Research on Post-Pandemic Era: China and ASEAN Capacity Cooperation and Value Chain Enhancement

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Abstract: China and ASEAN have a long history of economic and trade collaboration, with ASEAN being a significant partner for China. After the COVID-19 pandemic, the global value chain system has undergone profound adjustments, and the industrial development of China and ASEAN has been constrained by the strategic positioning of developed economies from various directions. China and ASEAN should work together on production capacity, using industrial transfer, economies of scale, efficient resource allocation, and technology sharing to upgrade regional industries and value chains. Lastly, based on evidence, they should enhance trade and investment, focus on building industrial parks, and promote economic and tech cooperation.

Keywords: China-ASEAN, capacity cooperation, value chain

1. Introduction

In the post-COVID-19 era, the global value chain system is undergoing significant adjustments. Developed economies are actively reshaping their comparative advantages in manufacturing by utilizing their position as "lead firms" in the global value chain to strengthen governance. This shift is driving the global value chain towards higher levels of upgrade, and it has had a detrimental impact on China's manufacturing sector, which is currently in the ascending phase of the global value chain. Advanced economies have initiated a new round of strategic positioning for technological transformation ahead of time, using a "dual transfer" strategy to restrain China's ascent in the value chain's high-end. They achieve this by strengthening industrial chain governance, raising entry barriers for upstream industries. Simultaneously, amidst trade disputes, they implement blockades on downstream industries to hinder China's "smart manufacturing" capabilities. China's manufacturing sector is currently facing comprehensive strategic pressures from developed countries in areas such as strategy, regulations, technology, and markets. In this context, reshaping and jointly constructing regional value chains will be a pragmatic choice for China's manufacturing sector to break free from being "chased and blocked" by other leading players. Collaborating with ASEAN in constructing regional value chains undoubtedly stands as the preferred option. China and ASEAN share close geographical proximity, giving them a distinct advantage in terms of cooperation location. The two have significant economic complementarity, diversified industrial development, abundant production factors, and vast potential for development in regional industrial and supply chain cooperation. Currently, China is actively promoting its domestic circulation as the main focus, aiming to facilitate the mutual promotion of domestic and international circulation, thereby creating a new development pattern. Within this strategic initiative, the construction of a robust domestic market and the commitment to expanding domestic demand are considered fundamental aspects. China boasts a vast market with a population of 1.4 billion and a total demand exceeding trillions of yuan. It is experiencing sustained growth at a relatively high rate, offering unique and irreplaceable market opportunities for countries and economies worldwide, including ASEAN.ASEAN countries are geographically adjacent to China, and they have a history of economic and trade cooperation with China spanning three decades. Given the opportunity presented by China's construction of a new development pattern, ASEAN can seek long-term sustainable economic growth for itself. By deepening economic and trade cooperation with China, ASEAN can not only tap into a vast market for exporting goods and diversify its overseas market objectives but also utilize Chinese direct investment and technological collaboration to optimize and upgrade its industrial structure, thereby achieving comprehensive economic and social development. China and ASEAN should actively promote the interconnection of industrial and supply chains, facilitating their accelerated integration to ensure the stability and security of these chains. Both China and ASEAN member states are essentially developing

countries and face significant challenges in upgrading their industrial and value chains. How to promote industrial upgrading, shift the focus of industrial and supply chains from downstream to midstream and upstream through mutual trade investment and economic and technological cooperation, and simultaneously advance the value chain from low-end to high-end will undoubtedly become the core focus of future economic and trade cooperation between China and ASEAN.

