Estimating the effects of regional value chains of the RCEP in a GVC-CGE model

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ABSTRACT

The Regional Comprehensive Economic Partnership (RCEP) is regarded as a value chain accelerator that will support global value chains (GVCs) and unlock regional value chains (RVCs) in particular. However, there is a lack of quantitative evidence to support this claim. This paper constructs a GVC-CGE model with embedded GVC trade structure and RVC participation measurement to assess the comprehensive impact of RCEP's tariff and non-tariff reductions on global trade and RVCs. The simulation results show a significant expansion of bilateral trade among member countries that only have trade agreements through RCEP, and the trade of intermediate goods boosts more than final goods for most member countries. The participation in RVCs among member countries has increased while the participation in extra-RVCs has decreased. This trend is especially noticeable in the textile, wearing apparel, motor vehicle, and food sectors in most member countries, except for the ASEAN apparel sector, which has seen a decrease in forward RVC participation. The financial and pharmaceutical sectors have experienced an increase in forward RVC participation in both member and non-member countries. The RCEP has significantly reconfigured regional production networks more than demand networks. China, Japan, and Korea have shifted their part of production and demand value chains from global to regional, which has elevated their importance in the RVCs at both the overall and sectoral levels.

1. Introduction

With the failure of the World Trade Organization (WTO) multilateralism mechanism, the rise of trade protectionism and the dual drive of regionalization and localization of supply chain under the impact of COVID-19, regional trade coordination mechanism is increasingly becoming a policy choice for countries looking to open up economic cooperation and participate in global governance, and regional economic integration has ushered in a new opportunity. After eight years of negotiations, the RCEP was formally signed on November 15, 2020 by a total of 15 member countries including ten ASEAN countries, China, Japan, South Korea, Australia, and New Zealand. Compared to the European Union (EU) and the United States-Mexico-Canada Trade Agreement (USMCA), RCEP is the world's most populous, diverse and dynamic free trade area (FTA), covering almost half of the world's population and almost one-third of its trade volume (Flach et al., 2021).

The 15 participating countries of RCEP are both participants in GVCs and important components of production networks in the Asia-Pacific region. RCEP serves as a consolidator of intra-regional economic and trade rules, promoting tariff concessions for trade in goods, rules of origin, customs procedures, and trade facilitation. This will help break down barriers to regional trade and encourage the formation of a unified and stable production and consumption market in Asia. There are some research evidences that the establishment and deepening of regional trade agreements (RTAs) or preferential trade agreements can facilitate cross-border production networks of the agreement parties (Choi, 2020 ; Blyde et al., 2015; Orefice & Rocha, 2014) or participation in global production networks (Sanguinet et al., 2022; Laget et al., 2018; Ruta, 2017; Baldwin, 2013), and enterprises with more backward and forward supply chain linkages benefit more from trade agreements (Li, 2022). The accelerated restructuring of GVCs is an important driving factor for the signing of RCEP. What are the new changes to global and regional trade, especially value chain networks, brought by the full implementation of RCEP? How to assess the impact of RCEP on value chain trade among member countries, and whether RCEP has accelerated the pace of regionalization of value chains? These questions are closely watched by academics and policymakers.

As the world's largest RTA, RCEP has attracted a significant amount of attention from researchers investigating its economic effects and other impacts. However, due to the limited period of formal implementation, there have been few studies on ex-post testing of economic effects using econometric models. Instead, many studies have focused on policy evaluation or ex-ante forecasting using quantitative models. The most widely used technique for this is the computable general equilibrium (CGE) model, which is applied to assess the potential impact of RCEP on trade, economic growth, welfare, and sectoral output of both parties and non-parties through reductions in both tariff and non-tariff costs (Raihan et al., 2022; Park et al., 2021; Petri & Plummer, 2020; Ji et al., 2018; Lee & Itakura, 2017; Li et al., 2017; Cheong & Tongzon, 2013). While studies on economic and trade implications offer valuable policy insights, they fail to take into account the significant changes occurring in the current trade landscape, particularly in terms of the impact on GVC trade. In terms of trade patterns, trade in intermediate goods accounts for 55 % in the RCEP economies, of which up to 60 % of trade in intermediate goods occurs among RCEP members (Helble & Ngiang, 2016). However, these studies rely on a standard CGE model and a database with simplified assumptions about imports in terms of production and consumption. This limits their ability to accurately capture the heterogeneous impact on trade in intermediate and final goods and therefore, the GVC effect cannot be effectively assessed.

Some studies link GVC accounting methods to assess the GVC effects of RTAs by splitting non-competitive input-output table data into inter-country input-output (ICIO) data based on the simulation results of standard CGE models. Antimiani et al. (2018) propose an extension to the standard GTAP model by linking the accounting framework of the value added in trade, allowing the inclusion of value chain analysis in counterfactual simulations using the GTAP model. The model enables the measurement of the value-added content in the total trade flows from the perspective of the sources of value added. Wen et al. (2021) assess the impact of RCEP tariff reductions on GVCs and find that RCEP strengthens the GVC position and participation of signatories. Zhou et al. (2021) combine the GTAP model with the Chinese regional input-output table to simulate the impact of RCEP on Chinese regions and industries under different GVC participation. Such studies that assume proportional sourcing of imports for all agents to form ICIO tables (Carrico, 2017) do not take into account the fact that imports of intermediate and final goods are subject to heterogeneous shocks, and this simplification obscures the policy effects.

The GVC-CGE model, which incorporates GVC trade characteristics, is a significant advancement in the CGE model's ability to analyze GVCs. It is increasingly being used to evaluate trade policies. By using ICIO table data, the GTAP model has been expanded to allow for cross-border linkages in the supply chain. For example, Koopman et al. (2013) introduce a new multilevel nested production function with constant elasticity of substitution (CES) in the GTAP model to characterize the substitution relationship between import sources in the demand for intermediate goods to improve the traditional Armington assumption. This is the first attempt at a GVC-CGE model. Similar attempts include the GTAP supply chains (GTAP-SC) model by Walmsley et al. (2014) and Walmsley and Minor (2016), the GTAP-MRIO model by Carrico (2017), and the METRO model developed by OECD (2018) and OECD (2020). The GTAP-HET model (Akgul et al., 2016) and the GTAP public procurement model (Aguiar et al., 2016) also contain cross-border links of supply chains based on ICIO data.

With the establishment of the GVC-CGE model, some assessments of the impact of RTAs based on this model are beginning to emerge. Cai et al. (2014) simulate the spillover impact of TTIP on BRICS countries based on the GVC-CGE modeling idea of Koopman et al. (2013). Li et al. (2017) evaluate the TPP and RCEP agreements using the GVC-GTAP model, and found that the TPP and RCEP promoted the transfer of Chinese processing industries to other developing member countries. Itakura and Lee (2019) construct a GVC-CGE model using the GTAP database and ICIO tables to analyze the impact of RCEP and CPTPP on welfare as well as industrial output in Asian countries. And results suggest that inclusion in the GVC structure has little impact on the size of the welfare effect in each country, while it has a significant impact on the magnitude of sectoral output changes. Li and Li (2022) construct a global CGE model embedded with GVC characteristics and introduced tariff and non-tariff trade costs to simulate and analyze the trade effects of RCEP and CPTPP. Sun et al. (2022) construct a GVC-CGE model, explain the basic principle of updating the CGE model database into the ICIO table, and simulates the change of the characteristics of GVCs brought by RCEP. Although these studies have quantified the impact of RCEP on trade in GVCs, they focus more on the trade and value-added in trade at the country level and less on the participation in GVCs, which better reflects the nature of GVCs (Choi, 2020; Wang et al., 2022). As such, they do not fully answer to what extent RCEP has deepened the regionalization of value chains.

This paper fills in the above gaps from four aspects: (1) We build a GVC-CGE model that incorporates GVC structure and a plug-in module of RVC participation to analyze the trade effects of RCEP from the perspective of value chain trade. Using this model, we examine the trade effects of RCEP on intermediate and final products, considering the widespread GVC trade in the RCEP region. Additionally, we examine the variation of RVC participation among member countries according to the forward and backward RVC participation indices. (2) In the simulation of RCEP, we construct a database that accounts for both intermediate and final product non-

tariff trade costs. The differences in tariff and non-tariff costs for different economic agents are taken into account, which, especially the latter, are usually omitted in the evaluation of the effects of RCEP. (3) The inclusion or non-inclusion of the GVC structure in the model has a significant impact on the sector-level results, this paper further compares the changes in RVC participation across sectors.

