sustainability

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Economic Transformation and Sustainable Development through Multilateral Free Trade Agreements

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Abstract: For sustainable economic development, a continuous and successful economic transformation is critical, and supporting economic transformation requires a better understanding of the close interaction between technology and skill at the micro- and macro-levels. The technology-skill links should especially be important in today's globalized world. This paper develops a large-scale global Computable General Equilibrium (CGE) model by incorporating recent theoretical advances in international trade: Heterogeneous workers endogenously sort into different technologies based on their comparative advantage, and aggregate productivity is determined by skill-technology assignment in equilibrium. We then calibrate our model to a real-world data set, and investigate how multilateral free trade agreements affect individual member states, as well as outside countries and regions in the case of the Regional Comprehensive Economic Partnership (RCEP). Overall, the results show considerable real productivity gains and economic transformation effects, due to technology-upgrading mechanisms.

Keywords: economic transformation; sustainable development; multilateral free trade agreements; regional comprehensive economic partnership (RCEP); worker and firm heterogeneity; technology upgrading; endogenous aggregate productivity; computable general equilibrium (CGE) model

Citation: Jung, J. Economic Transformation and Sustainable Development through Multilateral Free Trade Agreements. *Sustainability* **2021**, *13*, 2519. https://doi.org/10.3390/su13052519

Academic Editor: Andrzej Cieslik

Received: 20 January 2021
Accepted: 23 February 2021
Published: 26 February 2021

1. Introduction

How to facilitate and achieve successful economic transformation has been at the center of concern for sustainable economic development. From an economic perspective, economic transformation is defined as a continuous process of shifting various resources from lower-productive activities to higher-productive activities, which can occur both within and between sectors (e.g., References [1,2]). For developing and emerging countries, how to trigger or accelerate such transformation is of primary interest. Most developed countries have typically experienced structural transformations during the development period, with resource movements over time from primary to higher-productive manufacturing, and then to even higher value-added services. Such structural transformation, together with within-sector productivity growth, has been widely identified as crucial for economic development and growth (e.g., References [3–6]).

Understanding the pattern of successful economic and structural transformations should be especially important in today's globalized economy. There is now ample evidence that globalization and openness can be important drivers for economic/structural transformation and sustainable economic development. As globalization proceeds rapidly and in a much more complex way, multilateral free trade agreements, such as the Regional Comprehensive Economic Partnership (RCEP), have been pursued for economic transformation breakthroughs. Related to the issue of sustainability, recent works highlight, among others, the dynamic and diverse economic aspects in RCEP countries (e.g., References [7,8]).

The RCEP is a multilateral free trade agreement between 15 Asia-Pacific nations, including the 10-member countries of the Association of Southeast Asian Nations (ASEAN) and five countries (Korea, China, Japan, Australia, and New Zealand), which has recently been signed on 15 November 2020 after eight years of negotiations. Though India withdrew from the negotiations, the RCEP is the world's biggest trade pact covering about 30% of global GDP and population. Given its large economic magnitude in the global economy, the RCEP is expected to give rise to pervasive economic and structural transformation effects not only for member states, but also for outside countries. In particular, when countries are technologically asymmetric—more specifically, when firms are technologically different—how such mega-FTA (Free Trade Agreement) formations affect aggregate real productivity through competitions should be a primary concern for policy-makers and researchers.

Contemporary firm heterogeneity literature in international trade highlights aggregate productivity gains through the selection effects of globalization, in general. It is now widely documented that firms are largely different even within narrowly defined industries, and exporting firms are more productive and use higher technologies than non-exporting domestic firms (e.g., References [9–13]). Closely related to this literature, recent research advances in international trade highlight also worker-side heterogeneity in skills and globalization-induced real productivity gains through equilibrium skill-technology assignments (e.g., References [14–21]). Among others, Jung [22] highlights aggregate productivity/welfare gains and growth effects of globalization through a technology-upgrading mechanism.