2. Literature Review

Currently, there is limited research in the academic community regarding China-ASEAN production capacity cooperation and the enhancement of their position in the value chain. In the realm of production capacity cooperation, scholars have primarily focused on researching the essence and modes of international production capacity cooperation (Gao Ya,2015; Zhou Minliang, 2015; Xia Xianliang, 2015; Zhang Hong and Liang Song, 2015)^{[1][2][3][4]}. Some scholars also consider international production capacity cooperation as China's response to the trend of economic globalization. They argue that, based on the characteristics of the global economic landscape and China's industrial advantages, it involves leading domestic and foreign companies in various activities such as investments and engineering contracts in both domestic and international markets (Yuan Limei and Zhu Gusheng, 2016; Huang Xiaoyan and Qin Fangming,2017)^{[5][6]}.Other scholars have conducted research on China's production capacity cooperation and found that it has a promoting effect on aspects such as trade connectivity, policy coordination, and production performance (Haggai, K., 2017)^[7]. Domestic scholars have also used data on foreign investment in production capacity cooperation and manufacturing exports to conduct empirical analyses, revealing a close correlation between production capacity cooperation and manufacturing trade exports as well as regional economic growth (Liu Xiaoling and Xiong Xi,2017)^[8]. Certainly, other scholars have found that international production capacity cooperation, especially within the context of the "Belt and Road" initiative, can enhance the global value chain position of developing countries along the route. This can be achieved through methods like industrial transfer, economies of scale, technology spillover, and optimized resource allocation (Liu Min, Zhao Jing, Xue Weixian, 2018)^[9]. Some researchers have also explored using differences in production factors, economic development levels, and industrial policies as criteria for international production capacity cooperation, which can help optimize resource allocation and restructure the global value chain (Zou Zhiqiang,2017)^[10]. However, there is still limited research on how China and ASEAN's production capacity cooperation specifically impacts their value chain positions.

Given this background, this study first analyzes the enhancement of China's and ASEAN countries' GVC positions using the ESI index and proposes the hypothesis that China and ASEAN production capacity cooperation can improve their value chain positions. Secondly, the improvement in GVC positions manifests at the micro-level as cooperation between companies from both sides that achieve a higher GVC status in international division of labor. At the meso-level, it reflects industry upgrading. Therefore, the theoretical mechanism revolves around the explanation of how production capacity cooperation affects GVC position at the national and enterprise levels. Due to the lack of data for some ASEAN countries, this study selects specific years from 2006 to 2021 and focuses on nine countries (China and ASEAN countries: the Philippines, Singapore, Thailand, Vietnam, Myanmar, Cambodia, Malaysia, and Indonesia) where data is more comprehensive to empirically test the hypothesis that China and ASEAN production capacity cooperation can enhance their value chain positions. The study also validates the robustness of these findings and provides recommendations for China-ASEAN production capacity.

3. Evaluation and Analysis of China's GVC Position with Select ASEAN Countries

Due to variations in the value chain attributes of different products and the difficulty of measuring the position of non-production activities like research and design within the value chain, accurately assessing a country's value chain position is a complex endeavor. However, within the international division of labor system for products, specific products (including final products and components such as raw materials and parts) can reflect a country's value chain situation. As the technological sophistication of products increases, a country's overall value chain position also tends to rise accordingly. For instance, raw materials and generic components of a product correspond to the high-end research and development stages of the value chain. Lall et al. (2005)^[11] argue that a country's exported goods not only encompass labor skills and scientific technology but also reflect its position

within the processing value chain. The complexity of exported goods is closely linked to a country's position in the value chain. Therefore, a country's export commodity structure becomes indirect evidence to gauge its position in the value chain. Building upon the research by Tang Haiyan and Zhang Huiqing (2009)^[12] and Liu Min, Zhao Jing, and Xue Weixian (2018)^[9], this study employs the Export Similarity Index (ESI) as a measurement indicator. It assesses the relative distance between a country and the high-end segments of the global value chain by comparing the export structures of developing countries and advanced nations.

This article adopts the ESI index for two main advantages: firstly, the ESI index has a clear principle; secondly, the ESI index belongs to a relatively composite comprehensive indicator, measuring the overall value chain position without being influenced by differences in product attributes within the value chain. The formula for calculating ESI is as follows:

$$ESIit = \sum Min(Sijt, Srjt)$$
(1)

In the formula (1) mentioned above, "i" and "t" respectively represent China and selected ASEAN countries, as well as different years between 2002 and 2021. " S_{ijt} " and " S_{rjt} " represent the export commodity structures of the sample country and the reference country located at the high-end of the GVC. The ESI_{it} has a range of values from 0 to 1. A value closer to 1 indicates that the country's export structure is more similar to the reference country, signifying a higher GVC value chain position. Conversely, when the index approaches 0, it signifies a low GVC position for the country, indicating that the export commodity structure of country i in year t is entirely different from that of the reference country. The choice of export statistics criteria can impact ESI calculations. In this study, we use the widely adopted Harmonized System (HS) coding system. We employ the 2002 edition, which offers more detailed six-digit HS codes, covering over five thousand categories of goods. This approach helps highlight differences in the technological content of goods.

