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Research Article

The Impact of a Complex Computer Numerical Model Based on Economic Cooperation on the Value Chain of International Trade Facilitation

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With the advancement of global economic integration, traditional trade barriers have been greatly reduced, and the marginal utility of tariff reductions on trade expansion has become weaker and weaker. Especially under the global value chain division of labor system, intermediate products and parts have undergone multiple cross-border trades. The cumbersome trade procedures will greatly increase trade costs and destroy the driving force of trade. After improving infrastructure and optimizing customs clearance procedures, with the improvement of convenience, more countries and enterprises can participate in the global division of labor. Considering the industry characteristics of high-tech manufacturing, this paper selects panel data of high-tech manufacturing from multiple sample countries and uses the panel data two-way fixed-effect model to empirically analyze the impact of a country's trade facilitation level on the global value chain of high-tech manufacturing in a country. From the perspective of global value chain status, the improvement of a country's level of trade facilitation can significantly promote the country's high-tech manufacturing global value chain status. The level of foreign direct investment, the degree of opening to the outside world, the level of government public services, the level of human capital, and the R&D capability are all significantly positive at the 1% level, while the level of physical capital is significantly negative at the 1% level.

1. Introduction

On February 22, 2017, the protocol to the agreement on trade facilitation came into effect, making it the first landmark multilateral trade agreement since the establishment of the WTO. From a global perspective, after the "Trade Facilitation Agreement" comes into effect, the implementation of trade facilitation reforms by member states will simplify international trade procedures, further accelerate the flow of goods, speed up customs clearance and release, improve production and trade efficiency, and further reduce trade costs, boosting global economic and trade growth. According to OECD (2015) estimates, if all the clauses in the trade facilitation agreement are strictly implemented, the trade costs of low-income countries, lower-middle-income countries, and upper-middle-income countries will be reduced by 16.5%, 17.4%, and 14.6%, respectively [1–3]. Some researchers conducted a simulation analysis using a computable general equilibrium (GTAP) model and showed that the global economic growth effect brought about by trade facilitation measures is equivalent to three times the increase in the removal of import tariffs in all economies. The WTO (2015) study found that for LDCs, the estimated export growth rate increased from 7% to 18% with partial implementation of trade facilitation measures, and as high as 36% with full implementation [4, 5]. Promoting trade facilitation reform on a global scale is of great significance to the development of global economy and trade.

The development of global value chains is closely related to trade policies and the legal environment [6, 7]. Some researchers believe that a good contract enforcement system can help reduce the degree of contract incompleteness,

thereby deepening the division of labor and promoting technology application. They found that countries with low contract cost and high degree of financial development have a correspondingly higher degree of vertical integration of enterprises, and high contract execution efficiency will expand the positive impact of enterprises on the decision-making of vertically integrated production models. Some other researchers argue that as coordination costs and trade costs continue to decline, global value chains are increasingly attractive to firms interested in offshoring some production steps which, in turn, has contributed to the formation of regional and global production networks, mainly reflected in the rapid growth of trade in intermediate goods and the continued increase in foreign value-added content in exports. Some of them also pointed out that countries and enterprises at different stages of development have different determinants of their participation in global value chains [8–11]. Among them, policies such as trade policy, trade facilitation policy, inward FDI openness, and intellectual property protection are important policy factors. Through rational policy design and implementation, trade facilitation will help increase global value participation and have a positive impact on sustainable development prospects. They found a positive relationship between GVC participation and all measures of institutional quality. The quality of domestic institutions significantly affects the participation of contract-intensive industries in complex global value chains. Countries with weaker institutions deepen their ties with upstream suppliers in countries with better institutions and thus engage more deeply in global value chains [12–16]. Growth in GVC participation is positively correlated with better institutions, and institutional quality is an important determinant of an industry's ability to segment production processes across borders. Strong institutional characteristics, such as business environment and good infrastructure, also affect countries' participation in global value chains, and a high degree of contract enforcement and the rule of law promote a country's participation in exports and imports.

