

# **Impact of RTAs on the regional heterogeneity in global value chain**

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## **I 、 Introduction**

Currently, the world is facing a trend of deglobalization, and the occurrence of events such as the COVID-19 pandemic and the Russia-Ukraine conflict has made ensuring industrial safety the primary goal of all countries in the world. In this context, the global production system has been greatly impacted, accelerating the existing trend of restructuring global value chains (GVCs). Restructuring GVCs and reshaping domestic value chains (DVCs) to achieve shorter and more regionalized value chains has gradually become a consensus among major economies.

In 2020, the United Nations Conference on Trade and Development (UNCTAD) designated the period from 2021 to 2030 as the decade of GVCs restructuring. The Global Value Chains Development Report (2017) published by the World Bank indicated that in 2015, the geographical characteristics of GVCs could be categorized into three relatively isolated regional value chains, namely the GVCs centered around Germany, the United States, and China. According to a report published by the McKinsey Global Institute in 2019, regional trade as a proportion of global merchandise trade increased by 2.7% compared to 2013. Large-scale regional agreements such as the North American Free Trade Agreement (NAFTA), the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP), and the Regional Comprehensive Economic Partnership (RCEP) are also serving as significant driving forces for the reconstruction of global value chains. Against the background of the increasing number, depth and breadth of RTAs in the world at present, it is of practical significance to analyze the heterogeneous impacts of RTAs on member countries, which can help countries around the world to make more targeted decisions in conducting regional cooperation and to choose approaches and policies that are conducive to deeper regional cooperation.

## **II 、 literature review**

In a study of regional trade agreements, Li et al. (2017) analyzed economic and trade cooperation in the Asia-Pacific region based on the value chain perspective, and the results showed that the implementation of RECP has a positive driving effect on the Asia-Pacific industrial chain, which will promote the export of final products from developing countries in the region and increase the input of intermediate goods to countries in the region, thus promoting the transfer of processing trade industries in China and other countries in the region. Chen (2022) analyzes the new opportunities that the strengthening of interregional cooperation and the reduction of tariffs will bring to the reconstruction of regional value chains in China and member countries after RCEP comes into effect from the perspectives of institutional support, environmental creation and the construction of industrial division of labor system. Ou et al. (2021) show that the implementation of RCEP can promote intra-regional technological cooperation and boost investment, thus promoting technological innovation and facilitating the optimization and restructuring of inter-regional value chains. Dong et al. (2023) linked the GTAP model with the regional TERM model and found that the establishment of RCEP would significantly promote the circulation and cooperation of domestic electronics industry in the industrial chain. Li (2022) studied that the effective of RCEP would further expand the advantages of Guangxi Free Trade Pilot Zone, and also help promote the integration of value chain and industrial chain between Guangxi FTZ and ASEAN countries, and promote the industrial opening and upgrading of Guangxi FTZ. Li et al. (2021) pointed out that Hainan should seize the new opportunity of RCEP to reshape, strengthen regional cooperation with South and Southeast Asia as well as ASEAN countries, upgrade the industrial chain, supply chain as well as value chain, actively integrate into RCEP with the unplatform of Hainan free trade port, establish multi-party cooperation mechanism, and inject new momentum into regional economic development.

Two main types of modeling approaches have been used in studies on regional and global value chains, one is the CGE-GVC model and the other is based on coupled regional and global models.

In terms of the CGE-GVC modeling approach, most scholars have studied issues related to international trade by incorporating the GVC structure into the dynamic GTAP model (CAI et al., 2015; Itakura et al., 2019; Sun et al., 2021). CAI et al. (2015) introduced a new CES production function in the GTAP-GVC model by replacing the information on imports of intermediate goods in the country of origin with information from the World Input-Output Database (WIOD); Itakura et al. (2019) incorporated the GVC structure into the dynamic GTAP model to estimate the welfare and sectoral output effects of CPTPP and RCEP and compared the results with the results of the standard dynamic GTAP model; Zhou et al. (2019) constructed a linkage method between the standard GTAP model and the GVC decomposition accounting system, and quantitatively assessed the policy effects of Trump's tax reform on the value chain reconfiguration in China and the United States based on this method; Lim et al. (2021) applied the GTAP-E and GTAP-VA modules to the GTAP model to analyze the impact of factors that reverse the global value chain on the global economy, trade and energy markets. Sun et al. (2021) connected the GDYN model with the global value chain to estimate the impact of the COVID-19 on the global manufacturing and value chain dynamics; Dong et al. (2022) used the GTAP-GVC model, a global multi-regional multi-industry computable general equilibrium model that includes a value chain accounting system, and the GTAP-MRIO database to analyze the integrated impact of digital economy development on macroeconomics, industrial structure and international trade. Dong et al. (2023) linked the global multi-regional computable general equilibrium GTAP-GVC model containing the value chain analysis framework with the Chinese multi-regional computable general equilibrium TERM model, and studied and analyzed the impact of the completion of RCEP on the economic development of various regions in China.