The remainder of this paper is structured as follows: Section 2 presents the GVC-CGE model. Section 3 shows the data sources, data processing, and simulation scenario settings. Section 4 discusses the simulation results. Finally, Section 5 concludes the paper.

2. Modeling approach

2.1. Basic module

The GVC-CGE model constructed in this paper is based on the GTAP model, a global comparative static general equilibrium model based on the input-output accounting framework, which has been widely used in trade policy analysis. The GTAP model incorporates sub-modules that outline the economic agent behaviors, such as production, household and government consumption, and investment, in each country or region. These sub-modules are then interconnected to form a multi-country, multi-sector general equilibrium model through international trade.

2.2. GVC module

There are also some limitations in the GTAP model, such as the existence of only bilateral trade between regions. For any given product, although each manufacturer is free to choose the combination of imported and domestic products when producing, all domestic manufacturers in a given country use the same combination of imports from different countries. Additionally, final consumers such as households, governments, and investors will also use the same combination of imports from different countries. Fig. 1 illustrates the Armington structure of import in the standard GTAP model. Where QX_r^j is the amount of output of industry j in country r, there are a total of n industries here. For industry j, the combination of the amount of value-added QVA_r^j and intermediate input QZ_r^{ij} is chosen according to the cost minimization principle under the Leontief function, the i in the superscript stands for each type of product, and there are a total of n products. Here the product i can be sourced from both domestic QZ_{rr}^{ij} and foreign sources QIZ_r^{ij}. QY_r^{ik} represents the demand for product i by final demander k in country r, where k includes three types of economic agents, namely investors, private households and government, and can also be compounded by national product QY_{rr}^{ik} and imports QIY_r^{ik}. The total imports of each economic agent are summed into a total import volume, as shown in Eq. (1). The source of imports is then determined at the lowest level of nesting through the Armington equation.

$$QM_r^i = \sum_j^n QIM_r^{ij} + \sum_k^3 QIY_r^{ik} \tag{1}$$

Although such simplified processing significantly reduces database storage space and simulation runtime, it leaves out more complex GVC analysis based on ICIO tables such as Koopman et al. (2014) and Wang et al. (2013). It is important to note that the nature of products imported by economic agents from different countries varies. For example, China imports ICT products from the United States mostly for intermediate inputs, while ICT products imported from Malaysia are mostly for final consumption. Therefore, it is necessary to identify the sources of imports at the level of economic agents in the modeling, and the construction of the GVC module should include information on imports of intermediate and final products. The GTAP-SC model takes account of differences in the sourcing of imports by firms, final consumers and the capital goods sector, incorporates these supply chain cross-border linkages well into the standard GTAP model. This framework has been used to build subsequent GVC-CGE models such as the GTAP-MRIO model and
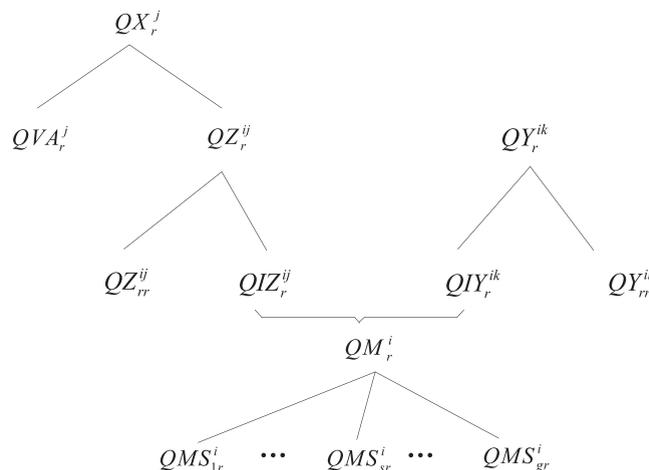

Fig. 1. Armington structure of the economic agents in the standard GTAP model.

METRO model. This paper also refers to the processing of the GTAP-SC model to build GVC module. In the import Armington structure of the GVC-CGE model (Fig. 2), each economic agent's imports are not aggregated into total imports, but rather determine their own import sources autonomously. This means that firms in industry j can choose between imports QZ^{ij}_{sr}, based on the elasticity of substitution and relative prices of intermediate goods from different sources, as shown in Eq.(2). Similarly, final demanders of type k choose between imports QY^{ik}_{sr}, and their equation for import demand is represented by Eq.(3).

$$QZ^{ij}_{sr} * az^{ij}_{sr} = QIZ^{ij}_r * \left(\frac{PZ^{ij}_{sr} \Big/ az^{ij}_{sr} * \left(\varphi^{ij}_r \right)^{\rho^{ij}_r}}{PIZ^{ij}_r * \delta^{ij}_{sr}} \right)^{\frac{-1}{\rho^{ij}_r + 1}} \tag{2}$$

$$QY^{ik}_{sr} * ay^{ik}_{sr} = QIY^{ik}_r * \left(\frac{PY^{ik}_{sr} \Big/ ay^{ik}_{sr} * \left(\varphi^{ik}_r \right)^{\rho^{ik}_r}}{PIY^{ik}_r * \delta^{ik}_{sr}} \right)^{\frac{-1}{\rho^{ik}_r + 1}} \tag{3}$$

Where az^{ij}_{sr} and ay^{ik}_{sr} are iceberg costs as in GTAP (Hertel et al., 2001), which can adjust the effective price and effective quantity, are the non-tariff barriers (NTBs) shock channels for intermediate and final products in the GVC-CGE model, respectively. QIZ^{ij}_r and QIY^{ik}_r are the supply of composite import i to industry j and k type final consumers, respectively. PIZ^{ij}_r and PIY^{ik}_r are the corresponding composite import prices respectively, PZ^{ij}_{sr} and PY^{ik}_{sr} are the domestic prices of imports from s region. For the import value of intermediate goods Z^{ij}_{sr}, it is obtained by multiplying the import price of intermediate goods PZ^{ij}_{sr} by the import volume QZ^{ij}_{sr}. The final product import value Y^{ik}_{sr} can also be obtained as follows. δ is share parameter for Armington CES over imports by region, φ is shift parameter for Armington CES over imports by aggregate region, ρ is the elasticity parameter for Armington CES over imports by aggregate region.

In addition, different economic agents will have heterogeneous effects when facing the impact of the same policy (Walmsley & Minor, 2016). In the GVC-CGE model, producers and consumers will be affected differently by the reduction or increase of tariffs, that is, imports of intermediate and final goods face heterogeneous impacts. This avoids averaging the impact across different economic entities and import sources as in the standard GTAP model.

2.3. Plug-in module of RVC participation

The plug-in module is designed to create ICIO tables and establish a quantitative analysis framework for RVC participation using these tables. The GTAP database contains single-region input-output tables and bilateral trade information, and we need to utilize other trade data to prepare ICIO tables before the policy shock, as well as to update ICIO tables after the policy shock based on the simulation results. The prepared and updated value-based ICIO table at market prices is shown in Table 1.

The ImpactECON database offers a comprehensive set of data, including domestic intermediate product input Z^{ij}_{ss} and domestic final demand Y^{ik}_{ss}. Additionally, it also includes data on intermediate product and final product imports at market prices and agent prices (Walmsley & Minor, 2020). In a market-price ICIO table, the value of the import should be net of the tariffs of the importing country and the export taxes or subsidies of the exporting country, i.e., the import matrix should be the market price of the exporting country's exports plus the output of the domestic distribution sector resulting from the international transportation of the exports. Therefore, in this paper, the price conversion process is performed in the calculation of Z^{ij}_{sr} and Y^{ik}_{sr} submatrix. Taking Z^{ij}_{sr} as an example to illustrate the process. Firstly, the value of imports at market prices in importing countries is deducted from tariffs on intermediate goods to obtain the value of imports at world prices; Secondly, the value of imports at world prices is deducted from export taxes or subsidies to obtain the value of exports at market values in exporting countries; Finally, the international circulation output provided by ImpactECON database is split to each industry as international circulation costs in proportion to the circulation occupied by each
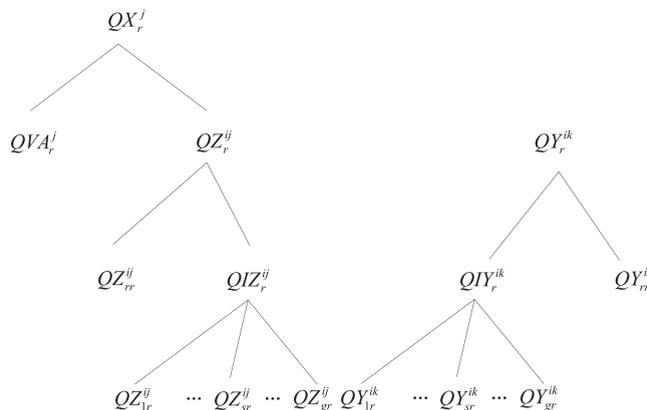

Fig. 2. Armington structure of economic agents in the GVC-CGE model.