Over the last decades, there has been a rapid rise of Regional Trade Agreements (RTAs): WTO reports that RTAs have not only increased in number, but also in-depth and complexity [23]. The major motive of forming RTAs has, among others, been to enhance aggregate productivity through trade openness and liberalization. There is now abundant evidence of how trade liberalization spurs firm productivity through various channels. Trade liberalization stimulates firms to innovate with increased export opportunities [24,25], and also learning-by-exporting occurs [26]. Trade liberalization affects trade flows not only for final goods, but also for intermediate goods. Recent studies also show a positive and significant relationship between access to imported intermediate goods and firm productivity [27–31]. There has also been a long empirical literature investigating the impact of import competition on firm productivity. Concerning the impact of import competition, recent studies provide rather mixed findings. For example, while numerous studies find productivity-enhancing effects of Chinese import competition [32,33], some recent studies also report its negative effect on the innovation of local firms [34,35]. Such mixed-effects should be much more complex in a mega-trading bloc, such as the RCEP, which includes a variety of member states from high-income countries to low-income countries.

In this paper, we develop a large-scale global Computable General Equilibrium (CGE) model incorporating recent advances in international trade theory. We extend the conventional CGE model by explicitly modeling heterogeneous firms and workers in technologies and skill levels. Exporting firms use higher technology and heterogeneous workers in individual skill levels endogenously sort into different technologies based on their respective comparative advantage. Thus, sectoral and economy-wide labor productivity is determined by skill-technology matching in equilibrium. Though theoretical implications might be straightforward in a simple two-country theory model, once incorporated into large-scale multi-country/region multi-sector global CGE models, it is not, a priori, possible to predict potential outcomes of any policy changes.

Our core theoretical framework is closely related to Jung and Mercenier [21] and Jung [22]. In a simple two-country (North and South) offshoring model, they show that globalization-induced Northern firms' offshoring to cheap-labor economies (South) may increase welfare and growth rate in the home country (North), due to technology-upgrading mechanism. By adapting their basic theoretical settings to a full multi-country/region multi-sector trade model, this paper tries to evaluate and quantify more comprehensively the possible economic effects of real-world multilateral free trade agreements, which could not be captured by traditional CGE analysis.

To investigate the real productivity and economic/structural transformation effects of multilateral free trade agreements through the previously described technology-upgrading mechanism, we apply the developed model to the case of the RCEP. The model was calibrated to a global Social Accounting Matrix (SAM), which was constructed using the GTAP 10 Database. As will be shown, the simulated results show that, though not for all, the RCEP creates, in general, pervasive real productivity gains and positive economic/structural transformation effects for member states. Given the large economic magnitude of the RCEP in the global economy, it is also shown that outside countries are largely affected.

The RCEP also includes various measures for service and investment liberalization among member states. It is now widely documented that, among others, financial constraints or frictions have considerable effects on FDI and trade (e.g., References [36–38]). More broadly, given ample evidence of a significantly positive impact of FDI on economic growth and development (e.g., References [39–41]), there has been abundant researches on the determinants of FDI, and a long literature emphasizes, among others, the role of institutional quality (e.g., References [42–51]). To account for these investment barriers, numerous CGE models also incorporate an iceberg-type [52] non-tariff barriers. Though the inclusion might be straightforward, we do not want to mix the effects. The effects of economic integration may be much more complex, due to heterogeneity in technological progress across countries [53]. In this paper, we focus on how a simple and transparent tariff reduction itself can induce significant economic transformation effects, due to skill-technology reallocations.

We are not the first to extend the conventional CGE framework to incorporate recent theoretical advances of firm heterogeneity in international trade. For example, a work by Balistreri and Tarr [54] models firm heterogeneity in the style of Melitz [55], and finds that the RCEP can produce significantly larger welfare gains than estimated using the conventional Armington structure [56]. Recently, Jung [57] also finds that incorporating Roy-like worker assignment [58] into CGE models may lead to even higher welfare gains, compared to Melitz-style models in which aggregate productivity gain comes only from the market-entry selection effects of firms having exogenously-given productivity differences. By developing a two-country trade CGE model, Jung [57] analyzes the welfare effects of bilateral trade liberalization in the case of Korea-US FTA, and shows that considering the close interplay between technology and skill may lead to different results not only quantitatively, but also qualitatively. This implies much more complex effects for multilateral free trade agreements. This paper is the first study that evaluates and quantifies with a real-world application the real productivity and economic transformation effects of multilateral free trade agreements through a technology-upgrading mechanism.