In terms of regional-global model linkage, current research focuses on two aspects. On the one hand, it is centered on linking China's multi-regional input-output tables with global input-output tables (MENG et al., 2013; Ni et al., 2016; Li et al., 2018; Yu et al., 2018; Meng et al., 2019), studying issues such as input-output table nesting, global value chain measurement and value-added trade accounting. MENG et al. (2013) link China's multi-regional input-output tables with global input-output tables to

describe how global production is fragmented and expanded through the linkages of regions within a country; Ni et al. (2016) extended the value added export and total export value added decomposition methods and argued that traditional gross trade overestimates the international trade surplus of China's regions; Li et al. (2018) constructed an international input-output model that includes domestic inter-provincial input-output models, extended the WWZ decomposition method on value added trade, and proposed a unified framework for decomposing foreign trade in domestic provinces; Yu et al. (2018) embed regional input-output tables into global input-output tables and construct corresponding carbon emission accounts to explain the value-added carbon emission transfer effects of domestic-foreign trade in China's regions using input-output models and structural decomposition analysis methods; Meng et al. (2019) further introduce a social network analysis approach to analyze the structural changes of global value chains based on a multi-regional input-output model. On the other hand, the soft linkage between the multi-regional general equilibrium model and the global general equilibrium model in China is mainly focused on (Zhang et al., 2021; Yang et al., 2022). Zhang et al. (2021) took RCEP as the research object and effectively linked the standard GTAP model with China's regional computable general equilibrium model (Sino-TERM), and found that after the establishment of RCEP, China's labor force will further shift to the southeast coastal region; Yang et al. (2022) linked the GTAP model with China's multi-regional CGE model and analyzed the the impact of the establishment of FTA on the economic development of ethnic regions and related industries in China, and found that the long-term economic development of some provinces and regions in ethnic regions will be inhibited to a certain extent due to the transfer of labor factors to developed regions.

The deep integration of domestic value chains and global value chains makes it necessary to focus on the interaction between them when modeling and simulating and evaluating policy shocks. Therefore, based on the existing research, this paper continues to explore the connection mode between the global model and the domestic regional model, and draws on the modeling method of the U.S. WinDC model developed by the GTAP team to link the input-output data of each Chinese province with the GTAP11 database. On the basis of the global model at the national level, the

domestic provinces of China are introduced into the global model to replace the "China" as a whole, and the economic cycle links between the domestic regions themselves and the regions and the economic cycle links between the countries are portrayed at the same time, so as to realize the coupling analysis of domestic value chains and global value chains.

### **III 、 Method**

#### **3.1 Database**

The model data is based on the GTAP database and 2017 China Multi-regional input-output table (MRIO). After processing the countries and departments in the two databases, the foreign trade data of each province in China's inter-provincial input-output table and China's overall data in the GTAP database Linked on the basis of foreign trade data from China to form a global database covering 17 sectors in 10 regions<sup>1</sup>.

#### **3.2 Model**

The economic interconnections between provinces within China and between Chinese provinces and other countries are mainly achieved through inter-provincial trade within China and international trade of each province. The model goes beyond the typical framework of a general CGE model and achieves the embedding of the multi-regional computable general equilibrium model of China within the globally applicable national-level computable general equilibrium model through the equations presented below.

##### **3.2.1 Interprovincial trade**

The output of each industry at the provincial level supplies four types of demand: intra-provincial demand, demand from other provinces, export demand, and demand for international transportation services. The total demand in the provincial market is

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<sup>1</sup> See appendix for detailed region and sector settings.

met by three types of supply sources: intra-provincial supply, supply from other provinces, and imported supply.

Provinces are economically linked through interprovincial inflows and outflows. Each province's intra-provincial demand is equal to its intra-provincial supply, with outflows being the total demand for the province's products from other provinces and inflows being the total demand for the province's products from other provinces, thus establishing economic linkages between the provinces.

$$\sum_{sr \in ar} XN_{i,sr}^s = \sum_{sr \in ar} XN_{i,sr}^d + XTT_{i,ar} \quad (1)$$

where  $XN_{i,sr}^s$  is the inflow of product  $i$  from province  $sr$ ,  $XN_{i,sr}^d$  is the inflow of product  $i$  from province  $sr$ , and  $XTT_{i,ar}$  is the quantity of international transport services provided by country  $ar$ . International transport services, as a product necessary for international import and export trade, are considered as part of the outflow from each province and their quantity is given as a fixed percentage of the import and export trade quantity.

### 3.2.2 International trade

The act of international trade is carried out between countries, so the provinces do not make direct trade links with other countries, but first sum up the import demand of each province at the national level, and then use the CET function structure to decompose the total imports into imports to each import source country to achieve the trade links at the national level.

$$XMT_{i,ar} = \sum_{sr \in ar} XM_{i,sr} \quad (2)$$

$$XW_{i,s,d} = XMT_{i,d} \left( \frac{PMT_{i,d}}{PMD_{i,s,d}} \right)^{\sigma_{i,d}^w} \quad (3)$$

$$PMT_{i,d} = \left[ \sum_s s_{i,s,d}^{xw} PMD_{i,s,d}^{1-\sigma_{i,d}^w} \right]^{1/(1-\sigma_{i,d}^w)} \quad (4)$$

Where  $XMT_{i,ar}$ ,  $XM_{i,sr}$  are the total national imports and the import demand of each province, respectively. Equations (3) and (4) use the CET function structure to decompose total imports into import quantities to each importing country, where  $XW_{i,s,d}$  is the quantity of product  $i$  exported from country  $s$  to country  $d$ ,

$PMD_{i,s,d}$  is the tariff-inclusive price of product  $i$  exported from country  $s$  to country  $d$ , and  $\sigma_{i,d}^w, s_{i,s,d}^{xw}$  are the elasticity and share parameters, respectively.