Domestically, some researchers believe that as long as any country sets up trade barriers in the global value chain, it will affect other trading partners through the transmission mechanism of the global value chain. Therefore, it is necessary to promote the reform of trade facilitation and improve the level of trade facilitation to deal with the problems faced in the development of global value chains. They also believe that the rapidly developing global value chain has brought new challenges to traditional international trade policies, especially in the process of many cross-border trade of intermediate products. Any country that increases trade barriers to intermediate products will increase trade costs and affect the cost and price of the final product [17, 18]. As a more complex system, the system quality involves the quality measurement of various systems. Therefore, its method is not single, but for different systems, the measurement methods are also different.

The higher the institutional quality of a country, the higher the technical content of its exports when studying the impact of institutional quality, global value chains, and the relationship between the two on the complexity of exports. The institutional quality of a country is conducive to improving its position in the global value chain, especially for countries with poor institutional quality, the improvement of institutional quality is more significant. Some other researchers found that the higher the institutional quality of a country, the higher its GVC participation and GVC status index. By analyzing the impact of the depth of China's FTA clauses on the degree of participation in the division of labor in the global value chain of enterprises, they found that the depth of FTA clauses has a significant role in promoting China's participation in the division of labor in the global value chain.

High-tech manufacturing is a typical manufacturing industry with high-technology content and high-added value, which can reflect a country's technological level and innovation ability. All countries in the world regard improving the international competitiveness of their high-tech manufacturing as a way to seize the commanding heights of the future economy. Therefore, the context of the high-tech manufacturing industry in various countries in the world has long been deeply embedded in the global value chain division of labor system. Accurately measuring and improving the global value chain status of a country's high-tech manufacturing industry are to enhance the international competitiveness of the country's high-tech manufacturing industry. Considering the industry characteristics of high-tech manufacturing, this paper selects panel data of high-tech manufacturing from multiple sample countries and uses the panel data two-way fixed-effect model to empirically analyze the impact of a country's trade facilitation level on the global value chain of high-tech manufacturing in a country.

2. Methods and Theory

2.1. Model Establishment. There is a positive correlation between the level of trade facilitation in a country and the global value chain status of the country's high-tech manufacturing industry. In order to further study the relationship between the two, this paper uses industry-level cross-country panel data to construct a basic econometric model:

$$\ln \mathrm{GVCP}_{imt} = \beta_0 + \beta_1 \ln \mathrm{TRADE}_{imt} + \beta_2 \ln \mathrm{X}_{imt} + \varepsilon_{imt}, \tag{1}$$

$$\ln \mathrm{CONT}_{imt} = \beta_0 + \beta_1 \ln \mathrm{TRADE}_{imt} + \beta_2 \ln \mathrm{X}_{imt} + \varepsilon_{imt}, \tag{2}$$

$$\ln \mathrm{DVR}_{imt} = \beta_0 + \beta_1 \ln \mathrm{TRADE}_{imt} + \beta_2 \ln \mathrm{X}_{imt} + \varepsilon_{imt}. \tag{3}$$

Among them, the subscript i represents the high-tech manufacturing industry, m represents the country, and t represents the year. GVCP stands for global value chain status, CONT stands for global value chain control capability, DVR stands for global value chain value-added capability, TRADE stands for trade facilitation level, X stands for a

series of control variables, and ε stands for random disturbance. Formula (1) is to test the impact of a country's trade facilitation on its position in the global value chain of high-tech manufacturing. Since the position of the global value chain is composed of value-added capabilities and control capabilities, this paper constructs formulas (2) and (3) to study the impact of a country's trade facilitation on the value-added and control capabilities of the country's high-tech manufacturing global value chain.