Currently, there is existing literature that often uses the number of patents as a surrogate indicator to measure a country's technological level. Research by scholar Humphrey (2004)^[13] has found that technological advancement is one of the key factors influencing the global value chain position, indicating that countries with world-class technology levels typically occupy high-end positions in the value chain. In this study, the United States and Germany, which have consistently led in patent applications to the European Patent Office (EPO) over the past fifteen years, are selected as reference countries for the high-end of the global value chain. By calculating the similarity in export commodity structures between the sample countries and the reference countries with a high position in the global value chain, using the ESI index, the study assesses the global value chain positions of China and ASEAN countries.

Country	2006	2010	2014	2018	2019	2020	2021	The average ESI growth rate
Philippines	0.077	0.146	0.073	0.140	0.151	0.149	0.144	0.44%
Cambodia	0.021	0.022	0.012	0.020	0.022	0.023	0.022	0.007%
Malaysia	0.166	0.184	0.167	0.205	0.220	0.230	0.237	0.47%
Thailand	0.178	0.158	0.145	0.194	0.192	0.197	0.187	0.06%
Singapore	0.185	0.263	0.230	0.292	0.309	0.308	0.309	0.79%
Indonesia	0.070	0.074	0.070	0.080	0.058	0.070	0.086	0.11%
Myanmar		0.083	0.078	0.026	0.021	0.022	0.021	-0.33%
Vietnam	0.062	0.132	0.100	0.119	0.152	0.156	0.149	0.58%
China	0.340	0.346	0.358	0.366	0.369	0.369	0.370	0.02%

Table 1: Comparison of ESI Values for Selected ASEAN Countries and China

Data Source: The data used in this analysis were calculated and compiled by the author based on original data from various sources.

As shown in Table 1, after excluding ASEAN countries with extremely limited data, this study selected the Philippines, Cambodia, Malaysia, Thailand, Singapore, Indonesia, Myanmar, Vietnam, and China as research samples. The ESI values for these sample countries were calculated for the years 2006-2021. Export data for the sample countries, categorized under the six-digit HS codes, were sourced from the United Nations UN Comtrade database. The table shows that, except for Myanmar, all the other countries have increased their ESI index during the sample years, indicating an improvement in their GVC positions. Singapore had the fastest increase at 11.9%, while Vietnam, Malaysia, and the Philippines also made significant progress. Myanmar's ESI index declined by 6.7%, possibly due to a complex external environment, limited infrastructure development, and political instability affecting its

production capacity cooperation and trade relations.

By comparing the ESI values of the sample countries, it's clear that China and ASEAN international production capacity cooperation has generally led to improved GVC positions. This leads to the following research hypothesis: China and ASEAN production capacity cooperation enhances their GVC positions.

4. Analysis of the Mechanisms by Which International Production Capacity Cooperation Affects the Enhancement of GVC Positions for All Parties in Cooperation.

A country or region can enhance its GVC position through two aspects: physical location and economic status. Drawing upon existing research in international production capacity cooperation and global value chain theory, this paper posits that countries or regions participating in international production capacity cooperation generally influence their global value chain position (physical location) and profitability (economic status) through several key factors.

