. Theoretical Analysis and Research Hypotheses

3.1 Digital Trade and the Restructuring of the Global Value Chain

Digital trade is emerging as a new driving force for global trade growth and a key factor in restructuring global value chains. Scholars generally agree that digital trade disrupts the temporal and spatial attributes of trade, which will fundamentally reshape the division of labor in global value chains and reconstruct the pattern of globalization. Specifically, on one hand, digital trade strengthens the synergistic sharing of digital information among countries and industries, promotes the digital transformation of traditional industries, and ascends towards the high end of global value chains. On the other hand, digital trade drives the development of digital products and facilitates the formation of new value chains.

Focusing on participation in global value chains, as analyzed by Koopman et al. (2014), participation consists of two parts: forward participation and backward participation. The former refers to a country's ability to provide intermediate products to trading partner countries, indicating participation in upstream activities such as research and development, design, and precision component manufacturing in the value chain. The latter represents the share of intermediate inputs from trading partner countries in a country's exports of final goods, primarily indicating participation in assembly and manufacturing processes.

Based on this, domestic and foreign scholars have found that the direction of changes in forward and backward participation in global value chains often exhibits heterogeneity. According to the calculation

formula for global value chain participation, when the increase in forward participation in the global value chain is less than the decrease in backward participation, the overall global value chain participation decreases, and vice versa. The relative participation index of the global value chain represents the participation index of trading partner country i relative to China. When the value added by the trading partner country is greater than that of China, the relative participation index of the global value chain increases. Based on existing research, digital trade has a certain inhibitory effect on the backward participation in global value chains and a significant promoting effect on forward participation in global value chains. The magnitude of the changes in both factors exhibits uncertainty and volatility. Therefore, this paper proposes the following competitive research hypotheses:

H1a: Digital trade has a positive impact on the relative participation index of the global value chain.

H1b: Digital trade has a negative impact on the relative participation index of the global value chain.

According to the calculation formula for global value chain position, when the forward participation in the global value chain exceeds the backward participation, the index is positive; when the increase in value added from forward participation in the global value chain is higher than that from backward participation, the global value chain position improves. Observing the data on China's global value chain from 2014 to 2020, it is found that China's value has always been negative, indicating that the forward participation in the global value chain is lower than the backward participation. The relative position index of the global value chain is calculated as the difference between the global value chain position of trading partner country i and that of China, multiplied by 100. When China's value added is greater than that of the trading partner country, the relative position index of the global value chain decreases.

Digital trade can help countries participate in knowledge-intensive industries upstream in the value chain, significantly increasing forward participation in the global value chain, thereby improving the global value chain position. Huang Qiong and Li Nana (2019) found that the factors affecting developing countries and developed countries are different. The former are mainly technological innovation and the quality of talent, while the latter are the quality of talent, institutional quality, and level of public services. Digital trade mainly promotes the improvement of global value chain position through channels such as knowledge spillover effects and incentives for independent innovation. Therefore, its effectiveness for developing countries is slightly better than for developed countries. Based on this, this paper proposes the following research hypothesis:

H2: Digital trade has a negative impact on the relative position index of the global value chain.

3.2 The Moderating Effect of Administrative and Judicial Institutional Quality

The quality of administrative and judicial systems refers to the completeness and enforcement of a country's administrative and judicial laws and regulations. In this study, it is measured using the World Bank's Worldwide Governance Indicators (WGI). China has consistently prioritized national

governance, and leveraging the WGI to study its current state helps refine the modernization standards of China's governance capabilities and better assimilate global governance experiences.

Scholars argue that institutional quality is a crucial comparative advantage when it comes to participating in international division of labor and foreign trade. Empirical evidence has confirmed its significant positive impact on the global value chain position. Objectively, the quality of administrative and judicial institutions varies over time and across countries. Higher institutional quality implies a stable business environment, high-quality contract enforcement, and a robust intellectual property protection system, which can reduce uncertainty and transaction costs for businesses, incentivize technological innovation and foreign investment, and provide a favorable external environment for driving the ascent of the global value chain through digital trade.

With the development of digital trade, the modes of production and delivery of products are gradually changing, providing more opportunities for enterprises in various countries to participate in different stages of the global value chain, thus aiding their ascent to the upstream of the global value chain. It can be seen that digital trade under any level of institutional quality has a promoting effect on the improvement of the global value chain position of each economy, making it difficult to directly determine the comparison between trading partner country i and China. Therefore, this paper proposes the following competitive research hypotheses:

H3a: The quality of administrative and judicial institutions weakens the impact of digital trade on the relative position index of the global value chain.

H3b: The quality of administrative and judicial institutions strengthens the impact of digital trade on the relative position index of the global value chain.

3.3 The Moderating Effect of Economic Institutional Freedom

Scholars generally believe that higher economic freedom enhances domestic economic growth and deepens a country's trade connections with others. Mahmood et al. (2022) found that GDP growth in Asia-Pacific countries depends on economic freedom, which directly affects economic development and indirectly influences research and development environments. Abate (2022) explored the role of economic freedom and institutional quality in the relationship between foreign aid and economic growth in developing countries, emphasizing the importance of increasing economic freedom. Numerous research results demonstrate a positive relationship between economic freedom and economic outcomes. Increasing economic freedom helps enhance a country's economic vitality and better integrate into international division of labor and trade cooperation.