Table 1

The form of ICIO table prepared and updated, at market prices.

Output Input			Intermediate demand					Final demand					Total output
			1	...	r	...	g	1	...	r	...	g	
			1...n	1...n	1...n	1...n	1...n	1...3	1...3	1...3	1...3	1...3	
Intermediate input	1	1...n	Z_{11}^{ij}	...	Z_{1r}^{ij}	...	Z_{1g}^{ij}	Y_{11}^{ik}	...	Y_{1r}^{ik}	...	Y_{1g}^{ik}	X_1^i
	$\vdots$	1...n	$\vdots$	$\ddots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\ddots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$
	s	1...n	Z_{s1}^{ij}	...	Z_{sr}^{ij}	...	Z_{sg}^{ij}	Y_{s1}^{ik}	...	Y_{sr}^{ik}	...	Y_{sg}^{ik}	X_s^i
	$\vdots$	1...n	$\vdots$	$\vdots$	$\vdots$	$\ddots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\ddots$	$\vdots$	$\vdots$
	g	1...n	Z_{11}^{ij}	...	Z_{gr}^{ij}	...	Z_{gg}^{ij}	Y_{g1}^{ik}	...	Y_{gr}^{ik}	...	Y_{gg}^{ik}	X_g^i
Value-added			Va_1^j	...	Va_r^j	...	Va_g^j						
Total inout			X_1^j	...	X_r^j	...	X_g^j						

industry, and the circulation costs are summed with the value of exports priced at market values to obtain Z_{sr}^{ij}. And a similar process yields Y_{sr}^{ik}. The data of total output X_r^i is available in ImpactECON databases, and value added Va_r^j can be obtained from the constant equation of total output equals total input. Based on the updated results of the relevant data after the policy shock. The updated ICIO tables are also obtained by such a processing procedure.

Based on the ICIO table, we propose a measure method of the participation index of RVC to portray the impact of RCEP on RVCs. The index is derived from the production decomposition framework proposed by Wang et al. (2022). According to Wang et al. (2022), a country-sector's production activities can be decomposed into

$$\widehat{V}B\widehat{Y} = \widehat{V}L\widehat{Y^L} + \widehat{V}L\widehat{Y^E} + \widehat{V}LA^E B\widehat{Y} \tag{4}$$

Where $\widehat{V}$ is the diagonal matrix of value added coefficients, i.e., the ratio of value added to the output, expressed by the formula $V = Va/X$, A is the global direct consumption coefficient matrix, calculated by the formula $A = Z/X$, A^L is the local direct consumption coefficient matrix for each country, whose elements are the diagonal submatrices of A, and the elements of A^E are the non-diagonal submatrices of A, which represent the direct consumption coefficients of imports. B and L are the global and local Leontief inverse matrices, respectively, and $B = (I - A)^{-1}, L = (I - A^L)^{-1}$. $\widehat{Y}$ is the diagonal matrix of final demand, and $\widehat{Y^L}$ and $\widehat{Y^E}$ are the diagonal matrices with domestic and foreign final demand as the diagonal, respectively.

In Eq. (4), the first term refers to the domestic value chain, which portrays activities that are entirely produced and consumed domestically. The second term is the traditional trade (i.e. final goods trade), which involves domestically produced products that are exported to foreign countries and consumed as final goods. The third term is the global value chains, which involves domestically produced products that are exported to foreign countries, used as intermediate goods or returned to domestic consumption. The row sum of each term is the production decomposition of value added based on forward linkage (producer's perspective), while the column sum is the production decomposition of final goods and services based on backward linkage (user's perspective). To examine the RVC situation of the RCEP, we further decompose the row and column sums of Eq. (4) according to the flow of final products and the source of value added. The decomposition of value added is specified in Eq. (5).

$$Va' = \underbrace{\widehat{V}LY^L}_{V\_D} + \underbrace{\widehat{V}LY^E}_{V\_RT} + \underbrace{\widehat{V}LA^E BY^{RCEP}}_{V\_RVC} + \underbrace{\widehat{V}LA^E BY^{nRCEP}}_{V\_ERVC} \tag{5}$$

Eq. (5) shows that a country-sector's added value can be used to produce domestic final demand V_D, foreign final demand V_RT, participate in RVC production activities of RCEP V_RVC, and participate in extra-regional value chain (ERVC) production activities V_ERVC. Similarly, the factor inputs in a country-sector's production of final goods can be decomposed into four terms. The Y_D term that satisfies domestic final demand and originates from domestic factor inputs; The Y_RT term is factor input in foreign final demand production; The Y_RVC and Y_ERVC terms are factor inputs from within and outside the RCEP region in value chain production activities. The details are as in Eq. (6).

$$Y' = \underbrace{VL\widehat{Y}^L}_{Y\_D} + \underbrace{VL\widehat{Y}^E}_{Y\_RT} + \underbrace{V^{RCEP}LA^E B\widehat{Y}}_{Y\_RVC} + \underbrace{V^{nRCEP}LA^E B\widehat{Y}}_{Y\_ERVC} \tag{6}$$

Only the third term in Eq. (4) is the GVC activity, and its proportion in value-added or final goods can reflect the extent to which the country-sector participates in GVCs. Wang et al. (2022) accordingly propose the forward and backward linkage based participation index for the country-sector. Given Eqs. (5) and (6), we define the forward and backward linkage RCEP regional and extra-regional value chain participation index.

$$GVC\_Pf_r^j = \frac{\widehat{V}LA^E BY^{RCEP} + \widehat{V}LA^E BY^{nRCEP}}{\widehat{V}BY} = RVC\_Pf_r^j + ERVC\_Pf_r^j \tag{7}$$

If the forward RVC participation index RVC_Pf rises in member countries, the factors are more deeply embedded in the RCEP regional production network division of labor, i.e., the deepening of RVCs in RECP. If the forward ERVC participation index RVC_Pf in

member countries rises, the factors are more deeply embedded in the production network outside the RCEP region, i.e., the deepening of globalization.[1]

$$GVC\_Pb_r^j = \frac{V^{RCEP}LA^EB\widehat{Y} + V^{nRCEP}LA^EB\widehat{Y}}{\mathbf{V}B\widehat{Y}} = RVC\_Pb_r^j + ERVC\_Pb_r^j \tag{8}$$

Eq. (8) decomposes the backward GVC participation in sector *j* in country *r* into backward RVC and ERVC participation. If *RVC_Pb* rises in the member country, it indicates deeper regionalization of the vertical specialization division of final goods; if *ERVC_Pb* rises, deeper globalization of the vertical specialization division of final goods in the member country.

3. Data and scenario setting

3.1. Data sources and calculation of NTBs

The databases underlying the GVC-CGE model are the ImpactECON supply chain database (Walmsley & Minor, 2020) as mentioned in Section 2.3. The ImpactECON database adapts the GTAP 10 database (Aguiar et al., 2019) and other trade data[2] to separate import flows by exporting country and importing agent, thereby creating a complete supply chain database from the GTAP database. The ImpactECON databases distinguish between 141 countries/regions and 65 sectors, using 2014 as the base year. For this study, these data have been aggregated to 14 countries/regions and 27 sectors, as shown in Tables 2 and 3.