The rest of the paper is organized as follows. In Section 2, we describe the model and CGE application. In Section 3, we explain the data and model calibration. In Section 4, we study the effects of the RCEP on productivity, market structure, and economic transformation. Section 5 concludes with some concluding remarks.

2. Model Description

2.1. Heterogenous Firms

As is standard in monopolistic competition models, we assume a continuum of firms in the manufacturing sector, each producing a differentiated variety. Our main departure from the conventional framework is that firms are not identical in their used technologies. Now there is ample evidence that exporting firms are more productive and use higher technologies than non-exporting domestic firms. Based on the evidence, we assume two technologies for firms $n \in \{L, H\}$: L for low technology and H for high technology. These two technologies can be understood as strategy-specific technologies. Firms are free to enter the market, but exporting requires adopting high technology, which is associated with higher fixed set-up cost; we assume $f_H > f_L$.

Monopolistically competitive firms charge a constant mark-up over marginal production costs:

$$p_n = \frac{\sigma}{\sigma - 1} p_n^C, n \in \{L,\ H\}, \tag{1}$$

where σ is the elasticity of substitution between varieties, and p_n^C is the unit production cost for the final good of each firm type. With free entry of firms and by expressing fixed costs in terms of forgone outputs, the following zero-profit condition should be satisfied for all firms:

$$\frac{1}{\sigma} p_n x_n = p_n^C f_n, n \in \{L,\ H\}, \quad (2)$$

implying that mark-up revenues exactly cover the fixed costs.

2.2. Heterogenous Workers

Production of final goods combines primary factors and intermediate goods. We assume that workers are heterogeneous in their individual skill level z, at a given distribution with density $g(z)$ on support $[z_{min},\ z_{max}]$. Workers' productivity reflects not only their individual skill level, but also the technology they use. We denote by $\varphi_n(z)$ the technology-augmented labor productivity of a worker with skill level z. We assume a comparative advantage aspect of skill in technologies that we formalize as follows:

$$0 < \frac{\partial \varphi_L(z)}{\partial z} \frac{1}{\varphi_L(z)} < \frac{\partial \varphi_H(z)}{\partial z} \frac{1}{\varphi_H(z)}, \varphi_L(z_{min}) = \varphi_H(z_{min}). \quad (3)$$

Equation (3) implies that higher-skilled workers are relatively more productive with higher technology, while lower-skilled workers have relatively comparative advantage in lower technology. There should, then, be a skill threshold (z^*) sorting workers into two different technologies and/or two different firm types. Finally, in equilibrium, workers with $z \in (z_{min},\ z^*)$ are matched with low-tech domestic firms, and workers with $z \in (z^*,\ z_{max})$ are matched with high-tech exporting firms. z^* is endogenously determined in each country from the following no-arbitrage condition within sector:

$$w_L \varphi_L(z^*) = w_H \varphi_H(z^*), \quad (4)$$

where w_L and w_H are technology-specific efficiency wage rates.

2.3. Technology Upgrading Mechanism

Based on our model and assumptions, it should be clear that economy-wide labor productivity is determined not only by a given skill distribution, but also by used technologies. All other things being equal, from Equation (3) a leftward shift of the skill threshold (z^*) would lead to a higher aggregate productivity, while a rightward shift of z^* would lead to a lower aggregate productivity. Following Figure 1 illustrates the real productivity gain, due to the described technology-upgrading mechanism. Suppose that the equilibrium threshold decreases for some reasons that favor relatively high-tech exporting firms. We can measure the sector-wide real productivity as $\int_{z_{min}}^{z^*} \varphi_L(z) g(z) dz + \int_{z^*}^{z_{max}} \varphi_H(z) g(z) dz$. If z^* decreases from z_0^* to z_1^*, the sector-wide real productivity increases as much as the shaded area in Figure 1.

