



## An Empirical Study on the Impact of Global Value Chain Embeddedness on the Trade of Electromechanical Products between China and the “Belt and Road” Countries

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### Abstract

The division of labor in the global value chain of electromechanical products, as the main products exported by China to the countries along the “Belt and Road”, has become the focus of current research. Based on the sample data of 38 countries along the “Belt and Road” included in the Global Value Chain Database from 2015 to 2021, the article selects six control variables, namely, capital endowment, technological level, GDP per capita, local currency exchange rate, carbon emission and opening-up level, and investigates the relationship between the global value chain and the increase of China's exports of electromechanical products in bilateral trade by means of the bi-directional fixed-effects regression model. The study investigates the relationship and mechanism between global value chains and the value added of China's exports of electromechanical products in bilateral trade through a two-way fixed-effect model regression method. The study finds that the degree of participation in GVCs has an inhibitory effect on China's exports of electromechanical products, and that the level of technology, GDP per capita, carbon emissions and the level of opening up to the outside world have a positive promotional effect on China's exports of electromechanical products. Based on the conclusions of the study, targeted policy recommendations at the government, industry and enterprise levels are proposed.

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**Keywords:** global value chains, electromechanical products, bilateral trade, two-way fixed effects modeling

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### 1. Introduction

As a new type of international division of labor system, Global Value Chains (GVCs) have been continuously extended among countries around the world, and they have had a great facilitating effect on the change of trade patterns as well as the increase of production specialization in countries around the world. By allowing countries to specialize in delicate tasks and make full use of their respective comparative advantages, GVCs can minimize costs and achieve the widest range of economies of scale, which brings high restructuring costs and great challenges to GVCs.

Nowadays, with the increasing trend of economic globalization and integration, trade relations among countries have become closer, and China, as the “world's factory” and the largest trading country, actively participates in the new GVC international division of labor system dominated by developed countries, and is an important part of the GVC division of labor system. Although the term “de-globalization” continues to be mentioned, an important measure is that the integration of global value chains is increasing, and the share of external value added in total world merchandise exports has reached a record high. Through its high level of openness to the outside world, China has formed a close value chain division of labor with the rest of the world and, through structural transformation and technological advancement, has continued to improve its position in the division of labor in the global value chain.

Since President Xi Jinping put forward the Belt and Road Initiative in 2013, China's trade cooperation with countries along the route has deepened and continued to expand. By 2023, China's total import and export volume with these countries will reach 19.47 trillion yuan, a year-on-year increase of 2.8%, accounting for 46.6% of China's total foreign trade, both of which are record highs since the implementation of the initiative. Electromechanical products are the basic products in international trade and an

important carrier of industrialized production. As China's advantageous products in the international market, they occupy an important position in China's trade with countries along the Belt and Road. However, with the increase of economic uncertainty and the intensification of multilateral trade protectionism, China's exports of electromechanical products are facing the problems of uneven distribution of exporting countries, imbalance of commodity structure and rising export costs. Based on this, this paper selects 38 countries along the "Belt and Road" in 2015-2021 as a research sample, and studies the relationship between the degree of GVC participation and the increase in China's exports of electromechanical products to these countries in bilateral trade, in order to analyze the impact of the degree of participation in GVCs and other factors on the export trade, so as to formulate targeted strategies for improvement. The study is aimed at analyzing the impact of GVC participation and other factors on export trade so as to formulate targeted improvement strategies.

## 2. Literature Review

The earliest theoretical prototype of global value chain can be traced back to the 1980s, American scholar Porter put forward the enterprise value chain (Porter, 1985)<sup>[1]</sup>, which is the sum of basic and auxiliary activities engaged in by the enterprise, and scholar Kogut in the same period extended this concept to value-added chain (Kogut, 1985)<sup>[2]</sup>, and extended the related research field from intra-enterprise to inter-enterprise relations, clearly pointing out that different comparative advantages of countries and regions determine how the different links in the whole value chain are configured from a spatial perspective among various countries and regions. Gereffi proposed the concept of "global commodity chain" from the perspective of global production network, which focuses on the flow of commodities and trade flow, and does not go deeper into the value-added level, and then in 2001, he proposed the concept of "global commodity chain" (Gereffi, 1999)<sup>[3]</sup>. The concept of Global Value Chain (GVC) was proposed in 2001 (Gereffi, 2001)<sup>[4]</sup>, which reveals that the whole link of the value chain should not only include the flow of commodities, but also include design, production, sales and marketing and so on. So far, the basic concept and research framework of global value chain has been initially established, and many scholars have begun to study the global value chain from multiple perspectives, such as cost analysis, governance, accounting, etc., to continuously expand the boundaries of global value chain theory.