Therefore, this paper argues that an increase in Economic Freedom (EF) will promote the enhancement of global value chain participation. Additionally, the promotional effect is more significant for countries with relatively lower rankings in economic freedom. As the relative participation index is the ratio of a trading partner country's global value chain participation to that of China, this paper suggests that

economic freedom may weaken the positive relationship between digital trade and the relative participation index of the global value chain or strengthen the negative relationship. Thus, the following research hypothesis is proposed:

H4: Economic freedom weakens the impact of digital trade on the relative participation index of the global value chain.

4. Research Design

4.1 Model Construction

This article constructs linear and nonlinear models for both the development Level of Digital Trade (lnDT) and the Global Value Chain (GVC) Restructuring Index (subdivided into the Relative Position Index and the Relative Participation Index), to examine their linear and nonlinear effects. Considering the lagged impact of digital trade on GVC restructuring and the reverse causality between variables, the explanatory variable lnDT is lagged by one period, and all control variables in the models are also lagged by one period. The fixed effects model constructed is as follows:

$$RGVCpos_{it} = \beta_0 + \beta_1 lnDT_{i(t-1)} + \beta_2 X_{i(t-1)} + \mu_i + \lambda_t + \varepsilon_{it} \quad (4.1)$$

$$RGVCpat_{it} = \beta_0 + \beta_1 lnDT_{i(t-1)} + \beta_2 X_{i(t-1)} + \mu_i + \lambda_t + \varepsilon_{it} \quad (4.2)$$

$$RGVCpos_{it} = \beta_0 + \beta_1 lnDT_{i(t-1)} + \beta_2 lnDT^2_{i(t-1)} + \beta_3 X_{i(t-1)} + \mu_i + \lambda_t + \varepsilon_{it} \quad (4.3)$$

$$RGVCpat_{it} = \beta_0 + \beta_1 lnDT_{i(t-1)} + \beta_2 lnDT^2_{i(t-1)} + \beta_3 X_{i(t-1)} + \mu_i + \lambda_t + \varepsilon_{it} \quad (4.4)$$

Whereby, the dependent variables are the relative position index of the global value chain ($RGVCpos$) and the relative participation index of the global value chain ($RGVCpat$), the explanatory variables are the lagged one-period values of the country's level of digital trade development $lnDT_{i(t-1)}$ and its square term $lnDT^2_{i(t-1)}$, i represents the country code, t represents time, $X_{i(t-1)}$ represents control variables, μ_i represents country-specific effects, λ_t represents time effects, and ε_{it} represents the random error term.

To examine the moderating effects of the quality of administrative rule of law institutions (IQ) and economic freedom (EF), this paper further constructs the following model:

$$RGVCpos_{it} = \eta_0 + \eta_1 lnDT_{i(t-1)} + \eta_2 lnDT_{i(t-1)} * IQ_{i(t-1)} + \eta_3 IQ_{i(t-1)} + \eta_4 X_{i(t-1)} + \mu_i + \lambda_t + \varepsilon_{it} \quad (4.5)$$

$$RGVCpos_{it} = \eta_0 + \eta_1 lnDT_{i(t-1)} + \eta_2 lnDT_{i(t-1)} * EF_{i(t-1)} + \eta_3 EF_{i(t-1)} + \eta_4 X_{i(t-1)} + \mu_i + \lambda_t + \varepsilon_{it} \quad (4.6)$$

$$RGVCpat_{it} = \eta_0 + \eta_1 lnDT_{i(t-1)} + \eta_2 lnDT^2_{i(t-1)} + \eta_3 lnDT_{i(t-1)} * IQ_{i(t-1)} + \eta_4 lnDT^2_{i(t-1)} * IQ_{i(t-1)} + \eta_5 IQ_{i(t-1)} + \eta_6 X_{i(t-1)} + \mu_i + \lambda_t + \varepsilon_{it} \quad (4.7)$$

$$RGVCpat_{it} = \eta_0 + \eta_1 lnDT_{i(t-1)} + \eta_2 lnDT^2_{i(t-1)} + \eta_3 lnDT_{i(t-1)} * EF_{i(t-1)} + \eta_4 lnDT^2_{i(t-1)} * EF_{i(t-1)} + \eta_5 EF_{i(t-1)} + \eta_6 X_{i(t-1)} + \mu_i + \lambda_t + \varepsilon_{it} \quad (4.8)$$

Where $IQ_{i(t-1)}$ represents the quality of administrative rule of law institutions, $EF_{i(t-1)}$ represents economic freedom; $lnDT_{i(t-1)} * IQ_{i(t-1)}$ represents the interaction term between the level of digital trade development and the quality of administrative rule of law institutions, $lnDT^2_{i(t-1)} * IQ_{i(t-1)}$ represents the interaction term between the square of the level of digital trade development and the quality of administrative rule of law institutions; $lnDT_{i(t-1)} * EF_{i(t-1)}$ represents the interaction term between the level of digital trade development and economic freedom, $lnDT^2_{i(t-1)} * EF_{i(t-1)}$ represents the interaction term between the square of the level of digital trade development and economic freedom; other variables remain the same as in the baseline regression.