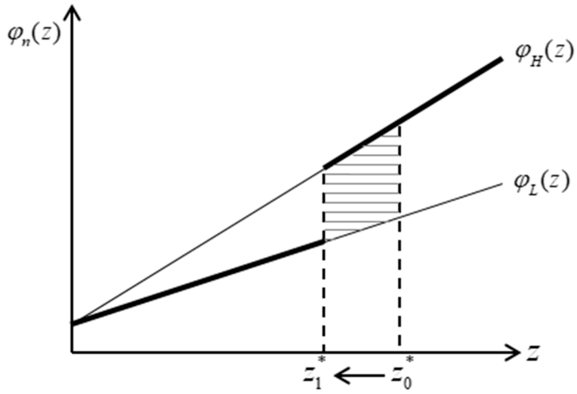

Figure 1. Real productivity gains, due to technology-upgrading mechanism.

In a highly stylized theoretical world, the implications should be straightforward. However, applications to the real world are much more complex. In particular, given the rapidly increasing interdependence of countries in today's globalized world, a priori it is not possible to predict how a certain shock will affect individual countries. We incorporate above theory into a large-scale global CGE model.

2.4. Global CGE Application

Incorporating technologically differentiated varieties complicates not only production side, but also the demand side. Conventional Armington framework assumes that in a perfectly competitive environment, there is only one representative firm in each sector that serves both domestic and foreign markets, and that consumers differentiate goods by geographic origin (e.g., References [59–61]). In our model, things become more complex.

Panel (a) in Figure 2 illustrates the conventional Armington demand system. In each country-i and sector-s, Armington composite good $D^{A}_{i,s}$ is a CES (Constant Elasticity of Substitution) composite of domestic good $D^{Dom}_{i,s}$ and imported good $D^{Imp}_{i,s}$, where $D^{Imp}_{i,s}$ is, in turn, a CES composite of exports of other countries-j to country-i.

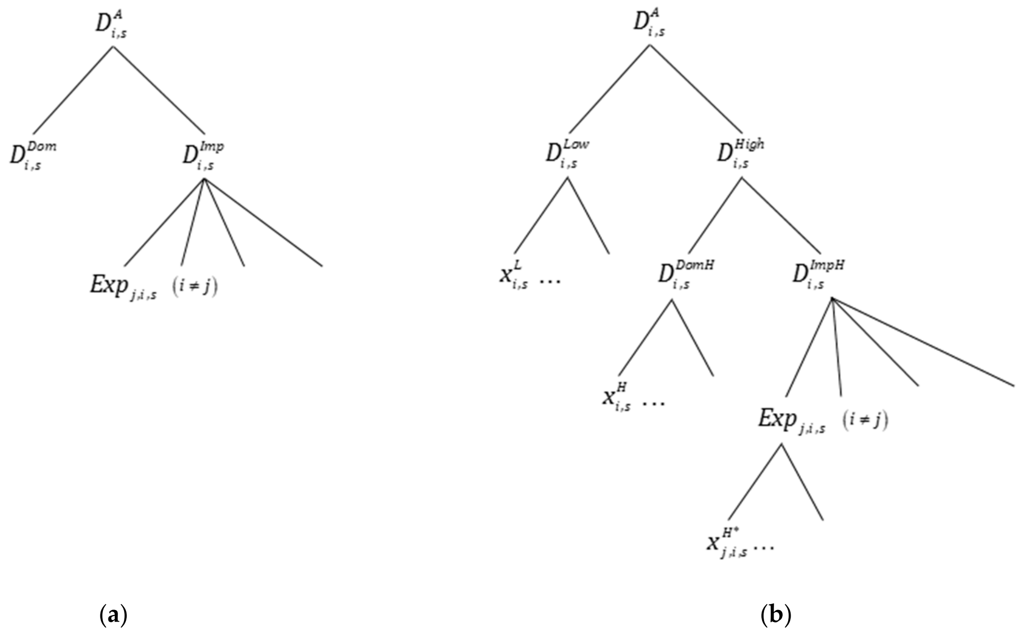

Figure 2. Demand structure: (**a**) Armington sector; (**b**) heterogeneous firm/worker sector.