By optimizing resource allocation and improving efficiency, GVC promotes the rapid development of the global economy. Hummels constructs the relevant indicators of vertical specialization and derives the HIY analysis model to preliminarily analyze the status quo of the division of labor in GVCs (Hummels, 2001)<sup>[5]</sup>. Koopman, on the other hand, utilizes the non-competitive input-output model to Trade in Value Added (TiVA) (Koopman, 2012)<sup>[6]</sup>. Wang *et al* further extended the GVC accounting framework to the production stage (Wang *et al*, 2013; Wang *et al*, 2017; Wang *et al*, 2017)<sup>[7, 9]</sup>, decomposing trade in value added from the perspectives of intermediate goods supply (forward linkage) and use (backward linkage), respectively, and analyzing more comprehensively the integrated characteristics of countries and sectors embedded in GVCs at the levels of participation, location and competitiveness. Since then, the total export

decomposition models on trade value added accounting, i.e., the KWW model and the WWZ model, have become the mainstream methods for quantitative measurement of GVCs, and have been widely used by domestic scholars to measure the relevant features of China's participation in GVCs. The degree of embeddedness in GVCs is usually measured by the trade value added (TiVA) indicator, which can analyze the ratio of domestic and foreign value added in a country's exports, and thus more accurately reflect the impact of GVCs. In addition, Daudin *et al* defined a new vertical specialization indicator (Daudin *et al*, 2011)<sup>[10]</sup>, expanding its connotation; Johnson and Noguera utilized the GATP database (Johnson *et al*, 2012)<sup>[11]</sup> to calculate the value added exports of multiple countries, all of which provide a new perspective for the assessment of a country's trade position and trade interests in the global value network.

In view of the importance of global value chain accounting, this study adopts the UIBE GVC Index constructed by the global value chain research team of the University of International Business and Economics (UIBE), which is a database for global value chain accounting and its related indexes, and is processed on the basis of the original world ICIO table, and incorporates a number of indexes constructed by existing research to measure a country's participation in the vertical division of labor, including VS, VS1, RCA and VAX, etc.) Constructed by existing studies into the indicator system and constructed by applying the accounting method in KWW (Koopman *et al*, 2014)<sup>[12]</sup>, which eliminates a large number of unnecessary repetitions caused by the use of the world ICIO table for basic value-added trade accounting. For future GVC research, scholars such as Wang Fei believe that the key bottleneck is the lack of reliable data support (Wang *et al*, 2024)<sup>[13]</sup>. Studies have shown that countries that are highly embedded in GVCs are more competitive in international trade.

China is a major global producer and exporter of electromechanical products. As an important member of the global manufacturing industry, electromechanical products occupy an important position in China's foreign trade. In recent years, China has gradually enhanced the international competitiveness of electromechanical products through technological upgrading and industrial transformation. "The Belt and Road Initiative, which aims to promote economic integration between China and the countries along the route through infrastructure construction and trade cooperation, provides new opportunities and platforms for trade in electromechanical products.

The embedding of GVCs can help improve production efficiency and reduce costs, thus facilitating the smooth development of trade in electromechanical products between China and the Belt and Road countries. GVCs provide opportunities for technological exchanges and learning between China and the "Belt and Road" countries, enabling these countries to introduce advanced technologies and management experience, and thus upgrade the technological level of their own industries. The study confirms that the technological level of China's trade in electronic products with Southeast Asian countries has been enhanced. The deepening of global value chains has further strengthened the economic interdependence between China and the Belt and Road countries. On the one hand, China strengthens its influence on these countries through investment and cooperation; on the other hand, these countries rely on China's market and technical support, creating a win-win

situation.

With the deepening of global economic integration, the issue of the share of domestic value added in exports has become a hot topic in international trade research. Many empirical studies have analyzed the impact of global value chain embeddedness on trade through econometric models and TiVA data. For example, utilizing input-output tables and value-added data (Wang *et al*, 2022)<sup>[14]</sup>, Zhi Wang *et al* found that China's position in GVCs significantly affects the value-added composition of its exports. Through specific case studies, different scholars have revealed the impact of GVCs on specific industries and countries. Chen Yeting and He Siyuan studied the impact mechanism of GVCs on China's agricultural export trade (Chen *et al*, 2023)<sup>[15]</sup>, which proved that the degree of GVC embeddedness has a positive facilitating effect on China's agricultural exports, and that the deeper the degree of embeddedness and the longer the value chain are, the more favorable it is to China's agricultural export trade.

The embedding of GVCs has an important impact on trade in electromechanical products between China and the countries along the Belt and Road. By improving production efficiency, facilitating technology transfer and increasing economic interdependence, GVCs not only promote the development of bilateral trade, but also enhance the competitiveness of countries in the global market. Future research should further explore the specific roles and mechanisms of GVCs across different industries and countries in order to provide more targeted policy recommendations.