The ImpactECON databases also separate differential tariff rates by agent. It is the first publicly available database of its kind to take account of differences in tariff rates paid by firms, final consumers and capital goods. This paper further constructs a database of NTB costs, which is calculated following the idea of equivalent tariff treatment. The equivalent tariffs of NTBs are usually estimated by gravity models such as Andriamananjara et al. (2004), Hummels and Schaur (2013), Ghodsi et al. (2016), etc. However, for large global general equilibrium model systems with multiple countries and sectors, the gravity model measures require a larger number of statistics and involve a large workload. Following Anderson and Van Wincoop (2004), all additional costs other than tariff costs involved in trading goods bilaterally rather than domestically are considered NTB costs. Therefore, we can obtain NTB costs indirectly by calculating trade costs. Novy (2013) has greatly improved the data operability of calculating trade costs based on the gravity model and has been widely adopted (Jacks et al., 2011; ESCAP-World Bank Trade Cost Database; Li et al., 2018; Li & Li, 2022; Turkson et al., 2022). Following Novy (2013), bilateral comprehensive trade cost is defined as follows.[3]

$$\tau_{sr}^i = \left(\frac{T_{ss}^i T_{rr}^i}{T_{sr}^i T_{rs}^i}\right)^{\frac{1}{2\sigma}} - 1 \tag{9}$$

Where τ_{sr}^i denotes the trade cost of product *i* between country *s* and country *r*, T_{sr}^i denotes the international trade flow from country *s* to country *r*, T_{ss}^i denotes the domestic trade flow of country *s*. The ImpactECON database provides domestic trade and bilateral international trade data. *σ* is the Pareto parameter of the productivity distribution in the production function that derives the gravity equation. Referring to Eaton and Kortum (2002), the value of *σ* is set to 8.3. Ghodsi et al. (2016) and Walmsley and Minor (2015) find that the equivalent tariff of NTBs on imports for intermediate, investment and final use is heterogeneous. This paper uses the data from the ImpactECON database on tariffs, domestic products and bilateral imports by agent to calculate the bilateral trade costs and the equivalent tariffs of non-tariff costs by agent by referring to Eqs. (9) and (10).

3.2. Scenario setting

Considering the tariff reduction and the promotion of non-tariff trade facilitation measures in the RCEP agreement, the scenario in this paper is a reduction of non-agricultural tariffs to zero, a 50 % reduction in agricultural tariffs from the current level, and a 30 % reduction in NTBs among the 15 RCEP members.[4] In contrast to the current tariff impact simulation using the CGE model, this paper

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[1] For non-member countries, a rise in forward RVC participation implies that their factor participation in value chain production activities in the RCEP region has also increased, and vice versa. A rise in forward ERVC participation implies that their factor participation in value chain production activities in the non-RCEP region has increased, and vice versa.

[2] The data sources used in the construction of the ImpactECON database include: (1) The GTAP 10 database. (2) Classification by Broad Economic Categories (BEC) R4; (3) Trade data by HS six-digit (HS6) commodity codes, source and destination (MAcMap HS6 a joint project between the ITC-UNCTAD-WTO and CEPII); (4) Tariff data by HS six-digit commodity, source and destination (MAcMap HS6 a joint project between the ITC-UNCTAD-WTO and CEPII).

[3] The advantages of this method of estimating trade costs are reflected in the simplicity of the calculation and the use of summed data with lower data requirements. More importantly, it has both a rigorous microscopic basis and is consistent with the results of robustness tests of the gravity model. In addition, the new generation of international trade and investment agreements focuses more on cooperation and harmonization of "behind-the-border" barriers, where the calculation of trade costs and the separation of non-tariff barriers include traditional border measures and "behind-the-border" measures, facilitating the analysis of the impact effects of the latest agreements (Li et al., 2018).

[4] According to Ecorys (2009), the maximum reduction of NTBs is generally 50 %. In comparison to the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP), which is considered the most open free trade agreement globally, the RCEP has fewer trade facilitation measures. As a result, the 30 % reduction in NTBs is set here.

Table 2
Regional aggregation.

Code	Corresponding economies/regions in the GTAP10 database
Oceania	Australia; New Zealand
CHN	China
JPN	Japan
KOR	Korea
RofAisa	Mongolia; Taiwan; Rest of East Asia; Bangladesh; India; Nepal; Pakistan; Sri Lanka; Rest of South Asia
ASEAN_H	Singapore; Brunei Darussalam
ASEAN_L	Cambodia; Laos; Rest of Southeast Asia
ASEAN_M	Indonesia; Philippines
ASEAN_T	Malaysia; Viet Nam; Thailand
IND	India
MCA	Canada; Mexico
USA	United States
EU	Austria; Belgium; Bulgaria; Croatia; Cyprus; Czech Republic; Denmark; Estonia; Finland; France; Germany; Greece; Hungary; Ireland; Italy; Latvia; Lithuania; Luxembourg; Malta; Netherlands; Poland; Portugal; Romania; Slovakia; Slovenia; Spain; Sweden; United Kingdom
ROW	All the other economies/regions

Note: Hong Kong, China is also included in the CHN group.

Table 3
Sectoral aggregation.

Code	Corresponding sectors in the GTAP 10 database
Agr	Paddy rice; Wheat; Cereal grains nec; Vegetables, fruit, nuts; Oil seeds; Sugar cane, sugar beet; Plant-based fibers; Crops nec; Bovine cattle, sheep and goats; Animal products nec; Raw milk; Wool, silk-worm cocoons; Forestry; Fishing
Mine	Coal; Oil; Gas; Minerals nec
food	Bovine meat products; Meat products nec; Vegetable oils and fats; Dairy products; Processed rice; Sugar; Food products nec; Beverages and tobacco products
tex	Textiles
wap	Wearing apparel
lea	Leather products
lum	Wood products
ppp	Paper products, publishing
p_c	Petroleum, coal products
chm	Chemical products
bph	Basic pharmaceutical products
rpp	Rubber and plastic products
nmm	Mineral products nec
i_s	Ferrous metals
nfm	Metals nec
fmp	Metal products
ele	Computer, electronic and optic
eeq	Electrical equipment
ome	Machinery and equipment nec
mvh	Motor vehicles and parts
otn	Transport equipment nec
omf	Manufactures nec
Oth_ind	Electricity; Gas manufacture, distribution; Water
cns	Construction
Transport	Transport nec; Water transport; Air transport; Warehousing and support activity
Financ	Financial services nec; Insurance
Oth_ser	Trade; Accommodation, Food and service; Communication; Real estate activities; Business services nec; Recreational and other service; Public Administration and defense; Education; Human health and social work; Dwellings

considers the heterogeneity of tariffs across different economic agents, as well as non-tariffs. The simulation of RCEP tariff reduction is achieved by shocking the import tariff variables of intermediate industries, investors, government and residential consumers. The potential impact of NTBs reductions for these economic agents is achieved by impinging on the az_{sr}^{ij} and ay_{sr}^{ik}.

4. Results analysis

4.1. Effects of RCEP on bilateral trade

Fig. 3 illustrates the changes in bilateral trade by economy and region. In terms of regional trade, The RCEP agreement boosts intra-regional trade by 11.1 %. However, there has been a trade diversion effect, with total exports of the RCEP region to non-RCEP regions decreasing by 3.4 % and imports from non-RCEP regions decreasing by 0.4 %. Trade among non-RCEP countries grows only marginally

by 0.2 %. In comparison, the impact of RCEP on world import trade is greater than that of exports. For example, total imports in the RCEP region increase by 4.8 %, which is 2.3 % more than total exports. Meanwhile, total imports of non-RCEP countries decrease by 1 %, and total exports remain almost unchanged. Overall, total world trade grows by approximately 1.0 %.

At the economic level, the RCEP has significantly enlarged trade among member countries. The RCEP establishes a trade agreement between the economies of China, Japan, Korea, and Oceania for the first time, resulting in a notable strengthening of bilateral trade between these countries and their trade relations with ASEAN. Japan's total exports to RCEP have grown the most, while Korea's total imports from RCEP have grown the most. Furthermore, trade between China, Japan, and Korea has expanded strikingly, with China and Japan's exports to Korea increasing by 27.0 % and 17.0 %, respectively. Additionally, Japan and Korea's exports to China have increased by 23.9 % and 19.7 %, respectively. Fig. 4 further shows that trade in intermediate goods plays a bigger role in the growth of bilateral trade among the three economies compared to trade in final goods. This implies a strengthening of the value chain network relationship among the three countries. For Oceania, the growth of imports of final goods is higher than that of intermediate goods, which can be attributed to the decrease in the cost of manufactured imports from China, Japan, and Korea. On the other hand, the growth of imports of intermediate goods is higher than that of final goods due to the decline in the cost of intermediate goods, such as raw materials, from ASEAN economies. For ASEAN economies, RCEP has further expanded their bilateral trade, especially exports from ASEAN_L to other ASEAN countries. However, inter-ASEAN trade has not seen as much growth as trade between China, Japan, and Korea. China and Korea's exports to ASEAN_T have increased significantly by about 9.4 % and 13.0 %, and more than 70 % of these growths are contributed by exports of intermediate goods. This suggests that RCEP has driven an industrial shift from China and Korea to Vietnam and Malaysia. Although the initial trade between China and Korea to ASEAN_L is small, RCEP has led to a significant increase in exports to ASEAN_L from these two countries.