On the other hand, panel (b) in Figure 2 illustrates our model's demand system when goods are technologically differentiated, as well as by geographic origin. At the first level, the aggregate consumption composite is composed of two types of goods: Low-tech goods $D^{Low}_{i,s}$ and high-tech goods $D^{High}_{i,s}$. While low-tech goods are provided only by domestic firms, high-tech goods are again a CES composite of $D^{DomH}_{i,s}$ and $D^{ImpH}_{i,s}$, where $D^{DomH}_{i,s}$ is provided by domestic high-tech (exporting) firms and $D^{ImpH}_{i,s}$ is provided by foreign high-tech (exporting) firms. $D^{ImpH}_{i,s}$ is, in turn, a CES composite of exports of other countries-j to country-i. Finally, assuming monopolistic competition and free entry of firms, $D^{Low}_{i,s}$, $D^{DomH}_{i,s}$, and $Exp_{j,i,s}$ are composites of available individual varieties of each firm type in country-i.

The final aggregate consumption composite in each sector in each country is consumed as private consumption, government consumption, investment, and intermediate goods for each sectoral production. Panel (b) of Figure 2 implies at the same time much higher competition dimensions on the firm side. For instance, a high-tech exporting firm in a sector-s in a country-i now faces competitions from domestic firms in the same sector, from other high-tech firms, both domestic and foreign exporters selling goods in country-i, as well as from firms (domestic, national high-tech, foreign high-tech) of other sectors, etc. Understanding and considering such complex competitions should be important to analyze and predict economic transformation and sustainable development effects of any policy changes. In particular, for the multilateral free trade agreements where many countries (typically largely asymmetric in many aspects) participate, such higher-dimensional competitions may change everything.

Finally, as is standard, in equilibrium, all the market clearing conditions apply in goods and factors markets. As explained before, one main difference from the conventional models is that, given different technologies in our model, labor market clearing conditions are formalized in terms of the technology-augmented efficiency units. In the following section, we calibrate our model to investigate the effects of the RCEP.

3. Data and Calibration

To apply the developed model to a real-world data set, we first need to decide the dimension of the model. To analyze the effects of the RCEP, the following regional aggregation is implemented as in Table 1. Currently, two large multilateral free trade agreements are ongoing: The RCEP and the CPTPP (Comprehensive and Progressive Agreement for Trans-Pacific Partnership). The two mega-FTAs have competitively been pursued, and some countries participate in both the RCEP and CPTPP. We consider all the countries engaged in the two mega-FTAs and aggregate the rest countries into two groups: The European Union (EU) and the remaining Rest-of-World (RoW). In Table 1, 15 countries from Korea to New Zealand (N° 1–15) are current member states of the RCEP, while 11 countries from Viet Nam to Chile (N° 9–19) are current member states of the CPTPP; Viet Nam, Malaysia, Singapore, Brunei, Japan, Australia, and New Zealand participate both the RCEP and CPTPP. We separately include the USA and India too: USA and India withdrew from the CPTPP and RCEP, respectively, due to some economic and political reasons, but still have the possibility of returning.

Table 1. Regional aggregation of the model.

N°	Code	Description	N°	Code	Description
1	KOR	Korea	13	JPN	Japan
2	CHN	China	14	AUS	Australia
3	THA	Thailand	15	NZL	New Zealand
4	IDN	Indonesia	16	CAN	Canada
5	PHL	Philippines	17	MEX	Mexico
6	KHM	Cambodia	18	PER	Peru
7	LAO	Laos	19	CHL	Chile
8	MMR	Myanmar	20	USA	United States of America
9	VNM	Viet Nam	21	IND	India
10	MYS	Malaysia	22	EU	European Union
11	SGP	Singapore	23	RoW	Rest of World
12	BRN	Brunei			

Applying the model with data requires a comprehensive and huge data set covering all the economic transactions between countries, as well as within each country, which is called Social Accounting Matrix (SAM). The global SAM for the model has been constructed using the GTAP 10 Database. The GTAP database is the most widely used data set in multi-country/region CGE models, due to its comprehensive coverage. The most recent GTAP database (version 10) covers 65 sectors in each of the 141 countries/regions, and reports production, consumption, tax, bilateral trade information, etc., for the reference year of 2014 [62].

Given our objective, industries are aggregated into three sectors: Primary, manufacturing, and service. Following conventional practice, we assume perfect competition in primary and service sectors, while monopolistic competition is assumed in the manufacturing sector. Moreover, in the current GTAP Database, the data for Myanmar includes East

Timor; but given the very small economic size of the latter, its inclusion would not affect the main results.