### 3.2.3. Government account balance

In the model, government revenue comes from two sources: tax revenue from different regions and tax revenue from import and export.

$$\begin{aligned}
 GREV_{sr} = & \underbrace{\sum_h k_{h,sr}^h YH_{h,sr}}_{\text{Direct taxes}} + \underbrace{\sum_i \tau_{i,sr}^n PD_{i,sr} XD_{i,sr}}_{\text{Taxes on local goods}} \\
 & + \underbrace{\sum_i \tau_{i,sr}^n PN_{i,sr}^s XN_{i,sr}^d}_{\text{Taxes on national goods}} + \underbrace{\sum_i \tau_{i,sr}^i PM_{i,sr} XM_{i,sr}}_{\text{Taxes on imported goods}} \\
 & + \underbrace{\sum_a \tau_{a,sr}^p PX_{a,sr} XP_{a,sr}}_{\text{Taxes on production}} + \underbrace{\sum_a \sum \tau_{f,a,sr}^v PF_{f,a,sr}^b XF_{f,a,sr}}_{\text{Taxes on factor use}}
 \end{aligned} \tag{5}$$

$$\begin{aligned}
 GREV_{ar}^{tot} = & \underbrace{\sum_i \sum_d \tau_{i,ar,d}^e PE_{i,ar}^s XW_{i,ar,d}}_{\text{Export taxes/subsidies}} \\
 & + \underbrace{\sum_i \sum_s \tau_{i,s,ar}^m PWM_{i,s,ar} XW_{i,s,ar}}_{\text{Import taxes}} + \underbrace{\sum_{sr} GREV_{sr}}_{\text{Aggregate sub-regional tax revenues}}
 \end{aligned} \tag{6}$$

$$GEXP_{ar}^{tot} = \sum_{sr} GEXP_{sr} \tag{7}$$

Equations (6) and (7) represent the revenue components of the government, where  $GREV_{sr}$  is the tax revenue at the provincial level,  $GREV_{ar}^{tot}$  is the gross domestic revenue,  $YH_{h,sr}$  is the income of the population,  $XD_{i,sr}$  and  $PD_{i,sr}$  are the quantities and clearance prices of locally produced products for local consumption,  $XN_{i,sr}^d$  and  $PN_{i,sr}^s$  are the quantities and prices of domestic products,  $XM_{i,sr}$  and  $PM_{i,sr}$  are the quantities and prices of imported products,  $XP_{a,sr}$  and  $PX_{a,sr}$  are the quantities of local output and producer prices of output,  $XF_{f,a,sr}$  and  $PF_{f,a,sr}^b$  are the quantity of local output and producer prices of output,  $XF_{f,a,sr}$  and  $PF_{f,a,sr}^b$  are the quantity of factor inputs and factor prices,  $XW_{i,ar,d}$  is the quantity of international trade,  $PE_{i,ar}^s$  is the price of production of exports,  $PWM_{i,s,ar}$  is the CIF price of imports,  $k_{h,sr}^h, \tau_{i,sr}^n, \tau_{i,sr}^i, \tau_{a,sr}^p, \tau_{f,a,sr}^v, \tau_{i,ar,d}^e, \tau_{i,s,ar}^m$  are the tax rates of each tax. Equation (8) indicates that total domestic government expenditure is the sum of provincial government expenditure, where  $GEXP_{sr}$  and  $GEXP_{ar}^{tot}$  are provincial government expenditure and total domestic government expenditure, respectively.

## IV、Results

### 4.1 Scenario

In this paper, we will focus on China's expansion of regional trade cooperation with more countries in the world in the context of Sino-US trade frictions and explore the industrial space impacts of different RTA scenarios on GVCs and DVCs. In the process, we analyze the impact of deepening regional trade relations on the GVC and DVC patterns under different scenarios, as well as the trend of the transformation of global industrial chain patterns along GVCs and DVCs. Therefore, this paper will conduct simulations of the following scenarios:

Table 1 Scenario Setting

| Scenario             |     | Setting                                                                                                                                                                                                                                                       |
|----------------------|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Baseline             | BAU | Scenarios of maintaining the status quo in China-US trade tariff levels and regional trade, setting model parameters with reference to the real tariff levels in China and the US, establishing a baseline for further deepening of regional trade agreements |
|                      | S1  | Strengthening regional trade cooperation between China and ASEAN (Association of Southeast Asian Nations, ASEAN) countries by completely eliminating trade tariffs between China and ASEAN countries;                                                         |
| Simulation scenarios | S2  | Regional Comprehensive Economic Partnership (RCEP) countries deepen regional cooperation across the board and eliminate trade tariffs among RCEP countries                                                                                                    |
|                      | S3  | Regional trade cooperation will further expand to countries along the “Belt and Road”, increase cooperation with India on the basis of cooperation among RECP countries, and cancel trade tariffs between RECP countries and India                            |

### 4.2 Impact on world trade

From the perspective of total trade volume among world regions, the deepening of regional trade can increase the total trade of partners within RTAs, corresponding to three scenarios, with intra-regional trade rising by 0.9%, 1.9% and 4.29% under the gradual deepening of regional cooperation in Asia. In the short term, due to demand

and supply capacity constraints, the increase in intra-regional trade reduces trade flows between the region and other regions, and other regions of the world are influenced to expand their trade ties with each other. From the simulation results, the deepening of Asian cooperation leads to some increase in intra-regional trade in both Europe and North America, and reduces the demand for imports from other regions.