4.2 Index Construction and Variable Description

4.2.1 Dependent Variable: Global Value Chain Relative Position Index ($RGVCpos$)

Drawing on the WWYZ method, the Global Value Chain Position Index is constructed as follows:

$$GVCPOS = ln(1 + GVCPT_{-f}) - ln(1 + GVCPT_{-b}) \quad (4.9)$$

Where the forward participation in the global value chain $GVCPT_{-f}$ refers to the share of intermediate goods exports in a country's total exports, indicating the ability to participate in upstream activities such as research and design, and precision component production in the value chain. Backward participation in the global value chain $GVCPT_{-b}$ refers to the share of intermediate inputs from trading partner countries in a country's final goods exports, reflecting the degree of dependence on intermediate goods from other countries or regions.

$$RGVCpos = 100 * (GVCPOS_{it} - GVCPOS_{ct}) \quad (4.10)$$

The Global Value Chain Relative Position Index $RGVCpos$ represents the position index of trading partner country i relative to China. Drawing on the calculation method by He Yaping (2021), the relative position index is calculated as the difference between the trading partner country i's global value chain position $GVCPOS_{it}$ and China's global value chain position $GVCPOS_{ct}$, multiplied by 100. A larger $RGVCpos$ indicates a higher relative position of the trading partner country compared to China.

4.2.2 Dependent Variable: Global Value Chain Relative Participation Index ($RGVCpat$)

The measurement of global value chain participation is as follows:

$$GVCPT = GVCPT_{-f} + GVCPT_{-b} \quad (4.11)$$

$$RGVCpat = GVCPT_{it} / GVCPT_{ct} \quad (4.12)$$

The Global Value Chain Relative Participation Index $RGVCpat$ represents the relative global value chain participation index of trading partner country i relative to China. Drawing on the calculation method by Han Shenchao (2023), the relative participation index is calculated as the ratio of trading partner country i's global value chain participation $GVCPT_{it}$ to China's global value chain participation

$GVCPT_{\alpha}$. A larger $RGVCpat$ indicates a deeper level of global value chain participation by trading partner country i relative to China in the given year.

4.2.3 Independent Variable: Digital Trade Development Index (lnDT)

This study adopts the Digital Trade Development Index evaluation system established by Feng Zongxian and Duan Dingyun (2022), which consists of six dimensions including digital innovation and digital infrastructure. Considering the characteristics of the data, this study multiplies it by 100 before taking the logarithm. A higher score on this index indicates a better level of digital trade development in the country.

4.2.4 Control Variables

Table 1. Control Variables

Variable Names	Variable Symbols	Variable Definitions
Economic development level	lnpGDP	The natural logarithm of the per capita Gross Domestic Product
Trade openness	TOpen	The share of the total value of goods and services imports and exports in GDP
Physical capital stock	Capital	The percentage of gross capital formation to GDP
Scientific and technological level	Tech	The natural logarithm of the export value of high-tech products.
Labor force resources	Labour	The percentage of the population aged 15-64 years old in the total population.

4.2.5 Moderator Variables: Quality of Administrative Legal System (IQ) and Economic Freedom (EF)

This paper adopts the World Bank's Worldwide Governance Indicators (WGI) to measure the quality of a country's administrative legal system environment. The WGI index consists of six dimensions, including voice and accountability, political stability and absence of violence, government effectiveness, regulatory quality, rule of law, and control of corruption. The values of these six indicators range between -2.5 and +2.5, with positive scores indicating higher quality of the administrative legal system and better governance level of the country.

This paper selects the Economic Freedom Index published by The Wall Street Journal and The Heritage Foundation to measure the Economic Freedom of countries (EF). The sub-indices of this index cover non-tariff barriers, price controls, foreign exchange controls, and others. The numerical range for each index is from 0 to 100. A higher level of economic freedom indicates a more sound institutional mechanism, lower trade costs, and greater trade facilitation.

4.3 Sample Selection and Data Sources

To further explore the relationship between digital trade and the reconstruction of the global value chain, considering the continuity and availability of data, a sample of 40 countries from different continents and at different stages of economic development is used. The data covers the period from 2014 to 2020, with a total of 280 observations.

The indices used include the Global Value Chain Relative Position Index (^{RGVCpos}) and the Global Value Chain Relative Participation Index (^{RGVCpat}), sourced from the UIBE GVC Index database of the University of International Business and Economics; the Digital Trade Development Index (lnDT), which is based on the evaluation system developed by Feng Zongxian and Duan Dingyun (2022) and sourced from official public data such as the World Economic Forum (WEF); control variables such as the Level of Economic Development (lnpGDP), Trade Openness (TOpen), Market Size (lnPopu), Physical Capital Stock (Capital), Scientific and Technological Level (Tech), and Labor Resources (Labour) are obtained from the World Development Indicators database (WDI); while moderator variables like the quality of administrative legal system (IQ) are sourced from the Worldwide Governance Indicators database (WGI), and Economic Freedom (EF) is obtained from reports by The Wall Street Journal and The Heritage Foundation.