Trade facilitation may affect the value-added ability and control ability of a country's high-tech manufacturing global value chain by promoting a country's economic growth and foreign service factor input, thereby affecting its position in the global value chain. In order to test whether there is a theoretical mediation effect, this paper draws on the comprehensive mediation effect test method proposed by Wen Zhonglin et al. (2004) to analyze the influence mechanism between variables. The specific model formula is as follows:

$$\ln \mathrm{CONT}_{\mathrm{imt}}/\mathrm{DVR}_{\mathrm{imt}} = \beta_0 + \beta_1 \ln \mathrm{TRADE}_{\mathrm{imt}} + \beta_2 \ln \mathrm{X}_{\mathrm{imt}} + \varepsilon_1, \tag{4}$$

$$\ln \mathrm{M}_{\mathrm{imt}} = \alpha_0 + \alpha_1 \ln \mathrm{TRADE}_{\mathrm{imt}} + \alpha_2 \ln \mathrm{X}_{\mathrm{imt}} + \varepsilon_2, \tag{5}$$

$$\ln \mathrm{CONT}_{\mathrm{imt}}/\mathrm{DVR}_{\mathrm{imt}} = \eta_0 + \eta_1 \ln \mathrm{TRADE}_{\mathrm{imt}} + \eta_2 \ln \mathrm{M}_{\mathrm{imt}} + \eta_3 \ln \mathrm{X}_{\mathrm{imt}} + \varepsilon_3, \tag{6}$$

Among them, M represents the intermediary variable, that is, the GDP per capita and the proportion of foreign service factor input (FSERCIVE) that measure the level of economic growth. Other variables are consistent with the variables in the basic model. In the mediation effect model, the coefficient β_1 represents the total effect of a country's trade facilitation on the value-added capability or control capability of the country's high-tech manufacturing global value chain, and the coefficient $\eta 1$ represents a country's trade facilitation on the global high-tech manufacturing industry of a country. The coefficient $\alpha_1 * \eta_2$ represents the effect of a country's trade facilitation on the value-added capacity or control capacity of the country's high-tech manufacturing global value chain through intermediary variables, that is, the mediation effect or indirect effects. Partial and complete mediation tests are considered in the test procedure, and Sobel tests are also included.

The first step is to test formula (4); if the coefficient β_1 is significant, then we test the second step; if the coefficient β_1 is not significant, we stop the mediation effect test; for the second step, we test formula (5) and formula (6); in turn, if both α_1 and η_2 are significant at the same time, there is a mediating effect, and the third step is carried out; if at least one of the coefficients α_1 and η_2 is not significant, then the fourth step is tested. If $\eta 1$ is significant, then there is partial mediation effect; if $\eta 1$ is not significant, there is a complete mediation effect; the fourth step is to do the Sobel test; and its test statistic is Z. If z passes the test, it means that there is a mediation effect; otherwise, there is no mediation effect. Of course, if the calculation results of the first three steps have confirmed the existence of the mediation effect, the calculation of the fourth step is not necessary.

2.2. Data Sources. The empirical part of this paper uses the industry panel data of high-tech manufacturing in 30 sample countries from 2012 to 2016. The 30 countries are Australia, Austria, Belgium, Brazil, Canada, Switzerland, China, Germany, Denmark, Spain, Finland, France, the UK, Greece, Hungary, Indonesia, India, Italy, Japan, Korea, Latvia, Mexico, the Netherlands, Norway, Portugal, Romania, Russia, Sweden, Turkey, and the USA.

3. Results and Discussion

In order to ensure the unbiasedness and validity of the regression results and try to avoid the occurrence of "pseudo-regression," it is necessary to test the stationarity of each variable before constructing the model. This paper uses the high-tech manufacturing panel data of 30 sample countries from 2012 to 2016 and conducts a stationarity test to avoid the existence of inefficient estimates. The methods of stationarity test mainly include LLC test, ADF test, IPS test, and HT test. Since the data in this paper belongs to short panel data with individuals greater than time, the HT test method is used to test the stationarity of the panel data. It is a statistical inference method used to judge whether the differences between samples and populations are caused by sampling errors or essential differences. Significance test is the most commonly used method in hypothesis test, and it is also the most basic form of statistical inference. Its basic principle is to make a certain assumption about the characteristics of the population first, and then make an inference about whether this assumption should be rejected or accepted through statistical inference of sampling research. The null hypothesis of this test is since there is a unit root, that is, the variable is not stationary, and the specific test results are shown in Table 1 below. According to the results of the stationarity test, each variable rejects the null hypothesis at the 1% significance level, indicating that each variable is stationary. At the same time, in order to prevent the influence of multicollinearity on the empirical results, this paper calculates the variance inflation factor (VIF) of each variable, and the VIF value of each variable is far less than 10, indicating that there is no multicollinearity among the variables.