RCEP has somewhat suppressed trade from member countries to non-member countries. Japan's exports to RCEP have increased by 17.5 %, but its exports to non-member countries have decreased by more than 10.0 %, resulting in only a 2.5 % increase in total exports, as is the case for China, Korea and Oceania. It is noteworthy that China's reduction in final goods to non-member countries is greater than that of intermediate goods, while the opposite is true for Japan and Korea. This reflects China's role in GVCs, where it mainly processes and assembles products in the smile curve and exports them to developed countries such as the EU and the United States. The exports of ASEAN_T and ASEAN_L to the EU and the NAFTA members have slightly increased. As can be seen from Fig. 4,
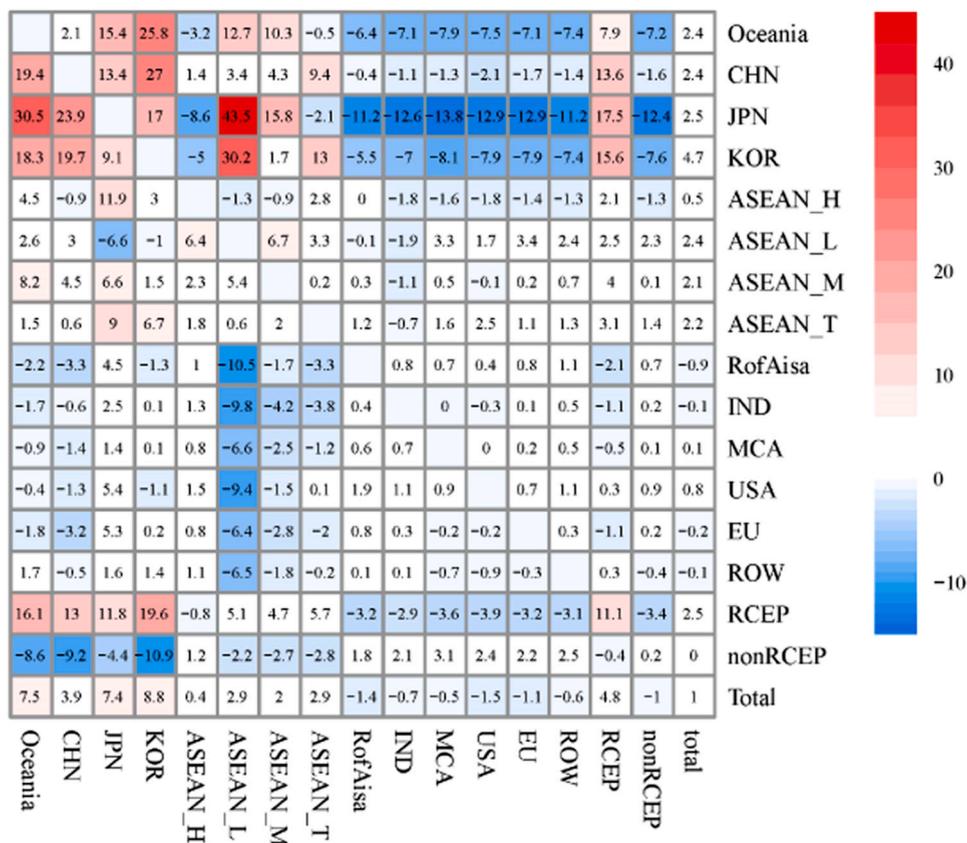
Exporter \ Importer	Oceania	CHN	JPN	KOR	ASEAN_H	ASEAN_L	ASEAN_M	ASEAN_T	RofAisa	IND	MCA	USA	EU	ROW	RCEP	nonRCEP	total
Oceania		2.1	15.4	25.8	-3.2	12.7	10.3	-0.5	-6.4	-7.1	-7.9	-7.5	-7.1	-7.4	7.9	-7.2	2.4
CHN	19.4		13.4	27	1.4	3.4	4.3	9.4	-0.4	-1.1	-1.3	-2.1	-1.7	-1.4	13.6	-1.6	2.4
JPN	30.5	23.9		17	-8.6	43.5	15.8	-2.1	-11.2	-12.6	-13.8	-12.9	-12.9	-11.2	17.5	-12.4	2.5
KOR	18.3	19.7	9.1		-5	30.2	1.7	13	-5.5	-7	-8.1	-7.9	-7.9	-7.4	15.6	-7.6	4.7
ASEAN_H	4.5	-0.9	11.9	3		-1.3	-0.9	2.8	0	-1.8	-1.6	-1.8	-1.4	-1.3	2.1	-1.3	0.5
ASEAN_L	2.6	3	-6.6	-1	6.4		6.7	3.3	-0.1	-1.9	3.3	1.7	3.4	2.4	2.5	2.3	2.4
ASEAN_M	8.2	4.5	6.6	1.5	2.3	5.4		0.2	0.3	-1.1	0.5	-0.1	0.2	0.7	4	0.1	2.1
ASEAN_T	1.5	0.6	9	6.7	1.8	0.6	2		1.2	-0.7	1.6	2.5	1.1	1.3	3.1	1.4	2.2
RofAisa	-2.2	-3.3	4.5	-1.3	1	-10.5	-1.7	-3.3		0.8	0.7	0.4	0.8	1.1	-2.1	0.7	-0.9
IND	-1.7	-0.6	2.5	0.1	1.3	-9.8	-4.2	-3.8	0.4		0	-0.3	0.1	0.5	-1.1	0.2	-0.1
MCA	-0.9	-1.4	1.4	0.1	0.8	-6.6	-2.5	-1.2	0.6	0.7		0	0.2	0.5	-0.5	0.1	0.1
USA	-0.4	-1.3	5.4	-1.1	1.5	-9.4	-1.5	0.1	1.9	1.1	0.9		0.7	1.1	0.3	0.9	0.8
EU	-1.8	-3.2	5.3	0.2	0.8	-6.4	-2.8	-2	0.8	0.3	-0.2	-0.2		0.3	-1.1	0.2	-0.2
ROW	1.7	-0.5	1.6	1.4	1.1	-6.5	-1.8	-0.2	0.1	0.1	-0.7	-0.9	-0.3		0.3	-0.4	-0.1
RCEP	16.1	13	11.8	19.6	-0.8	5.1	4.7	5.7	-3.2	-2.9	-3.6	-3.9	-3.2	-3.1	11.1	-3.4	2.5
nonRCEP	-8.6	-9.2	-4.4	-10.9	1.2	-2.2	-2.7	-2.8	1.8	2.1	3.1	2.4	2.2	2.5	-0.4	0.2	0
Total	7.5	3.9	7.4	8.8	0.4	2.9	2	2.9	-1.4	-0.7	-0.5	-1.5	-1.1	-0.6	4.8	-1	1

Fig. 3. Rate of change in bilateral trade volume under RCEP scenario (%). Note: The vertical coordinate represents the exporter and the horizontal coordinate represents the importer. For example, the number 2.1 in the first row and the second column represents a 2.1 % increase in exports from Oceania to China, while China's exports to Oceania grow by 19.4 % and are listed in the 2nd row and first column. Source: Model simulations.