Table 2 Interregional Trade Changes (%)

|               | Scenario | North America | Europe | Asia  | Rest of world |
|---------------|----------|---------------|--------|-------|---------------|
| North America | S1       | -             | -0.02  | -0.32 | 0.08          |
|               | S2       | 0.04          | -0.01  | -1.11 | 0.23          |
|               | S3       | 0.08          | -0.06  | -1.79 | 0.39          |
| Europe        | S1       | -0.02         | -0.01  | -0.28 | 0.06          |
|               | S2       | -0.03         | 0.01   | -0.87 | 0.17          |
|               | S3       | -0.04         | -      | -1.63 | 0.33          |
| Asia          | S1       | -0.08         | -0.18  | 0.90  | -0.20         |
|               | S2       | -0.38         | -0.56  | 1.90  | -0.62         |
|               | S3       | -0.63         | -1.14  | 4.29  | -1.22         |
| Rest of world | S1       | -0.01         | -      | -0.17 | 0.11          |
|               | S2       | -0.05         | -0.01  | -0.27 | 0.16          |
|               | S3       | -0.03         | 0.05   | -0.80 | 0.47          |

Under the influence of regional trade agreements, the trade between member countries is closer, but the impact on regional trade agreements of different countries and regions has obvious differences. In the S1 scenario, the cooperation between China and ASEAN countries promotes bilateral trade exchanges, improves the GDP and welfare levels of China and ASEAN countries, and the trade diversion effect affects the GDP and welfare levels of other regions. In the S2 scenario, the entry of Japan and South Korea will further increase the overall trade volume. Only Japan's exports to China and ASEAN to South Korea will decrease slightly, and Japan's GDP and welfare will also increase. Due to the substantial increase in imports, South Korea's GDP decline has decreased, but the overall domestic welfare level has improved due to the reduction in price levels.

Table 3 Changes in Bilateral Trade (%)

|    |       | China | Japan | Korea | ASEAN | India |
|----|-------|-------|-------|-------|-------|-------|
| S1 | China | -     | -0.48 | -0.47 | 5.22  | -0.29 |
|    | Japan | 0.18  | -     | 0.07  | -1.79 | 0.19  |
|    | Korea | 0.11  | 0.12  | -     | -1.51 | 0.15  |
|    | ASEAN | 3.29  | -0.91 | -0.94 | 1.32  | -1.46 |
|    | India | 0.19  | 0.01  | -0.09 | -1.75 | 0.00  |
| S2 | China | -     | 6.07  | 6.57  | 3.05  | -0.66 |
|    | Japan | -0.81 | -     | 28.37 | 4.52  | -3.78 |
|    | Korea | 0.59  | 6.24  | -     | 5.98  | 0.07  |
|    | ASEAN | 3.69  | 0.66  | -5.51 | 0.41  | -1.44 |
|    | India | 0.56  | -1.91 | -4.01 | -2.60 | -     |
| S3 | China | -     | 5.43  | 5.83  | 2.16  | 27.69 |
|    | Japan | -0.46 | -     | 28.27 | 4.20  | 4.58  |
|    | Korea | 0.91  | 6.30  | -     | 5.93  | -1.32 |
|    | ASEAN | 4.00  | 0.56  | -5.57 | 0.08  | 5.91  |
|    | India | 8.02  | 1.42  | -1.18 | 12.88 | -     |

In the S3 scenario, we attempt to continue to expand the scope of regional trade agreements to form a broader regional cooperation in Asia as a whole. However, instead of weakening the negative impact on India after becoming a member country, it further expands the extent of India's loss, mainly because India and China are located in a similar position in the global value chain, with a large share of processing trade. After joining the regional trade agreement, the short tariff reduction among member countries on the one hand makes India's exports grow significantly, and on the other hand makes India's domestic products lose their price advantage over Chinese products, and imports to China increased significantly by 27.69%, causing a shock to India's domestic production.

Table 4 Changes in GDP and welfare levels (%)

|                   | S1    |         | S2    |         | S3    |         |
|-------------------|-------|---------|-------|---------|-------|---------|
|                   | GDP   | Welfare | GDP   | Welfare | GDP   | Welfare |
| United States     | -0.03 | -0.03   | -0.10 | -0.11   | -0.13 | -0.14   |
| China             | 0.05  | 0.08    | 0.14  | 0.18    | 0.28  | 0.32    |
| Germany           | -0.04 | -0.04   | -0.12 | -0.13   | -0.17 | -0.19   |
| Japan             | -0.08 | -0.09   | 0.14  | 0.38    | 0.14  | 0.38    |
| Korea             | -0.11 | -0.15   | -0.10 | 0.43    | -0.13 | 0.38    |
| Other Europe      | -0.03 | -0.03   | -0.08 | -0.09   | -0.11 | -0.13   |
| ASEAN             | 0.04  | 0.31    | 0.00  | 0.29    | 0.05  | 0.37    |
| India             | -0.04 | -0.06   | -0.08 | -0.12   | -0.51 | -0.30   |
| Mexico            | -0.02 | -0.02   | -0.06 | -0.07   | -0.07 | -0.08   |
| Rest of the World | -     | -       | -0.03 | -0.03   | -0.03 | -0.03   |

## 4.3 Impact on China

### 4.3.1 Industry Impact

The implementation of regional trade agreements has led to closer trade ties between China and its member countries, and both total exports and imports have increased significantly. Specifically, for the manufacturing industry sectors, except for the wood processing, paper printing and non-metal products sectors where the total export volume is relatively small, resulting in a larger increase, the main growth sectors of China's exports are the textile industry, chemical products and the metal products sector, with more significant growth in the transportation equipment manufacturing sector in the downstream sector and smaller growth in the electronic equipment, instrument manufacturing and equipment sectors. From the perspective of growth sectors, China's export growth is still concentrated in the upstream sectors of the industrial chain and labor-intensive industries, and its competitiveness in high-tech industries is insufficient.