4.1. Industrial Transfer Effects

International production capacity cooperation primarily promotes the cross-border transfer of factors of production such as labor, technology, and capital through mechanisms like trade and investment transfers to facilitate the international transfer of industries. Industrial transfer is an economic behavior or process where a country or region optimizes its industries by relocating product production, sales, research and development, or corporate headquarters to another country or region when there are changes in resource supply or product demand conditions. China's industries face challenges such as overcapacity and rising labor costs. Particularly, low-end manufacturing in China has lost its traditional comparative advantage. To break through these industrial development bottlenecks and expand into international markets, industrial upgrading is necessary. The ASEAN region offers strategic advantages, including its favorable geographical location, relatively open economic system, and apparent labor cost advantages in ASEAN countries. For instance, Vietnam has a large population, abundant labor resources, competitive currency exchange rates, a flexible labor market, and lower industrial land and electricity costs. The resource advantages in the ASEAN region are also evident. For example, Indonesia possesses abundant natural resources, including oil, natural gas, metals, and coal. It is one of the world's largest producers of palm oil, giving it a significant advantage in agriculture and plantation industries. Thailand is a major exporter of rice and fruits worldwide, with a well-developed agricultural processing industry. The region is also rich in marine and fisheries resources. The ASEAN countries have competitive tax and tariff policies (Wang Haiquan, Wu Dejin., Chen Yanhe, 2021). Chinese investments in ASEAN have led to further industrial relocation to the region. This has not only strengthened industrial complementarity between China and ASEAN but has also benefited China by optimizing its own industrial structure and promoting technological progress; ASEAN countries' development of their own factors of production, including labor, technology, and capital, towards higher levels, has created more resources and opportunities for technological innovation. This shift from industrial transfer to value chain transfer has promoted international production capacity cooperation and ultimately led to an enhancement of their value chain positions.

4.2. Economies of Scale Effects

China and ASEAN's production capacity cooperation relies on the comparative advantages of each nation. It entails efficiently segmenting the original production processes, bolstering diverse production factors, and scaling up the segmented production segments, thus reshaping the industrial production process. This strategy capitalizes on both industrial comparative advantages and economies of scale. Economies of scale refer to the phenomenon in the globalized economic environment where China and ASEAN countries participate in the international division of labor based on factors such as labor costs, resources, and technology. Different countries specialize in specific industrial sectors, leading to specialized production. As each country excels in its respective fields, it achieves high efficiency and quality in continuous production. With the gradual expansion of enterprise scale to meet international market demand for their products, economies of scale are employed to reduce the per-unit product cost. The expansion of enterprise scale brings about greater benefits, as it allows for more capital to be invested in innovation and technology research and development. This leads to improved production efficiency and product quality. Larger enterprise scale also attracts more talent, driving upgrades in

technology and management within the company.Under economies of scale, enterprises reduce costs and, through innovation and technology research and development, increase the added value of their products and market competitiveness. This further drives the upgrading and development of industries within the international division of labor system, promoting an increase in their value chain position.

4.3. The Effect of Optimized Allocation of Production Factors

China and ASEAN's production capacity cooperation has expanded the scope for each country to leverage its comparative advantages.Liu et al. (2018) found that international production capacity cooperation can reshape the global value chain through international trade, investment, and development pathways.Under ideal conditions, international production capacity cooperation has the potential to surpass the initial optimal allocation framework and extend to a broader scope, achieving Pareto optimization effects.Taking intermediate goods exports as an example, if China and ASEAN countries are positioned at the lower end of the value chain, they can gradually increase capital investment and enhance labor force and other production factors to optimize labor allocation. This can result in improved quality and added value for intermediate goods exports, ultimately leading to higher-quality exports.Optimizing resource allocation enables enterprises to achieve more efficient and higher-value production, thereby driving technological upgrades, quality improvements, and innovation. This is beneficial for enhancing the competitiveness and long-term sustainable development of enterprises. Moreover, as other production factors continue to be optimized, it promotes the overall value chain to move towards higher levels, resulting in an elevated value chain position for both China and ASEAN countries.