The models of panel data include mixed-effects model, fixed-effects model, and random-effects model. Before conducting empirical analysis, F test, Hausman test, and LM test are needed to verify which model to use. The F test is used to analyze whether the mixed-effects model or the fixed-effects model is used. If the null hypothesis is rejected, it means that the fixed-effects model is better than the mixed-effects model. The LM test is used to analyze whether the mixed-effects model or the random-effects model is used. A random-effects model should be selected. Hausman's test is used to analyze whether a fixed-effects model or a random-effects model is used, and if the null hypothesis is rejected, the fixed-effects model is better than the random-effects model. The specific test results are shown in Table 2. According to the results of various tests, this paper selects

Table 1: Stationarity test and VIF test.

Variable	Statistic	*P*	Test method	Is it stable	VIF
lnGVCP	0.272	0.001	HT	Stable	—
lnTRADE	0.553	0.001	HT	Stable	2.52
lnFDI	0.512	0.001	HT	Stable	2.23
lnOPEN	0.375	0.001	HT	Stable	2.59
lnPUB	0.144	0.001	HT	Stable	1.87
lnHC	0.129	0.001	HT	Stable	2.81
lnCAP	0.249	0.001	HT	Stable	1.88
lnRD	0.132	0.001	HT	Stable	2.69
lnGDP	0.271	0.001	HT	Stable	4.77
lnFSERVICE	0.223	0.001	HT	Stable	2.51

Table 2: Mixed-effects, fixed-effects, and random-effects tests.

Inspection type	Statistics	*P* value
F test	150.01	0.001
LM test	4977.50	0.001
Hausman test	35.42	0.001

the panel data fixed-effect model, and at the same time, in order to reduce the endogeneity problem caused by missing variables at the industry level, the two-way fixed-effect model of industry fixed effect and time fixed effect is used for empirical analysis.

This paper uses two-way fixed-effect models of industry fixed effect and year fixed effect to carry out regression analysis on the global value chain status, global value chain control, and global value chain value-added capacity of high-tech manufacturing industry, respectively. The results are shown in Table 3.

The result shows the following:

(1) From the perspective of global value chain status, although the influence coefficient of trade facilitation decreases after adding control variables, the influence of trade facilitation is significantly positive at the level of 1%, which indicates the improvement of the country's high-tech manufacturing global value chain can significantly promote the status of the country. For the control variables, the level of foreign direct investment (FDI), the degree of opening to the outside world (OPEN), the level of government public services (PUB), the level of human capital (HC), and the level of research and development (RD) are all significantly positive at the 1% level, while the physical capital level (CAP) is significantly negative at the 1% level, as expected in this paper

(2) From the perspective of global value chain control, no matter whether the control variable is added or not, the impact of a country's trade facilitation level on the country's global value chain control ability is significantly positive at the level of 1%, and a country's trade facilitation level is significantly positive. The improvement of the level can significantly improve the country's high-tech manufacturing global value chain control. As for the control variables, the influence of each control outcome variable on the control ability of the global value chain and the influence on the position of the global value chain have not changed in the direction and significance of the influence, but the numerical value of the influence coefficient has changed