From the changes in exports in different scenarios, it can be seen that China's chemical products, metal products, electronic equipment, instrument manufacturing, equipment manufacturing, and transportation equipment manufacturing products are less competitive than similar products in Japan and South Korea. In the S2 scenario, after the RECP member countries cut tariffs each other, the export growth of the aforementioned industries all declined compared with the S1 scenario, and the export volume of the equipment manufacturing sector even declined in the S2 scenario compared with the base period. In the S3 scenario, because of India's entry, the increase in overall demand increases the export volume of each industry compared to the S2 scenario, but the most significant growth in China's exports is still in the lower value-added manufacturing industries such as chemical products, metal products and non-metal products, which shows that China is still at a lower position in the GVCs.

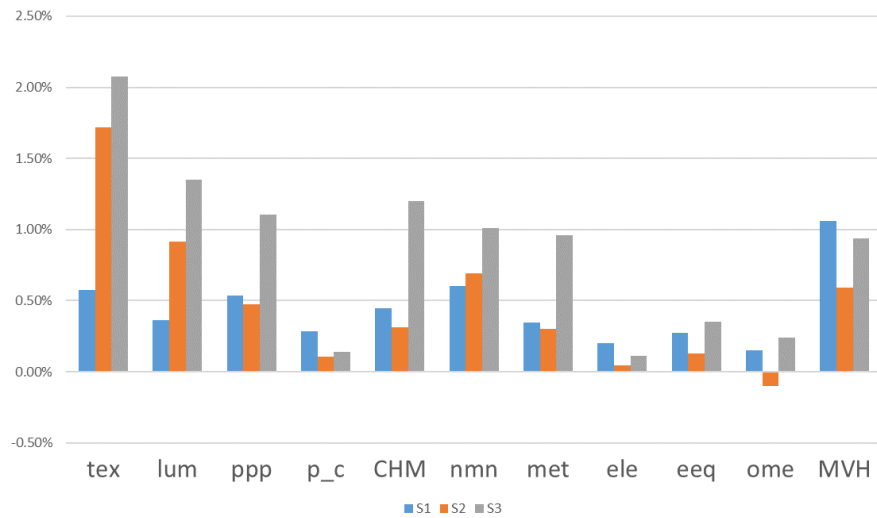


Figure 1 Changes in exports of manufacturing products

### 4.3.2 Regional Impact

From the perspective of the growth of China's provinces, under the S1 scenario, the growth of GDP is concentrated in the main export provinces in the eastern and southern coastal areas, while the growth of the provinces in the central and western regions is not obvious. In the S2 and S3 scenarios, the central and western regions achieved a certain growth rate, but the growth rate was still lower than that of the eastern and southern regions, and the overall economic impact gradually weakened from the southeast coast to the inland provinces.

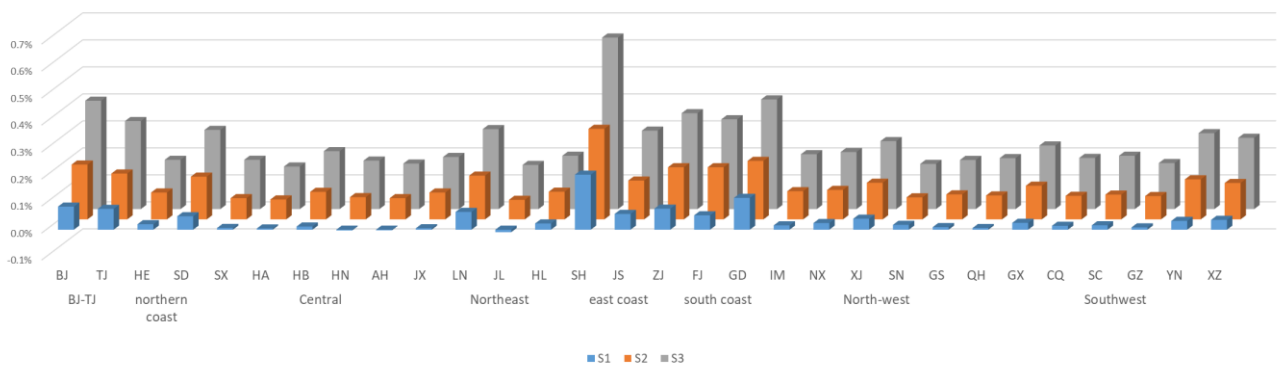


Figure 2 Changes in GDP by province

Comparing the inter-provincial trade and import and export trade of each province in the S1 and S3 scenarios, in the S1 scenario, although the import and export of each region has a certain increase, except for the eastern and southern coastal areas and the Beijing-Tianjin region, the level of inter-provincial trade The growth of trade with ASEAN countries has not been further transmitted to the central and western regions along with the DVCs. In the S3 scenario, the growth of inter-provincial trade in most regions has already exceeded the growth of imports and exports. It can be seen that in wider regional trade cooperation, China can better leverage its relatively complete industrial chain advantages and realize the integration of DVCs and GVCs.