4.4. Technology Spillover Effect

Intermediate product trade is one of the crucial components of international production capacity cooperation between China and ASEAN.In the context of production capacity cooperation between China and ASEAN countries, relevant enterprises are typically situated in downstream segments of the value chain. When importing intermediate trade products from China, there is often an element of technology transfer to compensate for the lack of technology, which is reflected in the increased complexity of exported technology. The technological complexity of a country's exports plays a significant role in the technological level of its products. The higher the technological complexity of exports, the more advanced the technological level, which can lead to a greater market share for exported products. There is empirical evidence indicating that within the framework of RCEP, the reduction in tariffs on intermediate goods in the China-ASEAN Free Trade Area is beneficial for enhancing China's export technological complexity in the agricultural sector (Cao Liang, Zhi Yinpíng, Tan Zhi, 2022)^[14]. Technological level is an important factor in the ascent of value chain positions.During the intermediate goods trade between China and ASEAN, China provides technical support and capital investment to ASEAN importing countries. This not only ensures the quality standards of intermediate products but also significantly boosts the technology levels in these importing countries, which is conducive to enhancing their value chain positions.

Technology spillover effects can also be achieved through technology acquisition, but this requires that both China and ASEAN countries, who are purchasing the technology, have well-developed infrastructure, abundant human resources, and a high level of regional industrialization to fully leverage their technological capabilities. At present, many ASEAN nations have less advanced industrial infrastructure, incomplete supply chains, and aging infrastructure like roads and airports. This affects business operations and emphasizes the importance of ongoing infrastructure improvements in China-ASEAN cooperation to boost their value chain positions through technology spillover effects.

5. Model Specification and Data Description

5.1. Construction of Econometric Models

The previous sections have discussed the relevant theories regarding how international production capacity cooperation influences GVC positions. By analyzing the mechanisms through which China-ASEAN production capacity cooperation enhances the value chain, this paper has laid the foundation for examining how international production capacity cooperation affects GVC positions and validating the scientific basis of these inferences. The model constructed in this study is as follows:

 $ESI_{it} = \alpha + \beta_1 x_{1,it} + \beta_2 x_{2,it} + \gamma_1 x_{3,it} + \gamma_2 x_{4,it} + \gamma_3 x_{5,it} + \gamma_4 x_{6,it} + \varphi_i + \omega_t + \zeta_{it}$

(2)

In the model, subscripts i and t represent sample country i and year t, and the dependent variable ESI represents the sample country's GVC position. Among them, x_1 and x_2 measure the explanatory variables of international production capacity cooperation, x_3 to x_6 are control variables, β_i represents regression coefficients, ϕ_i and ω_t represent cross-sectional error terms and time-varying error terms, and ϵ_{it} represents the random error term.

5.2. Variable Selection and Analysis

5.2.1. Primary Variables

(1) China-ASEAN Capacity Cooperation: Most ASEAN countries are developing nations. In this study, the research sample consists of countries with relatively abundant data among China and ASEAN countries, including the Philippines, Cambodia, Malaysia, Thailand, Singapore, Indonesia, Myanmar, and Vietnam. The sample countries primarily engage in capacity cooperation through methods such as foreign trade and attracting foreign direct investment (FDI). Therefore, in this study, we select the proportion of China's import trade with ASEAN countries to the sample country's total import trade and the amount of FDI in the sample country as proxy variables for international capacity cooperation. These variables are denoted as "Import" and "FDI" in the empirical analysis.

5.2.2. Control Variables

(1) Physical Capital: In this study, we measure the level of physical capital in sample countries by the proportion of fixed capital formation to the Gross Domestic Product (GDP). In the empirical analysis, this variable is denoted as "Capital."

(2) Human Capital: Sufficient human capital can enhance the productivity of the export sector in sample countries, theoretically contributing to an improvement in GVC position. We measure this using the proportion of a country's labor force participation rate. In the empirical analysis, this variable is denoted as "LR."

(3) Research and Development (R&D) Investment: R&D expenditure significantly influences enterprise productivity levels. Improving productivity and advancing technological capabilities benefit a country's export sector and its GVC position. In this study, we measure a sample country's R&D investment using the number of patent applications. In the empirical analysis, this variable is denoted as "PA."