Tables 2 and 3 show the average bilateral tariff rates between the 15-member countries before the RCEP. The ten countries N° 3–12 in Table 1 have already formed the ASEAN Free Trade Area (AFTA).

Table 2. Average bilateral tariff rates before the RCEP: Primary sector.

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
(1)	KOR	0.00	0.56	0.35	0.00	0.25	0.00	0.00	0.52	0.17	0.00	0.00	0.00	0.07	0.04	0.17
(2)	CHN	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.01
(3)	THA	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.06
(4)	IDN	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.03	0.00	0.00	0.04	0.04
(5)	PHL	0.00	0.06	0.23	0.00	0.00	0.00	0.00	0.00	0.38	0.00	0.00	0.00	0.00	0.02	0.00
(6)	KHM	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.00	0.00
(7)	LAO	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
(8)	MMR	0.04	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
(9)	VNM	0.03	0.01	0.00	0.01	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.03
(10)	MYS	0.00	0.00	0.12	0.00	0.00	0.19	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00
(11)	SGP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
(12)	BRN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
(13)	JPN	0.06	0.06	0.16	0.00	0.05	0.14	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.02	0.11
(14)	AUS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
(15)	NZL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 3. Average bilateral tariff rates before the RCEP: Manufacturing sector.

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
(1)	KOR	0.00	0.04	0.05	0.01	0.01	0.03	0.00	0.00	0.01	0.01	0.01	0.00	0.05	0.13	0.14
(2)	CHN	0.04	0.00	0.01	0.02	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.06	0.02	0.03
(3)	THA	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.02
(4)	IDN	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.05	0.04
(5)	PHL	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.01
(6)	KHM	0.08	0.02	0.04	0.04	0.00	0.00	0.00	0.00	0.03	0.00	0.04	0.00	0.10	0.00	0.00
(7)	LAO	0.27	0.05	0.03	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.21	0.00	0.00
(8)	MMR	0.03	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.13	0.00	0.00
(9)	VNM	0.05	0.05	0.02	0.02	0.01	0.00	0.00	0.00	0.00	0.02	0.04	0.00	0.03	0.03	0.03
(10)	MYS	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
(11)	SGP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
(12)	BRN	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
(13)	JPN	0.02	0.02	0.01	0.01	0.00	0.01	0.02	0.01	0.01	0.01	0.02	0.00	0.00	0.04	0.09
(14)	AUS	0.05	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.00
(15)	NZL	0.02	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.04	0.00	0.00

To calibrate the model to the constructed SAM, we need some more specifications for the functional forms. In particular, we assume linear technologies for $\varphi_n(z)$, $n \in \{L, H\}$:

$$\varphi_n(z) = c + a_n z, \quad n \in \{L, H\}. \tag{5}$$

An influential study on the exporter premia reports that labor productivity is 12–24% higher at exporters, and that even within highly disaggregated samples exporters are 50–66% larger than non-exporters [63]. We set c = 1 and a_H/a_L=1.18. For the skill distribution, we assume uniform distribution and normalize the skill levels with $z_{min} = 0$ and $z_{max} = 1$. Though it might be more ambitious to introduce other skill distributions, currently no consistent data on the skill distribution covering all individual countries exists. Furthermore, in our framework, skills represent unobserved individual ability heterogeneity. As a second-best strategy, we assume a continuum of skill levels, uniformly distributed on normalized support [0, 1]. On the other hand, the current GTAP database distinguishes only five skill/occupation categories of workers: (a) Agricultural and other unskilled, (b) clerks, (c) service and shop workers, (d) officials and managers, and (e) technicians and associate professionals. Table 4 shows the share of each skill/occupation category in the total labor value-added of each RCEP member country.

Table 4. Share of skill/occupation categories (%) [1].