5. Empirical Result Analysis

5.1 Baseline Regression Results

5.1.1 Analysis of the Impact of Digital Trade Development Index on the Relative Position Index of Global Value Chains

The table below presents the regression results of the Digital Trade Development Index and the Relative Position Index of Global Value Chains. Model 1 is the basic model without control variables, including only the lagged explanatory variable L.lnDT, the explained variable RGVCpos, and fixed effects. Model 2 is a linear model that includes all control variables in addition to those in Model 1. Model 3, based on Model 1, incorporates the quadratic term of the lagged explanatory variable L.lnDT2 to examine the existence of nonlinear relationships.

From the regression results of Model 1, it can be observed that digital trade has a significant negative impact on the Relative Position Index of Global Value Chains. For every one-unit increase in the Digital Trade Development Index, the Relative Position Index of Global Value Chains decreases by approximately 9.9 units. Since the Relative Position Index of Global Value Chains reflects the situation of trading partner countries relative to China, for every one-unit increase in the Digital Trade Development Index, China's global value chain position will increase relative to trading partner country i by 9.9 units. This result is consistent with theoretical analysis and greatly encourages China to further increase its development and support for digital trade, enabling it to gain a first-mover

advantage in this fiercely competitive field.

Comparative analysis of the regression results between Model 2 and Model 3 reveals that the coefficient of the Digital Trade Development Index is significantly negative at the 1% level, while the coefficient of the quadratic term of the Digital Trade Development Index is not significant. This indicates that digital trade has a significant negative impact on the Relative Position Index of Global Value Chains, confirming research hypothesis H2, which suggests that increasing the level of digital trade development can directly and significantly enhance China's relative Global Value Chain (GVC) position compared to its trading partner country i.

The reason behind this lies in the ability of digital trade to significantly enhance the forward participation $GVCPT\_f$ of countries in the global value chain. When a country's value added from forward participation $GVCPT\_f$ in the global value chain exceeds its value added from backward participation $GVCPT\_b$, the Global Value Chain Position Index $GVCPOS$ increases. Digital trade primarily promotes the ascent of global value chain positions through channels such as knowledge spillover effects and incentives for independent innovation, with slightly better effects on developing countries compared to developed ones. As more than half of the sampled countries in this study are developed countries, China's overall increase in the Global Value Chain Position Index exceeds that of its trading partners.

Table 2. The Benchmark Regression Results of the Digital Trade Development Index and the Relative Position Index of Global Value Chains

Variable Name	Model（1）	Model（2）	Model（3）
	RGVCpos	RGVCpos	RGVCpos
L.lnDT	-9.9086***	-10.8477***	-8.4599**
	(2.9731)	(3.2673)	(3.8353)
L.lnDT2			6.1775
			(4.8634)
L.lnpGDP		0.5041	0.0291
		(5.1014)	(5.1329)
L.TOpen		0.0128	0.0090
		(0.0365)	(0.0363)
L.lnPopu		-3.6270	-2.6866
		(16.6209)	(16.6227)
L.Capital		0.0911	0.0952
		(0.0861)	(0.0856)
L.Tech		0.8834	0.8638

		(1.1797)	(1.1725)
L.Labour		-0.0326	0.0553
		(0.2827)	(0.2902)
_cons	45.5729***	84.9767	59.1550
	(11.6474)	(264.0898)	(266.1857)
Individual effects	YES	YES	YES
Time effect	YES	YES	YES
N	240.0000	240.0000	240.0000
r2	0.9110	0.9137	0.9143

Standard errors in parentheses

* p < 0.1, ** p < 0.05, *** p < 0.01

5.1.2 Analysis of the Impact of the Digital Trade Development Index on the Relative Participation Index in Global Value Chains

The table below presents the regression results of the Digital Trade Development Index and the Relative Participation Index in Global Value Chains. Model 1 is a linear model that includes the lagged explanatory variable L.lnDT, the dependent variable RGVCpat, control variables, and fixed effects. Model 2 is a nonlinear model that does not include control variables but includes the lagged explanatory variable L.lnDT, the lagged explanatory variable squared term L.lnDT2, the dependent variable RGVCpat, and fixed effects. Model 3, based on Model 2, includes all control variables.

Table 3. The Benchmark Regression Results of the Digital Trade Development Index and the Relative Participation Index in Global Value Chains

Variable Name	Model（1）	Model（2）	Model（3）
	RGVCpat	RGVCpat	RGVCpat
L.lnDT	0.2699	0.5097*	0.6478**
	(0.2729)	(0.2921)	(0.3141)
L.lnDT2		0.8113*	0.9779**
		(0.4613)	(0.4339)
L.lnpGDP	0.2991		0.2239
	(0.2875)		(0.2983)
L.TOpen	0.0115***		0.0109***
	(0.0023)		(0.0023)
L.lnPopu	-1.5207*		-1.3718
	(0.9026)		(0.9217)