(4) Institutional Quality: Referring to Tang Haiyan and Zhang Huiqing's research (2009)^[12], we consider institutional quality as a factor influencing capacity cooperation. We use the Economic Freedom Summary Index (EFI) published by the Heritage Foundation to assess institutional quality in both China and ASEAN countries. This index covers various aspects, including government size, legal structure, property rights protection, monetary policies, trade freedom, and regulations related to credit, labor, and business. It offers a comprehensive and objective measure of a country's institutional quality. In our empirical analysis, we represent this variable as "EFI."

5.2.3. Data Sources and Explanations

Based on the variables selected above, this study primarily utilizes panel data from 11 years, including 2002, 2006, 2010, 2014, and 2015-2021, from a total of nine countries in China and ASEAN. The data are sourced from the United Nations UN Comtrade, the World Bank, and UNCTAD databases for empirical research. The dependent variable, ESI, is calculated using 2002 export commodity data under the six-digit HS code from the UN Comtrade database. For the explanatory variables, Import data is derived from bilateral import commodity data within the sample, obtained from the UN Comtrade database, and FDI values are sourced from the UNCTAD database. The control variables include EFI from the Heritage Foundation, and Capital, LR, and PA from the World Bank's WDI database.

6. Results and Analysis of the Measurements

Table 2 shows that there are notable differences in ESI indices and other variables among the sample countries. These differences reflect the distinct characteristics of China and ASEAN nations, providing a solid basis for examining the impact of international capacity cooperation on a country's

GVC position.

6.1. Descriptive Statistical Characteristics of the Variables

Variable	Measur ement	Sample Size	Mean	Median	Standard Deviation	Min	Max
GVC Position	ESI	86	0.153	0.147	0.110	0.0120	0.370
China-ASEAN	Import	87	0.448	0.438	0.182	0.105	0.799
Capacity Cooperation	FDI	87	9.342	9.205	1.400	6.180	12.11
Physical Capital	Capital	77	0.277	0.256	0.0680	0.162	0.439
Human Capital	LR	87	0.678	0.676	0.0500	0.547	0.772
Research and Development Investment	PA	68	8.572	8.775	1.890	3.258	11.96
Institutional Quality	EFI	87	6.857	6.880	0.936	3.690	8.820

Data Source: Compiled and calculated by the author using Stata software.

6.2. Overall Regression Analysis

Based on the empirical model constructed earlier, fixed-effects and random-effects models were used to regress the data for the sample countries and years. The parameter estimation results are presented below:

	Fixed Effects	Random Effects	FGLS
Import1	0.146*	0.042	0.146**
	(1.91)	(0.60)	(2.14)
lnFDI1	0.015**	0.017***	0.015***
	(2.54)	(2.86)	(2.85)
Capital	-0.469***	-0.363***	-0.469***
	(-3.46)	(-2.72)	(-3.88)
LR1	-0.352***	-0.372***	-0.352***
	(-2.71)	(-2.84)	(-3.04)
PA	0.008	0.017***	0.008
	(1.28)	(2.81)	(1.44)
EFI	0.027*	0.019	0.027**
	(1.88)	(1.41)	(2.10)
2Constant	0.071	0.053	-0.034
	(0.66)	(0.47)	(-0.37)
Observations	68	68	68
Number of id	8	8	8
R-squared	0.423	0.346	
	FE	RE	FLGS

Table 3: Regression Analysis with Different Estimation Methods

Note:***, **, * represent the coefficients are significant at the 1%, 5%, 10% significance levels, respectively. The values in parentheses are the standard errors of the coefficients.

As shown in table 3, under the fixed-effects and random-effects models, both coefficients of the explanatory variables "Import" and "FDI," which measure capacity cooperation, are statistically significant and positive. This indicates that FDI from China and ASEAN countries significantly expanded the economies of scale for these nations, promoting the optimal allocation of production factors and generating significant positive effects on industrial development. Additionally, the intermediate goods trade resulting from China and ASEAN's capacity cooperation has produced positive technological spillover effects, elevating the export technology level of both China and ASEAN countries, thereby benefiting the enhancement of their GVC positions.

Among the other four control variables in the model:

(1) The coefficient of the fixed capital variable "Capital" is significantly negative. The reason behind this result may be that capital investment only yields positive effects when market mechanisms

are relatively perfect and properly guided. Otherwise, low capital utilization and an inappropriate investment structure can lead to adverse effects.