		(a)	(b)	(c)	(d)	(e)	Total
(1)	KOR	16.3	21.9	18.1	24.9	18.8	100.0
(2)	CHN	51.4	10.1	14.4	15.4	8.7	100.0
(3)	THA	35.7	16.2	6.8	25.9	15.4	100.0
(4)	IDN	52.1	19.0	5.0	8.3	15.6	100.0
(5)	PHL	28.7	10.5	7.3	39.4	14.0	100.0
(6)	KHM	57.2	12.9	3.9	14.3	11.7	100.0
(7)	LAO	70.3	6.0	3.5	11.1	9.1	100.0
(8)	MMR	50.6	13.6	5.3	17.4	13.2	100.0
(9)	VNM	52.1	10.9	4.6	16.6	15.9	100.0
(10)	MYS	32.5	13.3	7.7	21.8	24.8	100.0
(11)	SGP	5.1	10.7	7.8	51.1	25.4	100.0
(12)	BRN	23.5	9.7	11.6	30.9	24.3	100.0
(13)	JPN	24.6	13.4	9.1	27.3	25.6	100.0
(14)	AUS	17.2	12.8	10.7	40.7	18.6	100.0
(15)	NZL	14.2	11.5	9.8	44.4	20.1	100.0

[1] (a) Agricultural and other unskilled; (b) clerks; (c) service and shop workers; (d) officials and managers; (e) technicians and associate professionals.

Given the skill distribution, we calibrate fixed costs f_n, $n \in \{L, H\}$, so that initially, the shipments of exporting firms are 58% larger than non-exporting domestic firms; also, all the zero-profit conditions for individual firms are satisfied.

We also take all the elasticity information from the GTAP 10 Database. On the other hand, since the GTAP dataset has basically been developed for conventional CGE models, i.e., assuming perfect competition with only one representative firm in each sector, the dataset provides only Armington CES elasticities for regional allocation of imports at the regional level. We multiply these elasticities by 1.5 to get the elasticities of substitution between individual varieties in our model, leading to around 10.5 on average, which is reasonably acceptable: A largely cited work by Broda and Weinstein [64] reports that the average elasticity was around 12 when estimated at a much more disaggregated level.

All the other parameters and fixed variables are calibrated so that we exactly reproduce the initial SAM.

4. Effects of the RCEP

Given our model construction and calibration, in this section, we investigate the effects of the RCEP. Though the individual schedules of tariff commitments may be somewhat different, overall, the RCEP aims to eliminate tariffs on at least 90% of goods traded among member states. In the following analysis, we consider a 90% tariff reduction for all imports among the RCEP member states. We will investigate productivity effects, market structure effects, and economic transformation effects that the RCEP creates for member states, as well as for outside countries and regions. Moreover, as a sensitivity analysis, in Appendix A, the effects of the RCEP for the main variables are reported using alternative values of the elasticity of substitution between individual varieties: We multiply Armington regional elasticities by 1.1 to 1.7, which leads to around 7.7 to 11.9 on average. Table A1 shows, in general, that the more varieties are substitutable, the higher productivity effects occur, and that the RCEP-induced positive productivity effects are larger among the RCEP member countries.

4.1. Productivity Effects

We first investigate the effects of the RCEP on the skill/technology thresholds (z^*) in the manufacturing sector. As described before, in our model, the skill/technology thresholds are endogenous, and the variations are crucial for the aggregate productivity of each country/region. Given the technological difference between low-tech domestic firms and high-tech exporting firms, a decrease (leftward shift) of the threshold implies a technology-upgrading effect with an expansion of the high-tech activities: Now more firms and workers are associated with high technology, so that their real productivities increase. Contrarily, a rise (rightward shift) of the threshold induces a technology-downgrading effect with more firms and workers matched with low technology. Table 5 shows the percentage changes of the skill/technology thresholds in each country/region.

Table 5. Effects on the thresholds (% changes).