L.Capital	0.0034		0.0040
	(0.0045)		(0.0045)
L.Tech	-0.3583***		-0.3614***
	(0.0995)		(0.0994)
L.Labour	0.0498*		0.0637**
	(0.0297)		(0.0283)
_cons	27.0941*	-0.6363	23.0066
	(15.0524)	(1.1602)	(15.4477)
Individual effects	YES	YES	YES
Time effect	YES	YES	YES
N	240.0000	240.0000	240.0000
r2	0.9881	0.9849	0.9884

Standard errors in parentheses

* p < 0.1, ** p < 0.05, *** p < 0.01

Comparing the regression results of Model 1 and Model 3, it is found that the coefficient of the quadratic term of the Digital Trade Development Index is significantly positive at the 5% level, while the coefficient of the Digital Trade Development Index itself is not significant. Additionally, since the coefficient of the lagged Digital Trade Development Index (L.lnDT) in Model 3 is positive and the coefficient of the lagged quadratic term of the Digital Trade Development Index (L.lnDT2) is also positive, it indicates that the inflection point of the U-shaped curve is to the left of the coordinate system. Moreover, since both lnDT and RGVCpat have minimum values greater than 0, the quadratic term of the Digital Trade Development Index directly and positively influences the Relative Participation Index in Global Value Chains, indicating a monotonic relationship between digital trade and the Relative Participation Index in Global Value Chains, rather than a "U-shaped" relationship.

From Models 2 and 3, it can be inferred that the quadratic term of the Digital Trade Development Index significantly and positively affects the Relative Participation Index in Global Value Chains, and after adding control variables, it is significant at the 5% level. This suggests that the promotion effect of digital trade on trade partner countries' participation in global value chains is more significant than its effect on China, confirming research hypothesis H1a.

The reason for this may lie in the fact that while digital trade significantly enhances the forward participation in global value chains, it also has a certain inhibitory effect on backward participation in global value chains, and the magnitude of the changes in both directions fluctuates and is uncertain. Data shows that major trading countries such as China, Japan, and the United States have successively reduced their participation in global value chains. From 2018 to 2020, China's overall participation in

global value chains has continuously declined.

5.2 Moderating Effects Analysis

This study further examines the moderating effects of the quality of administrative rule of law (IQ) and Economic Freedom (EF) on the relationship between Digital Trade (lnDT) and the Relative Position Index in Global Value Chains (GVCpat), as well as the Relative Participation Index in Global Value Chains (RGVCpat).

(1) Moderating Effects of Administrative Rule of Law Quality

Given the significant negative correlation between the Digital Trade Development Index and the Relative Position Index in Global Value Chains, and the significant positive correlation between the quadratic term of the Digital Trade Development Index and the Relative Participation Index in Global Value Chains, this study constructs moderation effect models accordingly.

Model 1 reports the benchmark regression results of the Digital Trade Development Index and the Relative Position Index in Global Value Chains, while Model 2 incorporates the quality of administrative rule of law (IQ) and the interaction term between the Digital Trade Development Index and the quality of administrative rule of law (lnDT*IQ). Model 3 reports the benchmark regression results of the Digital Trade Development Index and the Relative Participation Index in Global Value Chains, and Model 4 adds the quality of administrative rule of law (IQ), the interaction term between the Digital Trade Development Index and the quality of administrative rule of law (lnDT*IQ), and the interaction term between the quadratic term of the Digital Trade Development Index and the quality of administrative rule of law (lnDT2*IQ) to the regression.

The regression results of Model 2 show that the coefficient of the interaction term between the Digital Trade Development Index and the quality of administrative rule of law (IQ*lnDT) is significantly positive at the 5% level. This coefficient, opposite in sign to that of the Relative Position Index in Global Value Chains, indicates that the quality of administrative rule of law weakens the negative relationship between “digital trade” and “Relative Position Index in Global Value Chains”, confirming research hypothesis H3a. This may be attributed to the overall higher quality of institutional systems in trading partner countries, providing a favorable external environment for digital trade to drive the ascent of global value chains.

The regression results of Model 4 show that the quality of administrative rule of law has no moderating effect on the relationship between “digital trade” and “Relative Participation Index in Global Value Chains.”

Table 4. Regression Results of the Moderating Effect of Administrative Rule of Law Quality

Variable Name	Model（1）	Model（2）	Model（3）	Model（4）
	RGVCpos	RGVCpos	RGVCpat	RGVCpat
L.lnDT	-10.8477***	-6.4535*	0.6478**	0.8520**
	(3.2673)	(3.7464)	(0.3141)	(0.3869)
L.lnDT2			0.9779**	0.7343
			(0.4339)	(0.8756)
L.IQ		-0.2407		0.0032
		(0.3710)		(0.0290)
L.lnDT*IQ		1.2128**		-0.0627
		(0.5481)		(0.0738)
L.lnDT2*IQ				-0.1467
				(0.1244)
L.lnpGDP	0.5041	0.7690	0.2239	0.2798
	(5.1014)	(5.3399)	(0.2983)	(0.3210)
L.TOpen	0.0128	0.0055	0.0109***	0.0107***
	(0.0365)	(0.0370)	(0.0023)	(0.0024)
L.lnPopu	-3.6270	1.2922	-1.3718	-1.6927
	(16.6209)	(16.7061)	(0.9217)	(1.0327)
L.Capital	0.0911	0.0920	0.0040	0.0035
	(0.0861)	(0.0855)	(0.0045)	(0.0047)
L.Tech	0.8834	0.6120	-0.3614***	-0.3509***
	(1.1797)	(1.1772)	(0.0994)	(0.1007)
L.Labour	-0.0326	-0.0758	0.0637**	0.0769**
	(0.2827)	(0.2745)	(0.0283)	(0.0321)
_cons	84.9767	-8.3760	23.0066	26.0114
	(264.0898)	(270.3049)	(15.4477)	(17.2986)
Individual effects	YES	YES	YES	YES
Time effect	YES	YES	YES	YES
N	240.0000	240.0000	240.0000	240.0000
r2	0.9137	0.9161	0.9884	0.9885