(2) The "LR" variable, representing human capital, exhibits a significantly negative coefficient. This may be due to the predominance of low-value activities in the labor force participation rates of these countries. Therefore, an increase in human capital may not necessarily lead to higher product value addition. An oversaturated labor force may not positively impact productivity in the export sector, thus not affecting the value chain status.

(3) The variable "PA," representing research and development (R&D) investment, exhibits a significantly positive coefficient. This suggests that increased R&D investment significantly enhances the technical complexity of China-ASEAN production capacity cooperation exports. It also contributes to higher productivity levels in the export sector, ultimately leading to an improvement in the GVC status.

(4) The coefficient for the "EFI" variable, representing institutional quality, is significantly positive. This indicates that institutional quality plays a crucial role in enhancing the value chain. A robust intellectual property protection system not only encourages companies to increase their R&D investments, promoting advancements in proprietary technology, but also facilitates the adoption of more advanced production processes by businesses. Simultaneously, an open trade system helps reduce tariffs and non-tariff transaction costs in international division of labor, facilitating better integration of China and ASEAN countries into the global production network. This further expands the depth of cooperation among enterprises in these countries.

6.3. Robustness Checks

The first two columns in Table 3 present the results of the basic analysis conducted using the fixed-effects and random-effects models. Based on the analysis results, corresponding conclusions have been drawn. To verify the robustness of the basic analysis in the empirical section, this paper employs the Generalized Least Squares (GLS) method to conduct further analysis of the sample data.

Since the sample data is constructed as a panel dataset over time, it is typically analyzed using Ordinary Least Squares (OLS). However, there may be issues of correlated errors and heteroscedasticity. To address such issues, Parks proposed the use of Generalized Least Squares (GLS) (Beck, Katz, 1995)^[15]. The panel data GLS estimation using the xtgls model allows for a more flexible covariance structure in dealing with disturbances and random effects. It utilizes the Feasible Generalized Least Squares (FGLS) estimation method to fit linear models for panel data with autocorrelation and heteroscedasticity in cross-sectional data (Erik, 2010)^[16]. Given that GLS might lead to parameter variability and underestimation, FLGS is employed in this study for robustness testing, as it assumes that errors are known.

The regression results in the third column of Table 3 show that the FLGS regression results are almost consistent with the basic regression results discussed earlier, confirming the conclusions regarding the impact of the various explanatory variables on GVC status mentioned earlier.

7. Conclusions

The study constructed the Export Structure Similarity Index (ESI) to measure the position of China and ASEAN countries in the global value chain. An analysis of the ESI index for ASEAN countries reveals that, under the backdrop of international production capacity cooperation between China and ASEAN, all sample countries, except for Myanmar, experienced an increase in their ESI index. This indicates that China's collaboration with ASEAN countries in production capacity can indeed promote an enhancement of their positions in the value chain.

The reasons for Myanmar's ESI index declining instead of rising may be attributed to the following factors, according to this study:(1)Myanmar has significant technological disparities compared to other ASEAN countries in the sample, which may hinder its ability to align its industrial structure with international standards and impact its international competitiveness.(2) Differences in labor rights and protections compared to China's labor laws may limit investment incentives for capacity building.(3)The political instability in Myanmar, marked by a military coup and subsequent violent conflicts between the military and anti-coup activists, has disrupted the political and economic landscape, negatively affecting capacity cooperation projects.

In addition to the findings mentioned above, this study further explains the theoretical mechanisms through which China and ASEAN's production capacity cooperation enhances the GVC positions of various countries. Using panel data from selected years between 2006 and 2021 involving nine countries from China and ASEAN, the study empirically tests the hypothesis that China and ASEAN's production capacity cooperation improves GVC positions. The research findings reveal that:

(1) Cooperation between China and ASEAN countries, coupled with technology spillover effects, has facilitated infrastructure connectivity and promoted the import of intermediate goods. Consequently, this has contributed to the enhancement of GVC positions in various countries.