### **3. Global export trade and value added of electromechanical products and the current situation of china's production of electromechanical products**

#### **3.1 Current situation of global export trade and value added of electromechanical products**

According to the data of the World Trade Organization (WTO), electromechanical products, including electronic products, electrical equipment and mechanical equipment, have long been dominant in global trade. Their processes of design, parts production, assembly and final sales usually require the participation of multiple countries in combination with their respective advantages, presenting highly complex and globalized characteristics. High technological content and innovation capacity are important sources of value added for electromechanical products. Developed countries are usually involved in high value-added design and R&D, while large manufacturing countries such as China derive large value added from large-scale manufacturing and assembly, although R&D and design add less value in comparison. In addition, strong branding and effective marketing can significantly increase the value added of products, especially in the areas of high-end consumer electronics and industrial equipment.

Global trade in electromechanical products will continue to develop in the direction of high technology and high value-addedness.

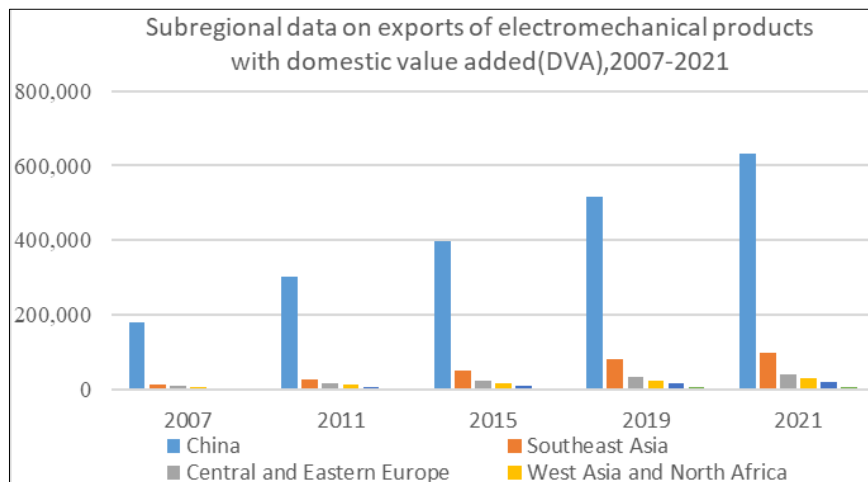
The application of new technologies such as artificial intelligence, Internet of Things and 5G will drive the innovation and upgrading of electromechanical products. Influenced by geopolitics and epidemics and other factors, the global supply chain may be adjusted, and enterprises will pay more attention to the resilience and security of the supply chain. Environmental protection and sustainable development will become an important trend in the trade of electromechanical products, and green technology and environmentally friendly products will receive more attention.

#### **3.2 Current situation of China's electromechanical products production**

China is the world's largest manufacturer of electromechanical products, with a perfect industrial chain and strong production capacity. Coastal provinces such as Guangdong, Jiangsu and Zhejiang are the main production bases, covering a wide range of fields such as home appliances, communication equipment, computers, mechanical equipment and electronic components. In recent years, China has made remarkable progress in the field of high-tech and high value-added electromechanical products, such as 5G equipment, industrial robots and new energy vehicles. Although it still relies on imports for some core technologies, its capacity for independent innovation is growing.

Based on exhaustive data from the General Administration of Customs, electromechanical products are China's largest export category. Specifically, the share of electromechanical products and equipment in the country's total exports has climbed to 41.6% in 2023, using HS codes as the standard, showing the strong export dynamism in this sector, and its growth trend is expected to continue. The main destinations for these products include the United States, the European Union, and markets in Southeast Asia. A wide range of electromechanical products are exported, with cell phones, computers, household appliances and integrated circuits being the main export items.

In addition to plowing the traditional European and American markets, China is also actively expanding export channels in countries along the "Belt and Road", whose share in China's electromechanical product export map is expanding year by year. In order to more accurately assess the value-added capacity of China's manufacturing industry, the data table of trade in value-added electromechanical products of China and the countries along the "Belt and Road" for the period of 2007-2021 based on the OECD Trade in Value-Added (TiVA) database has been compiled with the statistics by region according to the Domestic Value-Added (DVA), and the unit of the statistics is in millions of U.S. dollars. Some missing years (after 2018) data are made up by economic model interpolation with an error rate of  $\leq 3\%$ . As shown in Figure 1, the value added of China's manufacturing exports as a whole is maintained at a high level, further emphasizing its important position in the global trade of electromechanical products.