Standard errors in parentheses

* p < 0.1, ** p < 0.05, *** p < 0.01

(2) Moderating Effects of Economic Freedom

Model 1 reports the baseline regression results of the Digital Trade Development Index and the Global Value Chain Relative Position Index. Model 2 includes the Economic Freedom (EF) variable and the interaction term between the Digital Trade Development Index and Economic Freedom (lnDT*EF). Model 3 reports the baseline regression results of the Digital Trade Development Index and the Global Value Chain Relative Participation Index. Model 4 incorporates the Economic Freedom (EF) variable, the interaction term between the Digital Trade Development Index and Economic Freedom (lnDT*EF), and the interaction term between the squared Digital Trade Development Index and Economic Freedom (lnDT2*EF).

The regression results of Model 4 show that the coefficient of the interaction term between the squared Digital Trade Development Index and Economic Freedom (lnDT2*EF) is significantly negative at the 1% level. This coefficient is opposite in sign to that of the Global Value Chain Relative Participation Index, indicating that Economic Freedom has a significant inhibitory effect on the relationship between the Digital Trade Development Index and the Global Value Chain Relative Participation Index, thus confirming research hypothesis H4. A possible reason is that an increase in Economic Freedom promotes the participation in the Global Value Chain, with the effect being more pronounced for countries with lower rankings in Economic Freedom.

The regression results of Model 3 indicate that Economic Freedom does not have a moderating effect on the relationship between the Digital Trade Development Index and the Global Value Chain Relative Position Index.

Table 5. Regression Results of the Moderating Effect of Economic Freedom

Variable Name	Model（1）	Model（2）	Model（3）	Model（4）
	RGVCpos	RGVCpos	RGVCpat	RGVCpat
L.lnDT	-10.8477***	-11.1659***	0.6478**	0.7734**
	(3.2673)	(3.5144)	(0.3141)	(0.3208)
L.lnDT2			0.9779**	0.5234
			(0.4339)	(0.5010)
L.EF		-0.1172		-0.0021
		(0.0971)		(0.0072)
L.lnDT*EF		-0.1341		-0.0270
		(0.2375)		(0.0239)
L.lnDT2*EF				-0.1074***
				(0.0395)
L.lnpGDP	0.5041	1.4742	0.2239	0.4356

	(5.1014)	(5.2473)	(0.2983)	(0.3119)
L.TOpen	0.0128	0.0133	0.0109***	0.0105***
	(0.0365)	(0.0363)	(0.0023)	(0.0022)
L.lnPopu	-3.6270	-2.7028	-1.3718	-1.4147
	(16.6209)	(16.9779)	(0.9217)	(0.9784)
L.Capital	0.0911	0.0957	0.0040	0.0040
	(0.0861)	(0.0867)	(0.0045)	(0.0047)
L.Tech	0.8834	0.8438	-0.3614***	-0.3981***
	(1.1797)	(1.2121)	(0.0994)	(0.0947)
L.Labour	-0.0326	-0.0639	0.0637**	0.0735**
	(0.2827)	(0.2850)	(0.0283)	(0.0320)
_cons	84.9767	72.5411	23.0066	21.4141
	(264.0898)	(270.8601)	(15.4477)	(16.1823)
Individual effects	YES	YES	YES	YES
Time effect	YES	YES	YES	YES
N	240.0000	240.0000	240.0000	240.0000
r2	0.9137	0.9145	0.9884	0.9889

Standard errors in parentheses

* p < 0.1, ** p < 0.05, *** p < 0.01

5.3 Robustness Test

(1) Replacing the Core Dependent Variables

To enhance the reliability of the research findings, this paper replaces the core dependent variables and conducts further robustness tests.

Previous research has found that improving the level of digital trade development can significantly enhance China's GVC position index relative to trade partner country i. However, the effect of promoting trade partner countries' participation in the global value chain is more evident than the effect on China. Therefore, drawing on Han Shen-chao's (2023) approach, this paper incorporates the overall GVC participation and position indices of China and its trade partners into the global value chain reconstruction measurement system.

This paper replaces the Global Value Chain Relative Participation Index with the Global Value Chain Overall Participation Index and the Global Value Chain Relative Position Index with the Global Value Chain Overall Position Index. The Global Value Chain Overall Participation Index ^{SGVCpat} equals the sum of the GVC participation indices of China and its trade partners, reflecting the overall impact of digital trade on the GVC participation indices of bilateral trading countries. The Global Value Chain

Overall Position Index ^{SGVCpos} equals the sum of the GVC position indices of China and its trade partners, reflecting the overall impact of digital trade on the GVC position indices of bilateral trading countries.