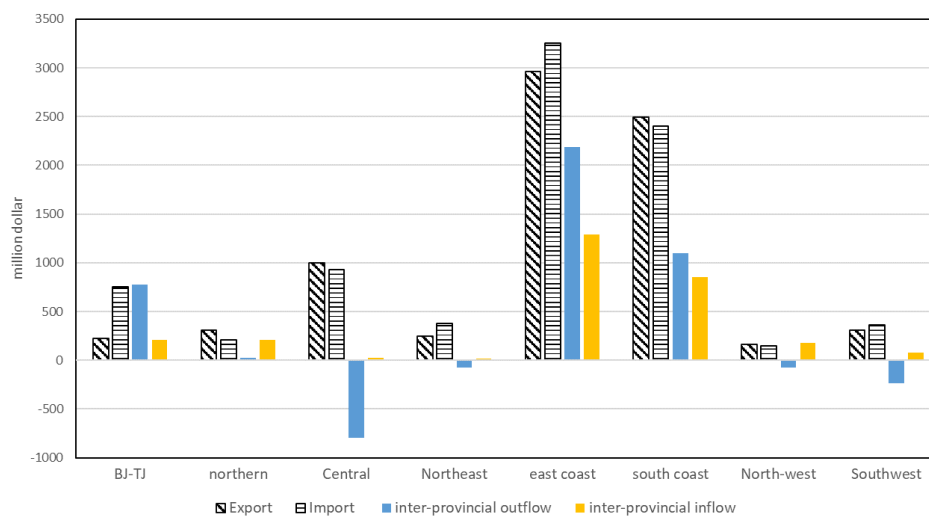


Figure 3 Changes in Trade by Region (S1)

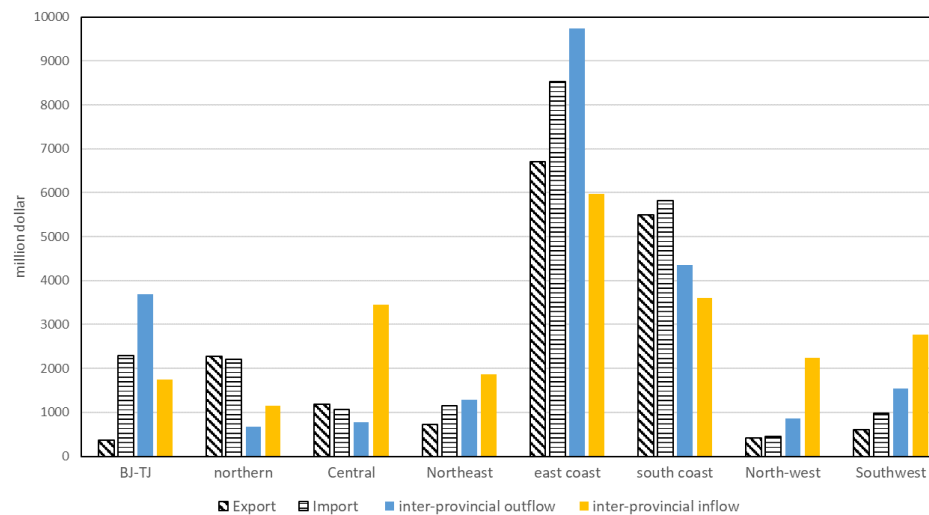


Figure 4 Changes in Trade by Region (S3)

## **V 、 Conclusion**

In this paper, based on GTAP11 data and 2017 Chinese inter-provincial input-output data, we conducted a simulation analysis of the heterogeneity impact of RTAs by constructing a Chinese province-world CGE model, and based on the model results, we obtained the following conclusions:

First, RTAs have obvious external effects in promoting the transformation of global value chains to regionalization, that is, countries that are not members of RTAs will passively increase trade with countries in their regions, accelerating the restructuring of GVCs.

Secondly, in the process of formulating regional trade agreements, countries with similar industrial structures in the region should be allowed to carry out certain industrial protection measures to expand the scope of cooperation while also guaranteeing that members can benefit equally from the cooperation.

Third, the position of a country in the GVCs will affect the trade diversion effect it receives. China is still in a lower position in the GVCs and is vulnerable to the negative impact of trade diversion effects. Therefore, China actively participates in multilateral trade cooperation , promoting industrial upgrading is an important way for China to reduce the negative effects of trade diversion effect.

Fourth, actively expanding international cooperation and enhancing the depth and breadth of regional trade agreements is conducive to bringing into play the advantages of China's industrial chain, fully integrating the domestic industrial chain with the global value chain, promoting the domestic economic cycle, and promoting the development of the central and western regions.