(2) China's collaboration with ASEAN nations in production capacity has driven a surge in foreign direct investment (FDI). Consequently, this has spurred advancements in the GVC positions of these countries, driven by factors such as industry transfer, optimized resource allocation, and economies of scale.

(3) In the context of China-ASEAN production capacity cooperation, R&D investment and institutional quality are key drivers of improved GVC positions. Conversely, human capital and physical capital variables, which showed negative associations, may be influenced by differences in labor laws and oversaturated labor resources in some ASEAN countries. Inadequate infrastructure can lead to inefficient capital utilization and hinder GVC position enhancement.

Based on this, the study offers the following insights:

1) Promoting trade facilitation among China and ASEAN countries. China and ASEAN production capacity cooperation should prioritize infrastructure connectivity and be supported by financial integration. Strengthening infrastructure development planning, aligning technical standards, and facilitating international transportation will promote trade growth between China and ASEAN countries.(1) Actively utilize existing bilateral and multilateral trade cooperation mechanisms, establish and enhance bilateral joint working mechanisms, strengthen the role of these mechanisms, and leverage the geographical advantages of Guangxi and Yunnan. Within the framework of RCEP, promote the implementation of bilateral tariff reduction and trade and investment facilitation measures.

2) Promoting the development of outbound direct investments between China and ASEAN countries. Due to the varying levels of economic development among ASEAN countries, the tasks and ease of achieving development goals differ, and there are differences in interdependence levels. China and ASEAN should enhance investment cooperation based on shared interests, improving the complementarity of their investments and optimizing their investment distribution. They should intensify economic collaboration efforts to encourage foreign direct investment, project contracting, and labor services cooperation. Starting with investments, they can drive the coordinated development of project contracting and service trade, using investment cooperation as a catalyst to promote industrial cooperation and the integration of supply chains and value chains.

3) Continuously strengthening the construction of overseas demonstration industrial parks, strategically planning the layout of these industrial parks, and enhancing their supporting facilities. Industrial parks are one of the crucial avenues for production capacity cooperation and have a positive impact on enhancing GVC. It is essential to prioritize the construction of industrial parks and include them in significant planning projects for China-ASEAN production capacity cooperation. China's high-quality production capacity in industries such as steel and chemicals is crucial for ASEAN countries, especially in sectors like transportation infrastructure and healthcare. The construction of industrial parks can leverage cluster effects to advance the progress of production capacity cooperation. To attract companies to settle and build industrial parks, China and ASEAN countries need sufficient funding, tariff exemptions, and other policy support. They should also establish supporting enterprises in the industrial chain, such as product logistics parks and technology parks.

4) Enhancing economic and technological cooperation is crucial. China has established bilateral technology transfer mechanisms with all nine ASEAN member countries and has successfully hosted nine China-ASEAN Technology Transfer and Innovation Cooperation Conferences. This has provided a communication channel for enterprises, universities, and research institutions in both regions, promoting cooperation in technology and industrial upgrading. Under the impact of the new technological industrial revolution, China is shifting towards capital and technology-intensive industries and upgrading value chain segments. ASEAN member countries can actively engage in China's transformation and enhance their own industrial, supply, and value chains through economic and technological cooperation, taking into account their respective economic and technological development situations.

5) China and ASEAN countries should improve their factor endowment structures and leverage each country's comparative advantages in factor endowments. China and most ASEAN countries share the advantage of low labor costs, enabling international capacity cooperation to shift towards higher value-added segments of the value chain by leveraging their human capital. The Philippines, Vietnam, Cambodia, and other countries primarily rely on agriculture, and they are relatively less advanced in agricultural production technology and industrial sectors. In contrast, China has more mature technology levels in these areas. Singapore, as a developed country, excels in the service industry, healthcare, and has a well-established financial system. Therefore, China's capacity cooperation with Singapore focuses on areas such as healthcare and chemicals. Tailoring cooperation strategies to the specific circumstances of each country enables the leveraging of complementary resource endowments. Consequently, it fosters the advancement of industrial and value chain positions between China and ASEAN countries.

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