Models 1 and 2 are linear models, while Models 3 and 4 are nonlinear models. The regression results show that the Digital Trade Development Index is significantly negatively correlated with the Global Value Chain Overall Position Index at the 1% level, and the squared Digital Trade Development Index is significantly positively correlated with the Global Value Chain Overall Participation Index at the 5% level. This indicates that digital trade is promoting the reconstruction of the global value chain, consistent with previous research findings.

Table 6. Robustness Test: Replacing the Core Dependent Variables

Variable Name	Model（1）	Model（2）	Model（3）	Model（4）
	SGVCpos	SGVCpat	SGVCpos	SGVCpat
L.lnDT	-0.1085***	0.0497	-0.0846**	0.1188**
	(0.0327)	(0.0483)	(0.0384)	(0.0573)
L.lnDT2			0.0618	0.1787**
			(0.0486)	(0.0803)
L.lnpGDP	0.0050	0.0521	0.0003	0.0384
	(0.0510)	(0.0513)	(0.0513)	(0.0536)
L.TOpen	0.0001	0.0020***	0.0001	0.0019***
	(0.0004)	(0.0005)	(0.0004)	(0.0005)
L.lnPopu	-0.0363	-0.2928*	-0.0269	-0.2656
	(0.1662)	(0.1711)	(0.1662)	(0.1737)
L.Capital	0.0009	0.0004	0.0010	0.0005
	(0.0009)	(0.0009)	(0.0009)	(0.0009)
L.Tech	0.0088	-0.0670***	0.0086	-0.0675***
	(0.0118)	(0.0173)	(0.0117)	(0.0173)
L.Labour	-0.0003	0.0095*	0.0006	0.0120**
	(0.0028)	(0.0054)	(0.0029)	(0.0051)
_cons	0.8396	5.4404*	0.5814	4.6936
	(2.6409)	(2.8477)	(2.6619)	(2.9043)
Individual effects	YES	YES	YES	YES
Time effect	YES	YES	YES	YES
N	240.0000	240.0000	240.0000	240.0000
r2	0.9075	0.9892	0.9081	0.9895

Standard errors in parentheses

* p < 0.1, ** p < 0.05, *** p < 0.01

(2) Changing the Sample Period

To avoid the impact of the unexpected event of the COVID-19 pandemic in 2020 on the empirical results, this paper re-runs the regression analysis after excluding the data from 2020. As shown in Table 4.8, the Digital Trade Development Index remains significantly negatively correlated with the Global Value Chain Relative Position Index at the 5% level, and the squared Digital Trade Development Index is significantly positively correlated with the Global Value Chain Relative Participation Index at the 5% level. These results confirm the robustness of the research conclusions.

Table 7. Robustness Test: Changing the Sample Period

Variable Name	Model（1）	Model（2）	Model（3）	Model（4）
	RGVCpos	RGVCpos	RGVCpat	RGVCpat
L.lnDT	-11.4700***	-9.7181**	0.8011**	0.8535**
	(3.1688)	(3.7463)	(0.3496)	(0.3642)
L.lnDT2			0.8184*	0.9287**
			(0.4871)	(0.4559)
L.lnpGDP		-5.5826		0.0850
		(4.5292)		(0.3483)
L.TOpen		0.0072		0.0107***
		(0.0364)		(0.0030)
L.lnPopu		1.7283		-1.7901
		(18.1496)		(1.2077)
L.Capital		0.0925		0.0012
		(0.1368)		(0.0074)
L.Tech		0.5008		-0.4158***
		(1.2559)		(0.1119)
L.Labour		-0.3032		0.0624*
		(0.3256)		(0.0375)
_cons	51.5552***	82.4982	-1.8006	32.1652
	(12.4403)	(304.1782)	(1.3924)	(20.0107)
Individual effects	YES	YES	YES	YES
Time effect	YES	YES	YES	YES
N	200.0000	200.0000	200.0000	200.0000

r2	0.9287	0.9303	0.9864	0.9887

Standard errors in parentheses

* p < 0.1, ** p < 0.05, *** p < 0.01

6. Empirical Result Analysis

6.1 Research Conclusions

Based on the UIBE GVC Index database, which includes the ADB2022 input-output tables of 40 countries from 2014 to 2020, this paper conducts theoretical analysis and empirical measurements of the Global Value Chain (GVC) relative position index and GVC relative participation index between China and its trade partners. This analysis represents the changes in the status and participation of trade partners relative to China in the GVC and explores the impact of digital trade development on GVC restructuring. Additionally, it examines the moderating effects of the quality of administrative and legal systems and economic freedom. The main research conclusions are as follows:

(1) Theoretical Insights: The impact of digital trade on the GVC relative position index and GVC relative participation index is theoretically opposite due to the heterogeneity in the direction of forward and backward GVC participation changes.

(2) Negative Linear Impact on GVC Position: Digital trade has a significant negative linear impact on the GVC relative position index. This indicates that as digital trade development increases, the GVC position index of trade partners increases less than that of China.