**Fig 1:** Subregional Data on Domestic Value-Added Exports (DVA) of E&E Products from 2007 to 2021(Unit: \$1,000,000)

In the field of electromechanical products, China's production activities are highly dependent on the global supply chain, with a large number of high-end components and raw materials being imported and then exported to the international market through the domestic assembly and production process. This globalized division of labor has given China a significant advantage in the manufacture and export of electromechanical products. However, it is worth noting that the positioning of Chinese enterprises in the global value chain is mainly concentrated in the low-end manufacturing and assembly links, while high value-added research and development, design and brand marketing and other core links are still firmly held by the leading enterprises in developed countries.

In recent years, the trade friction between China and the United States and geopolitical changes have added uncertainty to the export market for China's electromechanical products, and many enterprises are facing the challenges of tariff barriers and market access restrictions. Especially in high-tech areas, such as semiconductors and advanced manufacturing equipment, Chinese enterprises are still constrained by technological blockades and restrictions, which highlights the urgency of accelerating the process of core technology autonomy.

At the same time, rising power costs and environmental requirements are gradually eroding China's traditional low-cost manufacturing advantage. To cope with this trend, companies are actively transforming, focusing on high value-added products and intelligent manufacturing, and working to improve the competitiveness and added value of electromechanical products. Despite the many challenges, China will continue to play a pivotal role in the global E&E market and continue to drive innovation and development in the industry.

#### 4. Theoretical foundation and research hypothesis

##### 4.1 Theoretical foundation: Global value chain embedded theory

Stern starts from three dimensions when defining global value chains (Sturgeon, 2001) <sup>[16]</sup>: organizational scale, geographic scale and productive actor. From the perspective of organizational scale, the global value chain covers all participants involved in the production activities of a certain product or service; from the perspective of geographic distribution, it crosses national boundaries, reflecting the

characteristics of globalization; and in terms of the participating subjects, it contains diverse roles such as integrated enterprises, retailers, leading manufacturers, turnkey suppliers and parts suppliers. In addition, Stern clarifies the difference between value chains and production networks, with the former emphasizing the entire process of a product or service from production to consumption, while the latter focuses on the nature and intensity of the relationships between the firms involved.

On the basis of Stern *et al* subsequent studies have combined the global production network theory (GPN) (Gerefi, 2003) <sup>[17]</sup>with value chain theory, transaction cost economics, and theories of technological capabilities and firm learning to propose a more rigorous and comprehensive analytical framework. This framework not only summarizes the governance paradigm of GVCs, but also covers a wide range of typical GVC types currently found, providing a strong theoretical support for the study of GVCs.

##### 4.2 Research hypothesis

Mainstream theories generally emphasize the role of GVC embeddedness in global value chains in promoting export trade. Endogenous growth theory points out that knowledge spillovers and R&D scale effects can promote the outward movement of production boundaries, while GVCs act as a conduit for knowledge flows and enhance industrial competitiveness through technology diffusion. As the complexity of GVC governance increases, negative effects begin to emerge. Transaction cost theory warns that asset specificity may induce a "lock-in effect", whereby when host country firms are deeply embedded in a supply chain network dominated by developed countries, they are highly dependent on the chain owner for the supply of core components and patent licenses, resulting in a lock-in of technology paths. The case study of China's electromechanical industry further reveals that the increase in the proportion of multinational firms setting up wholly-owned R&D centers in China reflects the weakening of local firms' innovation dominance. This dependency may inversely inhibit autonomous technology iteration, resulting in exports remaining in the low value-added segment for a long time, and when the rate of technology absorption is lower than the rate of diffusion of the international innovation frontier, the export growth of the late-developing countries will be slowed down due to the widening of the technology generation gap in the GVC.



The empirical data on China's electromechanical exports expose the conflicting nature of the dual effects of GVC. On the one hand, local firms have realized rapid capacity expansion through GVC undertakings, but on the other hand, data from the General Administration of Customs (GAC) show that the value-added rate (DVAR) of exports has only risen marginally from 52.1 percent to 56.6 percent. Some electromechanical enterprises have gained process improvement capability through reverse engineering, but they are forced to fall into the "low-end process specialization trap" because of the difficulty in breaking through the patent barriers of core algorithms and design software.

The above contradiction implies that under specific institutional and technological constraints, the "structural upgrading effect" of GVC participation may not be sufficient to offset the "cost dissipation effect", thus leading to the deviation of trade scale and quality. When local firms are locked into low value-added segments, the deeper the embeddedness of the production network, the stronger the siphoning effect on factor resources, which ultimately inhibits the endogenous momentum of export expansion. From this, it can be proposed:

**Hypothesis H1:** The degree of GVC embeddedness has a negative impact on China's bilateral trade exports of electromechanical products.