## Appendix:

### GTAP11 Database

The GTAP database is constructed by the Center for Global Trade Analysis, which includes global bilateral trade, international transportation costs, and intermediate and final consumption of domestic goods and services. The article uses the 11th edition GTAP database published in 2022 (GTAP11). The GTAP11 database contains data on trade and domestic production in 65 sectors in 151 countries and regions in 2017. According to the research questions, the GTAP11 database is merged, and China's major trading partners and major economies in the world are retained to form data of 10 regions and 17 sectors. The corresponding relationship between regions is shown in Table A-1, and the corresponding relationship between sectors is shown in Table A-2.

ely,gdt,wtr,cns,trd,afs,cmn,ofi,ins,rsa,obs,ros,osg,edu,hht,dwe

Table A-1 GTAP11 regions

| region             | Countries and regions included                                                                                                                                                                                                                          |
|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| China              | China                                                                                                                                                                                                                                                   |
| United States      | United States                                                                                                                                                                                                                                           |
| Japan              | Japan                                                                                                                                                                                                                                                   |
| Korea              | Korea                                                                                                                                                                                                                                                   |
| Germany            | Germany                                                                                                                                                                                                                                                 |
| Other EU countries | United Kingdom, France, Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden |
| ASEAN              | Brunei, Cambodia, Indonesia, Laos, Malaysia, Philippines, Singapore, Thailand, Vietnam, other Southeast Asian countries                                                                                                                                 |
| India              | India                                                                                                                                                                                                                                                   |
| Mexico             | Mexico                                                                                                                                                                                                                                                  |
| Rest of World      | Other countries and regions of the world                                                                                                                                                                                                                |

Table A-2 GTAP11 sectors

| Sector description                                                | GTAP11 sectors                                                  |
|-------------------------------------------------------------------|-----------------------------------------------------------------|
| Agriculture, forestry and fishery products and services           | pdr,wht,gro,v_f,osd,c_b,pfb,ocr,ctl,oap,rmk,wol,frs,frh         |
| Energy Products                                                   | coa,oil,gas                                                     |
| Mineral Extraction Products                                       | oxt                                                             |
| Food and tobacco                                                  | cmt,omt,vol,mil,pcr,sgf,ofd,b_t                                 |
| Textiles and their products                                       | Tex,wap,lea                                                     |
| Wood products and furniture                                       | lum                                                             |
| Paper printing and stationery and sporting goods                  | ppp                                                             |
| Petroleum, coal products                                          | p_c                                                             |
| Chemical products                                                 | chm,bph,rpp                                                     |
| Non-metallic mineral products                                     | nmm                                                             |
| Metal products                                                    | i_s,nfm,fmp                                                     |
| Communication equipment, computers and other electronic equipment | ele                                                             |
| Instrument manufacturing                                          | eeq                                                             |
| Equipment manufacturing                                           | ome,omf                                                         |
| Transportation equipment manufacturing                            | MVH,oth                                                         |
| Other Services                                                    | ely,gdt,wtr,cns,trd,afs,cmn,ofi,ins,rsa,obs,ros,osg,edu,hht,dwe |
| Transportation, warehousing and postal                            | otp,wtp,atp,whs                                                 |

## China Multi-regional input-output table

The 2017 China MRIO is compiled by the Development Research Center of the State Council, which includes 31 provinces (autonomous regions, municipalities) and 42 sectors. Similar to the merging process of the GTAP11 database, the MRIO was merged to form 17 sectoral data, and the corresponding relationship between departments is shown in Table B-3.

Table A-3 MRIO sectors

| Sector description                                                | MRIO sectors                                                                                                                                                                                                                                                                                                                                                           |
|-------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Agriculture, forestry and fishery products and services           | Farming, Forestry, Animal Production and Fishery                                                                                                                                                                                                                                                                                                                       |
| Energy Products                                                   | Mining and Washing Products of Coal, Extraction Product of Crude Petroleum and Natural Gas                                                                                                                                                                                                                                                                             |
| Mineral Extraction Products                                       | Mining Products of Metal Ores, Mining and Quarrying Product of nonmetallic Mineral and Other Mineral                                                                                                                                                                                                                                                                   |
| Food and tobacco                                                  | Food and Tobacco Products                                                                                                                                                                                                                                                                                                                                              |
| Textiles and their products                                       | Textiles, Textile Wearing Apparel Leather, Fur, Feather and Its Products                                                                                                                                                                                                                                                                                               |
| Wood products and furniture                                       | Wood, Bamboo and Furniture Products                                                                                                                                                                                                                                                                                                                                    |
| Paper printing and stationery and sporting goods                  | Papermaking, Printing and Stationeries, Musical Instruments, Sports Goods                                                                                                                                                                                                                                                                                              |
| Petroleum, coal products                                          | Refined Petroleum, Coke Products and Nuclear Fuel Processing Products                                                                                                                                                                                                                                                                                                  |
| Chemical products                                                 | Chemical Products                                                                                                                                                                                                                                                                                                                                                      |
| Non-metallic mineral products                                     | Non-metallic Mineral Products                                                                                                                                                                                                                                                                                                                                          |
| Metal products                                                    | Metals and Its Processing Products, Fabricated Metal Products                                                                                                                                                                                                                                                                                                          |
| Communication equipment, computers and other electronic equipment | Communication Equipment, Computer, and Other Electronic Equipment                                                                                                                                                                                                                                                                                                      |
| Instrument manufacturing                                          | Measuring Instruments, Electrical Machinery and Apparatus                                                                                                                                                                                                                                                                                                              |
| Equipment manufacturing                                           | General-Purpose Machinery, Special-Purpose Machinery, Other Manufacture and Comprehensive Utilization of Waste Resources, Fabricated Metal Products, Repair of Fabricated Metal Products, Machinery and Equipment                                                                                                                                                      |
| Transportation equipment manufacturing                            | Transport Equipment                                                                                                                                                                                                                                                                                                                                                    |
| Other Services                                                    | Production and Supply of Electricity and Steam, Production and Distribution of Gas, Production and Distribution of Water, Buildings ,Wholesale and Retail Trade ,Transport, Storage and Post, Accommodation, Food and Beverage Services, Information transmission, Software and Information Technology Services, Financial Services, Real Estate, Renting and Leasing, |