	51	56	62	66	47	85	223	74	88	56	60	71	64	Oceania
46		37	69	63	53	53	70	-14	47	25	24	48	41	CHN
14	56		67	65	45	49	37	67	58	59	49	68	44	JPN
21	67	62		90	66	-6	71	79	72	63	55	67	48	KOR
58	76	75	53		92	54	14	390	77	61	65	81	59	ASEAN_H
88	90	-27	-735	80		56	102	99	33	6	22	21	23	ASEAN_L
44	95	73	49	73	14		-5	114	94	66	-84	44	36	ASEAN_M
117	141	55	84	55	93	2		84	88	16	-2	8	23	ASEAN_T
45	77	75	95	87	86	60	93		65	71	129	58	46	RofAisa
0	103	88	-107	94	69	46	50	49		-872	-1	111	47	IND
42	41	26	-418	89	66	57	82	115	102		239	119	50	MCA
-104	45	53	171	62	40	15	61	69	77	70		83	52	USA
-9	43	59	-343	80	61	38	83	58	101	29	0		52	EU
104	63	84	95	96	63	71	-142	184	134	64	65	61		ROW
Oceania	CHN	JPN	KOR	ASEAN_H	ASEAN_L	ASEAN_M	ASEAN_T	RofAisa	IND	MCA	USA	EU	ROW	

Fig. 4. Share of changes in intermediate goods trade in total trade (%).
Source: Model simulations and calculations.

the growth of exports of intermediate goods is not significant, while ASEAN_T's exports of intermediate goods to the United States have declined instead. Most non-member countries experience a slight decline in bilateral trade among member countries, especially a significant decline in exports to ASEAN_L, but a slight increase in exports to Japan. Exports from RofAisa are the most affected, with a decline of 0.9 %, while the United States exports instead grow by 0.8 %. However, the total imports of non-member countries have declined to varying degrees due to a decrease in income.

4.2. Effects of RCEP on RVC participation by economies

Fig. 5 illustrates the forward and backward participation of RVC and ERVC for each economy. In terms of the magnitude of GVC participation obtained by summing RVC and ERVC participation as shown in Eqs. (7) and (8), ASEAN economies, especially ASEAN_H and ASEAN_T, have higher GVC participation. ASEAN_H is known for its highly open economy and re-export trade, resulting in a
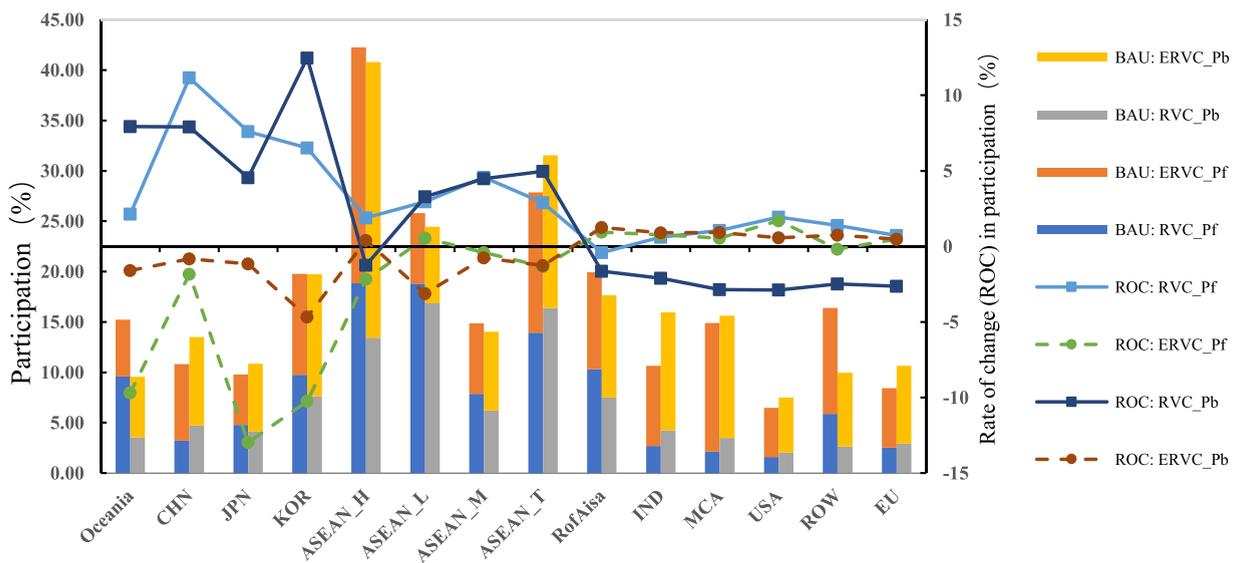

Fig. 5. EVC and ERVC participation by economy and their rate of change (%).
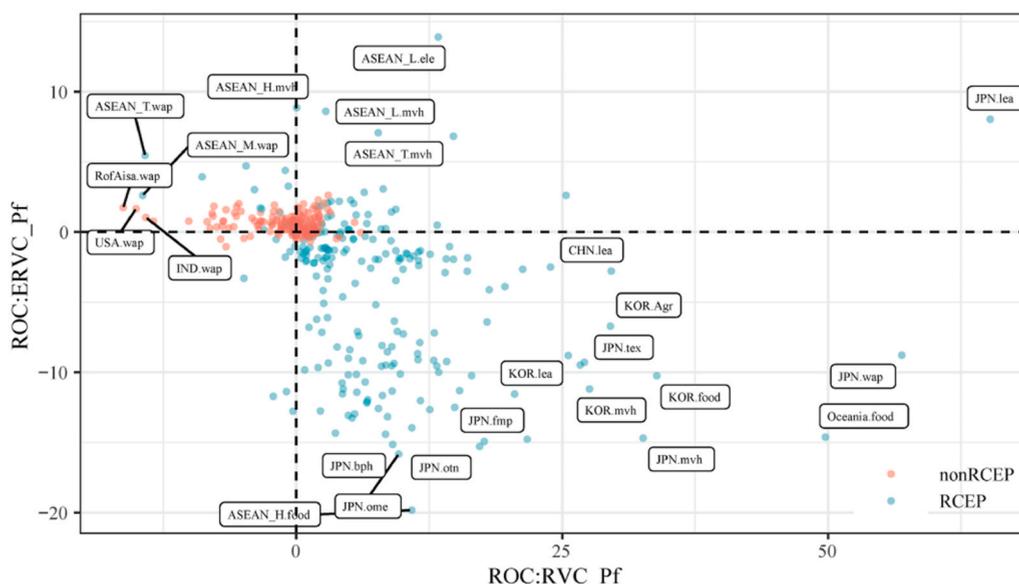Source: Model simulations and calculations.

Fig. 6. Rate of change in forward RVC and ERVC participation by economy-sector (%).
Source: Model simulations and calculations.

forward and backward GVC participation of 42.2 % and 40.8 %, respectively. While ASEAN_T is deeply involved in GVCs as global factories, with a forward and backward GVC participation of 27.9 % and 31.5 % respectively. Among the RCEP members, China, Japan, and ASEAN_T have greater backward than forward participation in GVCs, indicating that these economies act more as downstream producers. In contrast, Oceania, and the remaining ASEAN economies are resource-rich and primarily act as raw material suppliers. Among non-member countries, the United States, EU, and India exhibit greater backward participation than forward, with deeper vertical specialization in final goods. Compared with the participation in RVC and ERVC, the participation in RVC is less than that in ERVC in China and ASEAN_H, whether forward or backward, which indicates that such economies are more closely connected with the value chain outside the region. Conversely, Japan, Korea, ASEAN_M, and ASEAN_T exhibit similar levels of RVC and ERVC participation, while Oceania and ASEAN_L are more dependent on RVCs. The participation of non-member countries, excluding RofAisa, in RVCs is relatively low. For instance, MCA's RVC participation is only about one-sixth of ERVC participation.

In terms of the rate of change in RVC participation, RCEP has contributed to the deepening of RVCs, fundamentally due to a more pronounced expansion of bilateral trade in intermediate goods among member countries, as depicted in Fig. 4. The forward RVC participation of member countries has risen by 1.9–11.2 %, with China showing the most significant increase. Previously, China's participation in RVCs has not been high. RCEP provides an opportunity for deeper participation in RVCs. Although China's ERVC participation has slightly declined, its GVC participation has increased.[5] Japan and Korea have seen a significant increase in their participation in forward RVC. The increase in backward RVC participation ranges from 3.3 % to 12.5 % in the other member countries, except for ASEAN_H, where backward RVC participation decreases slightly. Korea has experienced the most significant increase in backward ERVC participation, and RCEP has contributed to the degree of regional division of labor for vertical specialization of final goods in Korea. For ASEAN economies, which are already more dependent on RVCs, RCEP's role in enhancing their participation in RVCs is relatively limited. However, the forward and backward RVC participation in ASEAN_T has also increased by 2.9 % and 5.0 %, respectively.