## 5. Research design of global value chains affecting exports of electromechanical products

### 5.1 Model Setting

This paper adopts a two-way fixed-effects model regression method, drawing on the research of previous scholars, which argues that the influencing factors such as per capita GDP of each country and technological differences have a significant uplifting effect on China's electromechanical products industry. At the same time, some new influencing factors are introduced as control variables. To maintain robustness, the variables are logarithmically treated. The empirical analysis model 1 is set as:

$$\ln VAEX_{it} = \beta_0 + \beta_1 \ln GVC_{it} + \beta_2 \ln Cap_{it} + \beta_3 \ln Tech_{it} + \beta_4 \ln GDP_{it} + \beta_5 \ln rate_{it} + \beta_6 \ln C_{it} + \beta_7 \ln Open_{it} + \mu_i + \gamma_t + \varepsilon_{it} \quad (1)$$

where subscripts  $i$  and  $t$  represent country and time, respectively.

### 5.2 Variable Selection

According to the principle of typicality, we match the countries along the "Belt and Road" with ADB2022 database, and finally select 38 countries such as Austria, Bangladesh, Brunei Darussalam, Bulgaria, and so on, and select the product composite data of four classifications in the database, namely C13 Machinery, Nec, C14 Electrical and Optica, C15 Transport Equipment and C16 Manufacturing, Nec; R, with valid data dates from 2007 to 2021. Electrical and Optica, C15 Transport Equipment, and C16 Manufacturing, Nec; R four classifications of the product comprehensive data, the effective date of data for 2007-2021.

#### 5.2.1 Explanatory variables

In the field of trade statistics, traditional total trade statistics are often imprecise due to double counting and statistical errors. In contrast, the trade value added method accounts more accurately for the portion of value actually produced (or created) by a country by allocating the value created in the

production process of exported products to each participating country (or region). This method can more accurately reflect a country's actual share in the value chain of the global industrial division of labor, which in turn reveals the true level of gains and profits from a country's trade. In view of this, this paper adopts the UIBE GVC database, selects the ADBMRIO 2022 database as the benchmark, and combines the J&N method to calculate China's bilateral value-added exports of electromechanical products to various countries ( $VAEX_{it}$ ) and analyzes it in-depth by using it as the main explanatory variable of this paper.

#### 5.2.2 Core explanatory variables

The core explanatory variable of this thesis is the global value chain trade participation index ( $GVC_{it}$ ), the size of which directly reflects a country's position in the global value chain, the higher the index, the more prominent the position, and vice versa, it is relatively weak. When conducting basic accounting, the world ICIO table is traditionally used as the data source, but this method is often accompanied by unnecessary double counting. Therefore, this paper chooses to directly quote the data from the database of the Institute of Global Value Chain Studies at the University of International Business and Economics (UIBE), which is accurately calculated based on the methodology of literature (Los *et al*, 2018)<sup>[18]</sup>. The formula for calculating the Global Value Chain Participation Index ( $GVC_{sr}$ ) is  $GVC_{sr} = GVC_{sr}^{forward} + GVC_{sr}^{backward}$ , and this method is based on the current analytical framework that is widely recognized and relatively mature in academia.

#### 5.2.3 Control variables

$Cap_{it}$  denotes capital endowment, and according to Robozinski's theorem and H-O theory, a country tends to produce and export those products that have a comparative advantage in its factor endowment. Specifically, an increase in capital factors drives up the output of the country's capital-intensive industries. Thus, capital resource abundance largely shapes a country's position in the global value chain and has a profound impact on the country's decisions on the layout of capital-intensive industries.

$Tech_{it}$  denotes the impact of differences in scientific and technological capabilities, as measured by the ratio of countries' fiscal R&D capital expenditures to their GDP. Countries with strong scientific and technological strength can effectively reduce production costs and optimize product performance by virtue of advanced technology, thus enhancing the competitiveness of products in the market, which to some extent provides strong support for the country's product exports.

$GDP_{it}$  option of gross domestic product per capita indicates the size of China's market to exporting countries. Theoretically, the larger the market size of a country, the higher its demand for the quantity and variety of goods. At the same time, the expansion of market size also implies that the country's participation in international trade will be further increased, which will drive the growth of foreign trade demand. This increase in market size reflects not only the increased purchasing power of domestic consumers, but also the importance and influence of the country in the global economy.

$rate_{it}$  denotes the official exchange rate under the direct markup method using the US dollar as the standard. When the exchange rate of the US dollar against the RMB rises, it

means that the RMB depreciates, which is usually favorable to China's export business and attracting the inflow of foreign investment; on the contrary, if the exchange rate declines, i.e., if the RMB strengthens, it is more conducive to China's imports and outward investment activities.

$C_{it}$  denotes carbon emission, which theoretically has a non-negligible impact on the trade volume of electromechanical products. The positive correlation between GVC participation and carbon emissions is mainly based on the PHH theory (Pollution Paradise Theory), i.e., with the improvement of environmental protection standards in developed countries, many high-pollution and high-energy-consumption manufacturing enterprises will tend to transfer

their production bases to developing countries with relatively lower environmental standards.