(3) From the perspective of the value-added capacity of the global value chain, no matter whether the control variable is added or not, the impact of a country's trade facilitation on the value-added capacity of the global value chain of the country's high-tech manufacturing industry is also significantly positive, and the improvement of a country's trade facilitation level can increase the value-adding capacity of the global value chain in the country's high-tech manufacturing industries. For the control variables, the impact of PUB and HC on the value-added capability of the global value chain of high-tech manufacturing is significantly positive. According to the "smile curve" theory, the R&D and design links and sales links at both ends of the "smile curve" are high. In the value-added link, although FDI and RD can promote the R&D innovation and technological progress of the domestic high-tech manufacturing industry, they cannot affect the high-value-added sales link, so the positive impact is not significant. The impact of CAP on the value-added capacity of the global value chain of the domestic high-tech manufacturing industry is positive but insignificant. The possible reason is that the improvement of the level of physical capital enables domestic high-tech manufacturing enterprises to produce differentiated products, thereby improving the value-added capacity. The nature and function of the product itself have not changed significantly, so it cannot have a significant impact on the value-added capability

In order to further explore the impact of a country's level of trade facilitation on its position in the global value chain of high-tech manufacturing, this paper uses the primary indicators of trade facilitation: customs and border management (C1), financial and information services (C2), infrastructure and transportation services (C3), and government and regulatory environment (C4) to carry out double fixed-effect regression analysis, respectively, and the regression results are shown in Table 4. According to the regression results, it is found that the impact of each first-level indicator on the position of the country's high-tech manufacturing global value chain is significantly positive at the level of 1%, which indicates that customs and border management, financial and information services, infrastructure and transportation services, and improvements in both the government and the regulatory environment can significantly enhance the global value chain position of a country's high-tech manufacturing industry. Among them, the improvement of infrastructure and transportation

Table 3: Basic regression results.

Variable	Global value chain status		Global value chain control capability		Global value chain value-added capabilities	
lnTRADE	1.284***	0.565***	1.149***	0.475***	0092***	0.072**
lnFDI		0.148***		0.146***		0.003
lnOPEN		0.573***		0.755***		-0.155***
lnPUB		0.322***		0.169*		0.172***
lnHC		2.345***		2.145***		0.189*
lnRD		0.249***		0.265***		0.008
lnCAP		-0.495***		-0.512***		0.023
Constant	9.235***	0.656	11.465***	3.094***	-2.158***	-2.467***

Note: Numbers in brackets represent t statistics; *, **, and *** represent significant levels at 10%, 5%, and 1%, respectively.

Table 4: Regression results of various subindicators of trade facilitation.

Variable	lnGVCP	lnGVCP	lnGVCP	lnGVCP
lnFDI_stock	0.163***	0.138***	0.138***	0.171***
lnOPEN	0.572***	0.672***	0.469***	0.645***
lnPUB	0.245**	0.271***	0.272***	0.372***
lnHC	2.435***	2.049***	2.485***	2.584***
LnZ1	0.257***	0.256***	0.203***	0.245***
lnCAP	-0.318**	-0.489***	-0.271*	-0.539***
lnCl	0.591***			
lnC2		0.625***		
lnC3			0.678***	
lnC4				0.245***
Constant	0.358	0.813	1.125	-0.442

Note: Numbers in brackets represent t statistics; *, **, and *** represent significant levels at 10%, 5%, and 1%, respectively.

services has the greatest role in promoting the status of the global value chain of high-tech manufacturing, while the improvement of the government and regulatory environment has the least effect on the global value chain of high-tech manufacturing, and the increase in the infrastructure and transportation services by 1% can improve the global value chain status by 0.678%.

4. Conclusions

(1) From the perspective of global value chain status, the improvement of a country's level of trade facilitation can significantly promote the country's high-tech manufacturing global value chain status. The level of foreign direct investment, the degree of opening to the outside world, the level of government public services, the level of human capital, and the R&D capability are all significantly positive at the 1% level, while the level of physical capital is significantly negative at the 1% level

(2) From the perspective of the value-added and control capabilities of the global value chain, the improvement of a country's level of trade facilitation can significantly improve the value-added and control capabilities of the country's high-tech manufacturing global value chain, but the improvement in control capabilities is far greater