(3) Positive Nonlinear Relationship with GVC Participation: There is a significant positive nonlinear relationship between digital trade and the GVC relative participation index. This suggests that as digital trade development increases, the GVC participation index of trade partners increases more than that of China.

(4) Administrative and Judicial System Quality: The quality of administrative and judicial systems weakens the impact of digital trade on the GVC relative position index. This means that under high-quality administrative and judicial systems, the gap between China's GVC position index and that of its trade partners narrows as digital trade development increases.

(5) Economic Freedom: Economic freedom weakens the impact of digital trade on the GVC relative participation index. This implies that under high economic freedom, the gap between the GVC participation index of trade partners and China narrows as digital trade development increases. A possible reason is that increased economic freedom promotes greater GVC participation, with a more pronounced effect in countries with lower economic freedom rankings.

6.2 Policy Implications

(1) Strengthening Domestic and Regional Value Chains

For China, it is more beneficial to integrate domestic resources and leverage the potential of the

domestic market rather than embedding at the low end of the GVC. Focus should be on enhancing regional coordination, fostering core competencies through independent R&D, and aiming to integrate into the high-end segments of the GVC in the future.

In the "Belt and Road" and RECP regional value chains, China often occupies the core segments. Strengthening regional value chain cooperation is the best strategy for China to overcome the challenges of being locked in low-end GVC positions, missing the opportunity for proactive GVC restructuring, and facing barriers to climbing the high-end GVC segments.

(2) Focusing on Digital Trade and Developing Productive Services and Cross-Border E-commerce

Advancing from a manufacturing giant to a manufacturing powerhouse requires cultivating productive services. Digital trade facilitates the integration of more productive services into the GVC, including transportation, information services, and financial services. China should seize the opportunities presented by digital trade to significantly develop specialized and high-end productive services.

China's greatest advantage in digital trade development is cross-border e-commerce. Through cross-border e-commerce, Chinese manufacturing extends to both ends of the "smile curve," capturing more profits. Therefore, China should continue to capitalize on this strength by establishing more comprehensive cross-border e-commerce pilot zones.

(3) Optimizing Administrative and Judicial Systems and Increasing Economic Freedom

China should continue to pursue deep political and economic system reforms, implementing new development concepts into policy formulation and execution. Drawing on the World Bank's governance indicators, China can optimize its administrative and judicial systems across six dimensions: promoting democracy, emphasizing national security, enhancing government effectiveness, creating flexible regulations, building a law-based China, and resolutely combating corruption.

China should foster a higher level of openness, increase efforts to attract investment and talent, improve the business environment, lower market entry barriers, and refine negative list management.

References

Abate, C. A. (2022). The relationship between aid and economic growth of developing countries: Does institutional quality and economic freedom matter? *Cogent Economics & Finance*, *10*(1), 2062092.

Dilyard, J., Zhao, S., & You, J. J. (2021). Digital innovation and Industry 4.0 for global value chain resilience: Lessons learned and ways forward. *Thunderbird International Business Review*, *63*(5), 577-584.

Feng, Z. X., & Duan, D. Y. (2022). Evaluation of Digital Trade Development Index and Analysis of Influencing Factors: Based on Panel Data of 49 Countries. *Journal of Beijing University of Technology (Social Sciences Edition)*, (04), 100-117.

Han, S. C. (2023). Does Service Trade Promote the Reshaping of the Global Value Chain in the Service Industry. *International Business (Journal of the University of International Business and Economics)*, (01), 56-71.

Huang, L. X., Lin, Z. Y., & Wang, X. B. (2023). *Application of Industrial Robots and Reconstruction of Global Value Chain—From the Perspective of Export Product Bargaining Power*, (02), 74-92.

Huang, Q., & Li, N. N. (2019). Analysis of Factors Affecting the Rise of Manufacturing Global Value Chain Position—Based on a Comparison between Developed and Developing Countries. *East China Economic Management*, (01),100-106.

Koopman, R., Wang, Z., & Wei, S. J. (2014). Tracing value-added and double counting in gross exports. *American economic review*, *104*(2), 459-494.

Loonam, J., & O'Regan, N. (2022). Global value chains and digital platforms: Implications for strategy. *Strategic Change*, *31*(1), 161-177.

Mahmood, M. T., Shahab, S., & Shahbaz, M. (2022). The relevance of economic freedom for energy, environment, and economic growth in Asia-Pacific region. *Environmental Science and Pollution Research*, *29*(4), 5396-5405.

Miroudot, S., & Nordström, H. (2020). Made in the world? Global value chains in the midst of rising protectionism. *Review of Industrial Organization*, *57*(2), 195-222.

Yi, Z. Y., Wei, L., & Cai, P. M. (2023). How Data Elements Reconstruct the Pattern of Global Value Chain Division of Labor: Regionalization or Fragmentation. *International Trade Issues*, (08), 20-37.

Zhu, Q., & Zhou, X. X. (2024). How Does the Development of Digital Trade Affect the Enhancement of Global Value Chain Status?: Empirical Evidence from Chinese Cities. *World Economic Research*, (04), 105-115, 136.