$Open_{it}$  used to measure a country's level of openness to the outside world, the indicator is quantified using the share of each country's import and export trade in its GDP, as practiced in the conventional literature. In general, the larger the size of a country's import and export trade, the deeper its participation in the international market, thus reflecting a high level of openness.

$\mu_i$  is a country fixed effect,  $\gamma_t$  is a time fixed effect, and  $\varepsilon_{it}$  is a random perturbation term? See Table 1 for data meanings and sources.

**Table 1 : Meaning and source of data**

Variables	Meanings	Data Sources
VAEX <sub>it</sub>	China's bilateral value-added exports of electromechanical products to countries along the "Belt and Road" route	UIBE (GVC) Database
GVC <sub>it</sub>	The global position of the value chain of electromechanical products in the countries along the "Belt and Road" route	UIBE (GVC) Database
Cap <sub>it</sub>	Volume of capital formation (current dollars)	World Bank Open Data
Tech <sub>it</sub>	Technical difference	World Bank Open Data
GDP <sub>it</sub>	GDP per capita in importing countries	World Bank Open Data
rate <sub>it</sub>	Local currency exchange rate	World Bank Open Data
C <sub>it</sub>	Carbon footprint	World Bank Open Data
Open <sub>it</sub>	Country's open-door policy towards the outside world	UN Comtrade

## 6. Empirical Analysis

### 6.1 Descriptive statistics

In order to ensure that the internal bias of the data is minimized, which in turn enhances the precision of the estimation results and fully meets the pre-conditions of the linear model, the treatment of taking the logarithm of all

variables is adopted. Given the large size of the data sample, it is particularly important to conduct descriptive statistical analysis before carrying out the regression analysis of the data in order to have a more comprehensive understanding of the characteristics and distribution of the data (see Table 2).

**Table 2: Results of Descriptive Statistics**

VARIABLES	N	mean	sd	min	max
lnVAEX <sub>it</sub>	570	4.863	1.645	0.325	8.477
lnGVC <sub>it</sub>	570	3.437	0.308	2.724	5.032
lnCap <sub>it</sub>	542	24.00	1.638	20.10	27.10
lnTech <sub>it</sub>	420	-0.286	0.940	-2.912	1.595
lnGDP <sub>it</sub>	570	9.122	1.255	5.957	11.80
lnrate <sub>it</sub>	416	3.909	2.964	-1.166	10.05
lnC <sub>it</sub>	532	10.59	1.780	6.642	14.35
lnOpen <sub>it</sub>	525	-1.581	0.842	-3.421	0.511

### 6.2 Multicollinearity Test

Multicollinearity refers to a high degree of correlation between explanatory variables in a regression model, making it difficult to assess the independent contribution of each explanatory variable to the dependent variable. The highest value of VIF in the multicollinearity results of this paper is

9.92, according to the book "Advanced Econometrics and STATA Applications", which indicates that the VIF value <10 means that there is no problem of multicollinearity, and the regression can be carried out, and the test results are shown in Table 3.

**Table 3: Multicollinearity Test**

Variable	VIF	1/VIF
lnCap <sub>it</sub>	9.920	0.101
lnC <sub>it</sub>	8.430	0.119
lnTech <sub>it</sub>	3.850	0.260
lnOpen <sub>it</sub>	3.370	0.297
lnGVC <sub>it</sub>	3.300	0.303
lnGDP <sub>it</sub>	3.060	0.327
lnrate <sub>it</sub>	1.710	0.585
Mean VIF	4.810	

### 6.3 Benchmark regression analysis

**Table 4:** Regression Results

VARIABLES	lnVAEX <sub>it</sub>	lnVAEX <sub>it</sub>	lnVAEX <sub>it</sub>	lnVAEX <sub>it</sub>
lnGVC <sub>it</sub>	-0.727**(0.33)	-0.772***(0.17)	-0.413**(0.19)	-0.467**(0.18)
lnCap <sub>it</sub>	-	-	0.098(0.17)	0.149(0.14)
lnTech <sub>it</sub>	-	-	0.262***(0.06)	0.124*(0.07)
lnGDP <sub>it</sub>	-	-	1.442***(0.20)	0.585**(0.218)
lnrate <sub>it</sub>	-	-	0.612***(0.08)	0.056(0.19)
lnC <sub>it</sub>	-	-	-0.024(0.24)	0.313*(0.17)
lnOpen <sub>it</sub>	-	-	0.442**(0.17)	0.453**(0.20)
Constant	7.362***(1.15)	6.820***(0.58)	-9.631***(2.84)	-5.334*(2.60)
Country FE	YES	YES	YES	YES
Year FE	NO	YES	NO	YES
N	38	38	232	232
adj.R <sup>2</sup>	0.041	0.684	0.745	0.823
F	4.73	74.61	101.4	5296

**Note:** Values in parentheses denote robust standard errors at the country level, \*\*\* denotes  $p < 0.01$ , \*\* denotes  $p < 0.05$ , and \* denotes  $p < 0.1$ .