(3) From the subdivision indicators of trade facilitation, customs and border management, financial and information services, infrastructure and transportation services, and government and regulatory environment all promote the global value of domestic high-tech manufacturing at a significant level of 1%. The status of the chain has been improved, but the effect of the promotion effect is not the same. The promotion effect of infrastructure and transportation services is the largest, followed by financial and information services, customs and border management, and government and regulatory environment

Data Availability

The tables used to support the findings of this study are included in the article.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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References

[1] J. S. Wilson, C. L. Mann, and T. Otsuki, "Trade facilitation and economic development: a new approach to quantifying the impact," *The World Bank Economic Review*, vol. 17, no. 3, pp. 367–389, 2003.

[2] B. Shepherd and J. S. Wilson, "Trade facilitation in ASEAN member countries: Measuring progress and assessing priorities," *Journal of Asian Economics*, vol. 20, no. 4, pp. 367–383, 2009.

[3] A. Portugal-Perez and J. S. Wilson, "Export performance and trade facilitation reform: hard and soft infrastructure," *World Development*, vol. 40, no. 7, pp. 1295–1307, 2012.

[4] A. Portugal-Perez and J. S. Wilson, "Why trade facilitation matters to Africa," *World Trade Review*, vol. 8, no. 3, pp. 379–416, 2009.

[5] A. Dennis and B. Shepherd, "Trade facilitation and export diversification," *The World Economy*, vol. 34, no. 1, pp. 101–122, 2011.

[6] M. Persson, "Trade facilitation and the extensive margin," *The Journal of International Trade & Economic Development*, vol. 22, no. 5, pp. 658–693, 2013.

[7] T. Iwanow and C. Kirkpatrick, "Trade facilitation, regulatory quality and export performance," *Journal of International Development: The Journal of the Development Studies Association*, vol. 19, no. 6, pp. 735–753, 2007.

[8] J. Felipe and U. Kumar, "The role of trade facilitation in Central Asia," *Eastern european economics t*, vol. 50, no. 4, pp. 5–20, 2012.

[9] R. L. Tung and H. F. Chung, "Diaspora and trade facilitation: the case of ethnic Chinese in Australia," *Asia Pacific Journal of Management*, vol. 27, no. 3, pp. 371–392, 2010.

[10] R. Hillberry and X. Zhang, "Policy and performance in customs: evaluating the trade facilitation agreement," *Review of International Economics*, vol. 26, no. 2, pp. 438–480, 2018.

[11] M. Amin and J. I. Haidar, "Trade facilitation and country size," *Empirical Economics*, vol. 47, no. 4, pp. 1441–1466, 2014.

[12] C. L. Mann, "Supply chain logistics, trade facilitation and international trade: a macroeconomic policy view," *Journal of Supply Chain Management*, vol. 48, no. 3, pp. 7–14, 2012.

[13] R. L. Ibrahim and K. B. Ajide, "Trade facilitation and environmental quality: empirical evidence from some selected African countries," *Environment, Development and Sustainability*, vol. 24, no. 1, pp. 1282–1312, 2022.

[14] R. Pomfret and P. Sourdin, "Trade facilitation and the measurement of trade costs," *Journal of International Commerce, Economics and Policy*, vol. 1, no. 1, pp. 145–163, 2010.

[15] G. Gereffi, J. Humphrey, and T. Sturgeon, "The governance of global value chains," *Review of International Political Economy*, vol. 12, no. 1, pp. 78–104, 2005.

[16] P. Antràs, "Conceptual aspects of global value chains," *The World Bank Economic Review*, vol. 34, no. 3, pp. 551–574, 2020.

[17] K. Nadvi, "Global standards, global governance and the organization of global value chains," *Journal of Economic Geography*, vol. 8, no. 3, pp. 323–343, 2008.

[18] Q. Yuan, L. Zhai, and T. Xu, "Price transmission effect of establishing FTA with African countries from the perspective of trade facilitation," *Mathematical Problems in Engineering*, vol. 2022, Article ID 5946679, 12 pages, 2022.