ERVC participation of member countries has decreased to varying degrees. In particular, Korea's ERVC participation has declined by 1.0 %, resulting in a 0.4 % decline in total GVC participation. China and other ASEAN economies, except ASEAN_H, have experienced a smaller decline in ERVC participation and eventually an increase in overall GVC participation. This is because China and ASEAN_T economies are more deeply involved in value chain production activities outside the RCEP region, and this value chain division of labor pattern is relatively stable and not easily replaced by RCEP. For non-members, ERVC participation all shows a weak increase, which is caused by the trade diversion effect, while non-members do not emerge a significant decline in RVC participation in the RCEP region due to the resilience of value chain relationships.

4.3. Effects of RCEP on RVC participation by sectors

Figs. 6 and 7 illustrate the rates of change in a pair of RVC and ERVC participation by sector for all economies. The result shows an

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[5] Note that the rate of change in GVC participation is not a direct sum of the rate of change in RVC participation and the rate of change in ERVC participation.
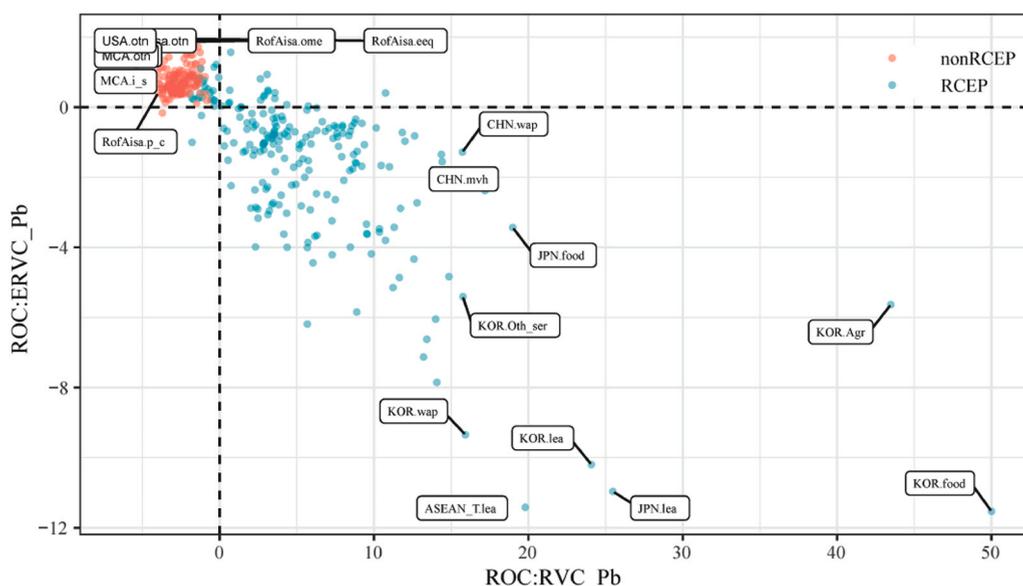
Fig. 7. Rate of change in backward RVC and ERVC participation by economy-sector (%).
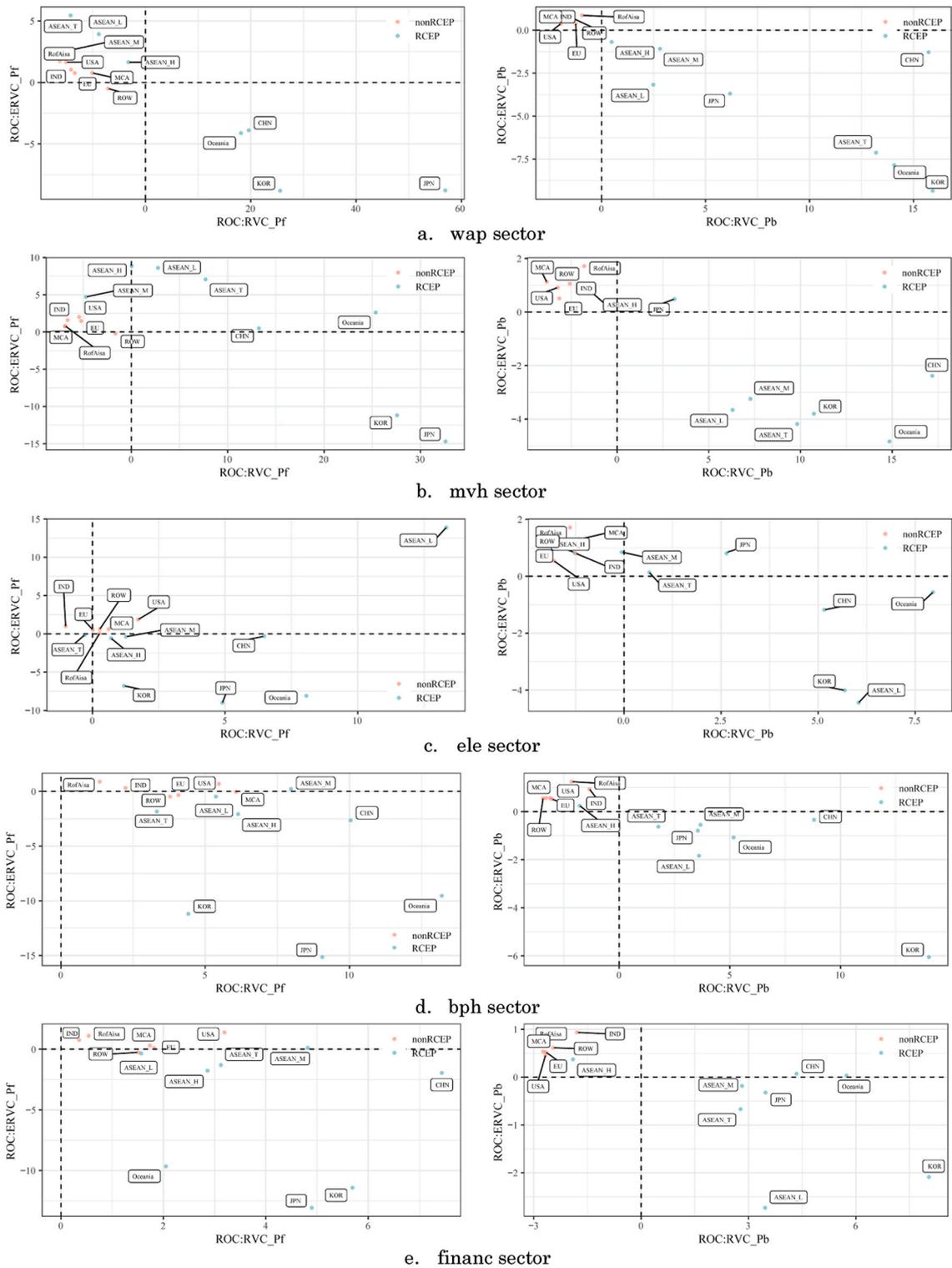Source: Model simulations and calculations.

overall increase in RVC participation across most member countries' sectors, accompanied by varying degrees of decline in ERVC participation. Notably, the industrial sectors in Japan, Korea, and China have experienced significant increases in RVC participation. The sectors with significantly increased RVC participation are concentrated in the wap, tex, lea, mvh and food sectors, while ERVC participation in the otn, ome, and bph sectors has declined significantly. The changes in RVC and ERVC participation across sectors in non-member countries are relatively insignificant, usually appearing a slight decrease in the former and a slight increase in the latter. The sectors that experienced a significant decline in a pair of RVC participation are primarily concentrated in the United States, India, and RofAsia economies. Specifically, the wap and otn are the sectors with relatively large declines in forward and backward participation, respectively. When Comparing changes in a pair of participation indicators, the forward participation of member country sectors is significantly more affected than the backward participation. Additionally, the change in backward participation in non-member countries' sectors falls in the left quadrant, i.e. RVC participation decreases and ERVC participation increases, while the change in forward participation is mostly concentrated around the 0 point.

This paper examines the sectors that have experienced significant changes in RVC participation or are representative sectors for further analysis. The results of the change in participation in these sectors are presented in Fig. 8.