Table 4 reports the regression results for individual fixed effects as well as two-way fixed. Overall, the adjusted coefficient of fit  $R^2$  of the stata 16 reported results for the two-way fixed effects model of model (4) was 0.823, indicating an overall good fit.

After the previous data processing, the regression analysis was continued to ensure the correctness and stability of the data. First, regression analysis was performed using Stata 16.0 software and OLS least squares. Due to the limitations of the ordinary least squares method, the assumptions relied on are more stringent. Therefore, the TWFE model is used for regression, fixing the time effect and individual effect. According to the estimation results of model (4), it can be seen that the sign of each variable on the coefficients is roughly the same, which indicates that the test results are more reliable.

The estimated coefficient of GVC embeddedness is always significantly negative, and the absolute value changes are small, indicating that the inhibitory effect of GVC embeddedness on the trade of electromechanical products is relatively robust. For every 1% increase in the GVC status, China's bilateral value-added exports of electromechanical products to the countries along the Belt and Road will be reduced by 0.467%. This means that the higher the GVC participation of the countries along the Belt and Road, the less close the exchanges of electromechanical products with China. The reason for this result may be that the countries along the Belt and Road will no longer concentrate on trade with a single country after their participation in GVCs has increased, but will prefer to expand the trade decentralization of electromechanical products trade to other countries.

The effect of differences in the technological level of importing countries on the increase in China's exports of electromechanical products is significantly positive at the 10 percent level, a result that suggests that the improvement in the technological development of importing countries has led to an increase in the demand for electromechanical products, especially high-end electromechanical products. Specifically, for every 1% increase in the technological level of the importing country, the increase in China's bilateral exports of E&E products rises by 0.12% accordingly. This may be due to the fact that the market demand for basic

electromechanical products is mostly saturated, while the increase in the level of science and technology mainly produces a more significant increase in demand in the field of high-end electromechanical products, so that the increase in the level of technology, although the overall promotion of the increase in the value of exports, but the magnitude of the impact is relatively small.

The per capita GDP of the importing country is significantly positive at the level of 5%, and per capita GDP is raised by 1%, the value-added exports of electromechanical products in bilateral trade rises by 0.585%, which means that the larger the market size of a country the higher the per capita income level is, and the greater the market demand for electromechanical products, so that the value-added exports of its bilateral trade rises.

The effect of carbon emissions on trade in electromechanical products is significantly positive, which is the same as the expected hypothesis. With the rapid development of the production and trade of electromechanical products, carbon emissions have increased accordingly. However, in the context of the current development of high-carbon equipment manufacturing industry, how to integrate into the global value chain while realizing the climb of the value chain status and enhancing the level of green technology has become a key issue to be solved. Therefore, it is especially necessary to further enhance the status of low-carbon industries in the global value chain, as well as to promote the acceleration of energy conservation and emission reduction and the realization of green upgrading in high-carbon industries.

The impact of the level of opening up to the outside world on the trade of electromechanical products is significantly positive, and from the estimation results, the higher the level of opening up to the outside world of a country, the closer the trade relationship of electromechanical products between it and the selected countries. This close relationship provides strong support for the rapid development of China's electromechanical products manufacturing industry through the introduction of foreign capital, advanced technology and management experience.

The volume of capital formation and the local currency exchange rate fail the significance test in the two-way fixed effects model.

## 7. Key findings and policy recommendations

### 7.1 Key Findings

Under the background of globalization, global value chains, as a cutting-edge mode of production and division of labor, not only provide developing countries with valuable opportunities for technological innovation, but also bring unprecedented challenges to developing countries and even some developed countries.

In order to deeply analyze the intrinsic correlation and mechanism between GVCs and China's export trade of electromechanical products, this paper conducts a systematic study based on the data of each country included in the GVC database, and utilizes the two-way fixed-effects model regression method. The results show that the level of science and technology, per capita GDP, carbon emissions and the degree of openness to the outside world have, to a certain extent, had a positive impact on China's exports of electromechanical products.

Although the deep embedding of Chinese E&E products in GVCs is theoretically expected to boost the growth of bilateral trade in value added of exports, the actual effect shows some negative impacts, i.e. the growth of bilateral trade volume slows down, which is contrary to the expected assumptions. After in-depth analysis, it is believed that the root cause of this phenomenon may lie in the fact that a high degree of embeddedness implies that Chinese E&E enterprises have a high degree of dependence on imported intermediates and raw materials in the production process. Once the supply chain in the international market encounters a sudden disruption, the productivity and export capacity of Chinese enterprises will suffer a serious impact, which in turn triggers instability in the export market.