Business Services, Research and Development,  
Technical Services, Management of Water  
Conservancy, Environment and Public Facilities,  
Services to Households, Repair and Other Services,  
Education, Health Care and Social Work Activities,  
Culture, Sports and Entertainment, Public  
Management, Social Security and Social  
Organization

transportation, warehousing  
and postal

Transport, Storage and Post

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## References

- [1] Cai S, Zhang Y, Meng B. Spillover effects of TTIP on BRICS economies : a dynamic GVC-based CGE model[J]. Ide Discussion Papers, 2015.
- [2] Itakura K, Lee H. Estimating the Effects of the CPTPP and RCEP in a General Equilibrium Framework with Global Value Chains[J]. GTAP Resource, 2019.
- [3] Lim, Byeongho, Yoo, Jeongho, Hong, Kyoungseo, Cheong, Inkyo. Impacts of Reverse Global Value Chain (GVC) Factors on Global Trade and Energy Market[J]. Multidisciplinary Digital Publishing Institute, 2021(12).
- [4] Meng B, Xiao H, Ye J, et al. Are global value chains truly global? A new perspective based on the measure of trade in value-added[J]. IDE Discussion Papers, 2019.
- [5] Sun J, Lee H, Yang J. The Impact of the COVID-19 Pandemic on the Global Value Chain of the Manufacturing Industry[J]. Sustainability, 2021, 13.
- [6] Zhou Lingling, Zhang Keyu. Reshaping Sino-US Value Chains under Trump's Tax Reform Based on the GTAP-GVC Model[J]. Finance & Trade Economics, 2019,40(11):20-34.DOI:10.19795/j.cnki.cn11-1166/f.20191111.002.
- [7] Dong Wanlu, Li Huijuan, Yang Jun. Research on the Impact of Digital Economy Development on China's Manufacturing Industry--Based on CGE model with GVC analysis framework[J]. Price: Theory & Practice,2022(09):78-82+205.DOI:10.19851/j.cnki.cn11-1010/f.2022.09.362.
- [8] Dong Wanlu, Li Huijuan, Yang Jun. Analysis of the Impact of RCEP on the Development of Electronics Industry in Global and Chinese Regions--Based on Global and Chinese Regional (including Shenzhen) CGE Model System [J]. Review of Economy and Management,2023,39(01):119-133.DOI:10.13962/j.cnki.37-1486/f.2023.01.010.
- [9] Ni Hongfu, Xia Jiechang. The Role of China Regions and its Changes in the Global Value Chains--Based on World Input Output Model Embedded with China Regions [J]. Finance & Trade Economics,2016(10):87-101.DOI:10.19795/j.cnki.cn11-1166/f.2016.10.009.
- [10] Li Shantong, He Jianwu, Liu Yunzhong. Research on Division of Labor of China's Domestic

- Value Chain from the Perspective of Global Value Chain[J]. Management Review,2018,30(05):9-18.DOI:10.14120/j.cnki.cn11-5057/f.2018.05.002.
- [11] Yu Lili,. Peng Shuijun. Research on Carbon Emission Transfer Effect of Chinese Regions in the Global Value Chains[J]. Statistical Research,2018,35(04):16-29.DOI:10.19343/j.cnki.11-1302/c.2018.04.002.
- [12] Zhang Keyu Zhou Lingling. RCEP's Impact on China's Economy and Regional Economic Structure [J]. Journal of International Trade,2021,No.467(11):37-53.DOI:10.13510/j.cnki.jit.2021.11.003.
- [13] Yang Yuwen, Sun Jiaze, Zhang Yunxia. Research on the Influence of RCEP Establishment on the Economic Development and Relevant Industries in Ethnic Areas[J]. Ethno-National Studies,2022(03):56-68+140.
- [14] LI Xin, Guan Huijuan, CAI Xiaofan. Study on TPP and RCEP Agreement Based on the Global Value Chain[J]. Journal of Central University of Finance & Economics, 2017(01):49-60.
- [15] Chen Hui. Opportunities, Challenges and Countermeasures of China's Participation in the Reconstruction of Regional Industrial Chains and Value Chains after RCEP Takes Effect [J]. Economic Review Journal,2022 (08):76-82.
- [16] OU Dingyu YI Zhuihui. The Promoting Effect of RCEP Regional Value Chain Reconstruction on Dual Circulation Development Pattern[J]. Consumer Economics,2021,37(04):20-32.
- [17] Li Shize, Shang Maomao, Zhong Lei. Influence of RCEP on the Construction of China(Guangxi)Pilot Free Trade Zone and its Countermeasures [J]. Social Sciences in Guangxi,2022(02):85-93
- [18] Li Meng, Huang Qingping, Zhai Ying. Discussion on the Strategic Connection between Hainan Free Trade Port and the New Development Pattern of Domestic and International Dual Circulation [J]. Reform of Economic System,2021(04):58-65