For the wap sector, RCEP has significantly developed the regional supply and demand markets for Chinese, Japanese and Korean garments, while the ASEAN economies are more visible as "garment factories" in the EU and the United States due to the low production costs brought about by the RCEP. As shown in Fig. 8(a), the backward RVC participation in the wap sector increases in all member countries. The main reason is that the trade creation effect of RCEP will greatly encourage its members to source more textiles and apparel from within the RCEP region and create a more integrated regional textiles and apparel supply chain (Lu, 2019). However, only China, Japan, Korea, and Oceania have seen a significant increase in forward RVC participation. For example, the forward and backward RVC participation in Japan's wap sector increases by 56.9 % and 6.2 % respectively. The RVC participation of the wap sector in ASEAN economies, on the other hand, is declining rather than rising, and ERVC participation goes up instead, especially for ASEAN_T. The EU and the United States have actually been important demand markets for ASEAN_T's wap products. The RCEP scenario demonstrates that the price of wap exports to various countries decreases and the value added of ASEAN_T's wap products absorbed by the EU and the United States increases in comparison to the baseline scenario.

In the mvh sector, there has been a significant increase in backward RVC participation in member countries, which also implies that more capital and labor factors from within the region are absorbed for the development of the automotive industry, especially for China and Korea. The forward RVC participation in the Japanese and Korean mvh sectors has increased by 32.6 % and 27.6 %, respectively, which is much higher than the increase in backward RVC participation. However, this is accompanied by a slight decline in ERVC participation, which implies a partial shift from global to regional export markets for Japanese and Korean automotive intermediate goods. For China and Oceania, their regional and international export markets for motor vehicles and parts have expanded due to export price advantages. In the case of ASEAN_H's mvh sector, its participation in ERVC has increased while its participation in RVC has decreased slightly. For non-member countries, the decline in forward RVC participation is slightly more pronounced than backward, for example, the forward and backward RVC participation of mvh sector in the United States declined by 5.4 % and 3.2 %, respectively.

For the ele sector, RCEP has not only boosted the participation of member countries in forward RVCs, but has also contributed most non-members to participating more deeply in the RVCs within RCEP. On the one hand, in the GVC division of ele products, China and

Fig. 8. Rate of change in forward and backward participation of RVC and ERVC in representative sectors.
Source: Model simulations and calculations.

some ASEAN economies import components from the United States, Japan, and other countries for processing, assembly, and re-export. This value chain lock is difficult to be broken in the short term. On the other hand, the export prices of ele products from the United States have decreased under the RCEP scenario, As a result, the cost of exports to the RCEP region has not increased, which

contributes to a slight increase, rather than a decrease, in the RVC participation of the ele sector in these non-member countries. It is worth noting that ASEAN_L's ele sector has seen a significant increase in both RVC and ERVC participation, thus its GVC participation increases from 28.9 % to 32.8 %. In terms of backward linkage, the RVC participation of ele sector in non-member countries has slightly decreased, while Japan's RVC and ERVC participation have both increased.

For the bph sector, RCEP promotes RVC participation in this sector in all economies, which means an increase in the global supply of bph products to the RCEP region, including from non-member countries. In China's bph sector, RVC participation has increased by 10.0 %, ERVC participation has decreased by 2.7 %, and GVC participation has increased by 0.41 %, while forward ERVC participation in Japan's bph sector has decreased more than the increase in RVC participation, and GVC participation has decreased by 7.0 %.

For the financ sector, the growth in RVC participation is relatively unimpressive across all sectors, due to its inherently small GVC participation as a service industry (Wang et al., 2022). Forward RVC participation in the financial sector has grown across economies, similar to the bph sector. Among them, China's financial sector has experienced the most significant growth in forward RVC participation while losing less ERVC participation, so that the role of an "upstream supplier" has become more pronounced on the whole. Korea and Japan follow, but at the cost of a greater decline in ERVC participation, while Oceania experiences a higher cost. The economic dynamism stirred by RCEP has led to the expansion of the United States and EU financial value added participation in RCEP regional value chain production activities as well. The financial sector has undergone similar changes to the bph sector in terms of backward RVC participation, with member and non-member countries located in quadrant IV and quadrant II, respectively. However, China is one of the exceptions, and its backward ERVC participation has not declined. This suggests that factor inputs from both within and outside the region have increased in the vertical specialization of the final output of the Chinese financial sector, and that China's economic development is increasingly attracting global financial indirect inputs. Relatively, the output of the Korean financial sector attracts more regional value added inputs than China.

5. Conclusions and policy recommendations

This paper builds a GVC-CGE model embedded in GVCs structure and the accounting of RVC participation to assess the impact of tariff and non-tariff reductions by RCEP on bilateral trade between member and non-member countries, especially on regional value chains.

RCEP has facilitated the expansion of regional bilateral trade. The most significant increase has been observed between member countries that have thus established FTAs, such as China, Japan, Korea, and Oceania, and between member countries with relatively smaller trade initially, such as Japan, Korea, and ASEAN_L. Additionally, there has been a greater increase in the trade of intermediate goods compared to final goods among most member countries.

The RCEP has promoted the deepening of RVCs, and the backward and forward RVC participation of member countries has increased, while ERVC participation has slightly decreased. i.e., member countries, especially China, Japan and Korea, have shown more tendency to "produce for the region" and "buy from the region". Non-member countries' participation in backward RVCs within RCEP has decreased. The textile, garment, leather, automotive, and food sectors in member countries have experienced more significant RVC deepening, while the transport machinery, mechanical equipment, and pharmaceutical sectors have seen a decline in ERVC participation. The participation in backward RVC and ERVC has increased and decreased, respectively, among representative industries in member countries, while non-member countries have experienced the opposite trend. Compared to backward linkages, forward RVC participation is more affected and complex in the sectors of member countries, RCEP reconfigures regional production networks significantly more than demand networks. For the garment sector in most ASEAN economies, forward RVC participation has not increased, but rather ERVC has increased, resulting in producing more globally rather than for the region. Given the economic dynamism brought by RCEP, not only member but also non-member countries produce pharmaceutical and financial products for the RCEP region. To some extent, China, Japan and Korea have shifted their production value chains and demand value chains from global to regional, and their importance in the RVCs is more elevated both at the overall and sectoral levels.

Based on the research findings presented in this paper, we can derive the following policy recommendations to foster deeper cooperation within the RCEP regional value chain.

Member countries should take advantage of the opportunities presented by RCEP and utilize its rules, such as tax reduction for trade in goods and trade facilitation, to strengthen trade relations in intermediate goods and enhance the resilience of regional value chains. It is important to note, however, that while RCEP offers significant benefits, it still has room for improvement in terms of the depth and breadth of trade liberalization when compared to higher-level agreements such as CPTPP. This paper only considers the reduction of non-tariff costs by 30 %, but as non-tariff barriers are further reduced among member countries and investment and trade facilitation deepen, the impact of RCEP on regional trade creation will continue to grow.

China, Japan and Korea need to play a leading role in the regional value chain. The formal establishment of free trade relations among the three countries through the implementation of RCEP is a positive step. It presents an opportunity for the three countries to strengthen their economic and trade cooperation in the Asia-Pacific region. They should utilize this opportunity to further promote the China-Japan-ROK free trade agreement negotiations, create a higher level, and more open trilateral institutional cooperation mechanism, and inject more vitality into the region's economic and trade cooperation.

To enhance RVC participation, member states should focus on strengthening regional industrial and supply chain cooperation. China, Japan, South Korea, and Australia can increase the participation of forward RVC by transferring processing and manufacturing industries like wap, mvh, and ele to ASEAN. Meanwhile, ASEAN_L, ASEAN_M, and ASEAN_T economies can take advantage of cost advantages and actively undertake regional industrial transfers to further enhance their participation in backward RVC. In addition, ASEAN should be more integrated into the industrial division of labor system to meet the needs of the regional market, and increase the

supply of manufactured goods to the region.

The absorption capacity of regional products in member countries, particularly in China as a demand hub for regional value chains, needs to be improved. However, China's backward RVC participation has not increased as much as forward RVC, and Korea's demand scale is limited despite a significant increase in backward RVC. In addition, only the full development of the potential of the RCEP demand market and the completion of the division of labor network can compensate for the loss of participation in the value chain at the aggregate level resulting from the shift of Japanese transport machinery, machinery and equipment and pharmaceutical products from supply to the world to supply to the region.

The RCEP has a considerable impact on non-member countries that share strong economic and trade relations with member countries, including India and other Asian economies. The RCEP is designed to be inclusive and open, and should consider expanding its membership to eligible economies to promote mutually beneficial cooperation and economic development in the Asia-Pacific region.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

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