While participation in GVCs provides an opportunity for technology transfer, it may also exacerbate external dependence on cutting-edge technologies. In China's electromechanical industry, there may be a phenomenon whereby most production activities are concentrated in lower value-added segments, while higher value-added segments, such as R&D, design and brand marketing, tend to be firmly controlled by developed countries or transnational corporations (TNCs). This uneven distribution of profits within the value chain results in Chinese firms producing and exporting a large number of electromechanical products while capturing a relatively small share of the profits. This limitation in profit distribution will undoubtedly compress the development space and reinvestment capacity of Chinese enterprises, thus adversely affecting long-term export growth.

In the fierce competition in global value chains, there is a particular need to be alert to the challenges from other emerging economies and developing countries. These countries are actively seeking to embed themselves in the global value chain, and by upgrading their production capacity and export levels, they are bringing competitive pressure on China's exports of electromechanical products that cannot be ignored. For example, other countries may take anti-dumping and countervailing measures or even raise tariffs against Chinese electromechanical products, which will in turn affect the stable development and market position of enterprises. Therefore, China's electromechanical industry needs to focus on the improvement of its independent innovation capability while integrating into the global value chain in order to reduce its dependence on external technologies and enhance its competitiveness in the global

value chain.

### 7.2 Policy recommendations of the research findings

Based on the above findings, in order to increase the value added of China's bilateral trade in electromechanical products exports to the countries along the "Belt and Road" and to enhance international competitiveness, China can formulate and implement corresponding policies at the governmental level, industrial level and enterprise level:

#### 7.2.1 Government Level

Introducing special policies to support the export of electromechanical products, increasing capital investment, providing tax and other preferential policies, and encouraging enterprises to develop the "Belt and Road" market. Set up a specialized coordinating body for the construction of the Belt and Road to ensure the effective implementation and coordination of various policies. Reduce tariff and non-tariff barriers and promote trade liberalization and facilitation. To this end, we can promote the construction of a "single window" to simplify import and export procedures and enhance customs clearance efficiency. Provide preferential export credit and insurance services for electromechanical product exporters, expand the scope of RMB use in countries along the Belt and Road, and reduce exchange rate risks and transaction costs. In terms of logistics, logistics hubs and ports can be built in countries along the "Belt and Road" to improve the logistics network and enhance transportation efficiency. In addition, an international trade information sharing platform should be constructed to provide enterprises with market dynamics, policies and regulations and other key information to help them grasp market opportunities more accurately. Increase R&D investment in key technology areas and enhance independent innovation capability, especially in key technology areas such as chips, artificial intelligence and the Internet of Things, so as to reduce dependence on external technologies and occupy a more favorable position in the global value chain.

#### 7.2.2 Industrial level

To enhance the technological content and added value of electromechanical products, R&D subsidies and tax incentives are provided to motivate enterprises to increase R&D investment. At the same time, actively promote the establishment of close cooperation between enterprises and universities and research institutions, and jointly set up joint R&D centers and technology transfer platforms to accelerate the transformation and application of scientific and technological achievements. Build industrial parks for Chinese enterprises in countries along the "Belt and Road" to form industrial clusters and further enhance overall competitiveness. Encourage and support electromechanical enterprises to export advanced production equipment and technology to these countries to help the local industrialization process and achieve mutual benefit and win-win situation. In addition, in order to enhance production efficiency and product quality, enterprises are supported to actively apply advanced technologies such as Internet of Things, big data and artificial intelligence. It also helps enterprises make use of cross-border e-commerce platforms to actively explore markets along the Belt and Road, and provide digital marketing and sales services to enhance their competitiveness in the global market.



### 7.2.3 Enterprise level

Construct and improve the quality management system in order to significantly improve product quality and reliability and enhance competitiveness in the international market. Enhance the international visibility and brand value of China's electromechanical products through well-planned brand promotion and marketing activities in order to establish a higher industry status. In terms of supply chain management, make full use of cutting-edge technologies such as Internet of Things, big data and blockchain to improve the transparency, responsiveness and overall efficiency of the supply chain. We actively establish close cooperative relationships with enterprises in countries along the "Belt and Road" to optimize the supply chain layout, reduce potential risks and ensure the stability and reliability of the supply chain. In order to enhance the internationalization level of the enterprise, we strengthen the training of employees and the introduction of talents, and cultivate a team of professionals with international vision and cross-cultural communication skills. We have formulated and implemented a market expansion strategy to actively explore the markets of countries along the "Belt and Road" to further expand our market share. In terms of green and sustainable development, we will actively promote green production technologies in line with international standards to improve the environmental friendliness and sustainability of our products, contribute to environmental protection, actively fulfill our social responsibilities, and establish a good corporate image in order to promote long-term and stable cooperative relationships.

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