KOR	CHN	THA	IDN	PHL	KHM	LAO	MMR
−1.218	−32.736	−20.861	−29.769	13.141	−9.182	−93.737	−55.982
VNM	**MYS**	**SGP**	**BRN**	**JPN**	**AUS**	**NZL**	**CAN**
−55.739	−38.414	−32.644	−22.520	−21.840	−67.326	−50.400	27.983
MEX	**PER**	**CHL**	**USA**	**IND**	**EU**	**RoW**	**Mean**
108.452	−0.759	−70.359	−8.764	−77.491	−63.115	−20.701	−27.130

Overall, we find that the RCEP creates positive technology-upgrading effects for member states. Among the member states, Laos is shown to be affected the most positively, with a decrease of the threshold by 93.74%. It is shown that Australia, Myanmar, Viet Nam, and New Zealand are also largely positively affected with decreases of the thresholds by more than 50%. On the other hand, one exception is found among the RCEP members: The threshold of the Philippines is shown to rise by 13.14%. Given its economic importance, the RCEP also affects largely other outside countries and regions. Though Canada and Mexico are affected negatively (technology-downgrading), the large market-expansion effect of the RCEP generates an overall positive technology-upgrading effect, which induces globally decreases of thresholds by 27.13% on average.

From the variations of the skill/technology thresholds, we now investigate the resulting real productivity effects of the RCEP. Given our model specification, we measure the real productivity as the technology-augmented efficiency units of labor at a given labor supply and skill distribution:

$$\int_{z_{min}}^{z^*} \varphi_L(z)g(z)dz + \int_{z^*}^{z_{max}} \varphi_H(z)g(z)dz, \tag{6}$$

where, given an equilibrium threshold z^*, workers with $z \in (z_{min}, z^*)$ are associated with low technology, and workers with $z \in (z^*, z_{max})$ are associated with high technology.

Figure 3 shows the calculated percentage changes of the measured real productivity for each country/region. Among the member states of t*he* RCEP, due to the highest decrease of the skill/technology threshold, Laos's real productivity gain is shown to be the highest with an increase of 1.29%, followed by Australia exhibiting an increase of 1.15%. On the other hand, with a rise of the threshold, the Philippines is shown to experience a slight, real productivity loss of 0.36%. Outside the RCEP, Canada and Mexico are shown to experience real productivity losses. In particular, Mexico exhibits a high real productivity loss of 4.32%.

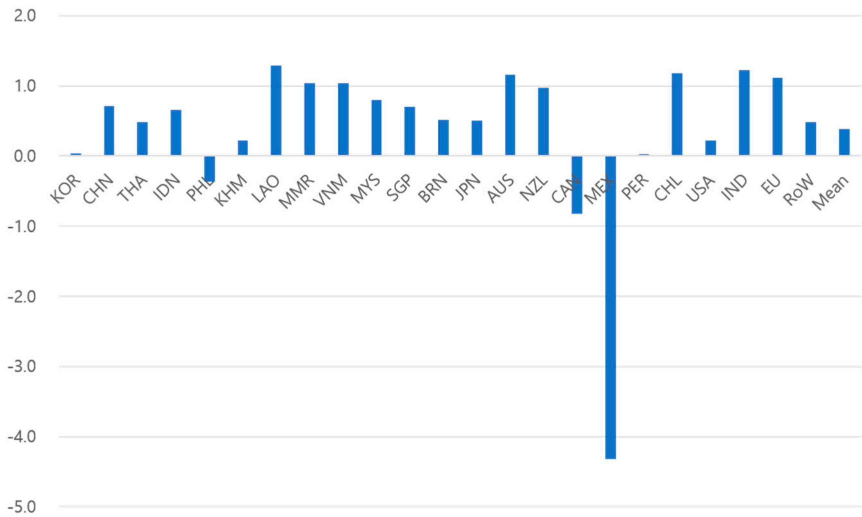

Figure 3. Effects on the real productivity (% changes).

The advent of a mega-trading bloc, such as the RCEP, may also generate large indirect effects that cannot be easily grasped at first glance. Current RCEP formation lead by China would enhance, in particular, regional manufacturing activities given China's high competitiveness in that sector. Looking at the results more in-depth reveals that the regional export of manufactured goods to the US increases largely, while the exports from other North American countries to the US contract. It is the case in particular for Mexico, whose economy is highly dependent on the US.

On the other hand, it should be noted that the measured effects on the real productivity in the manufacturing sector do not necessarily coincide with variations of other macroeconomic variables. The rightward shifting of the skill/technology threshold, and the induced decrease of the real productivity measure, may imply that the country transforms toward a more service-oriented economy. More calculation reveals that the real GDP of Mexico increases by 0.7%. The contraction of the manufacturing sector may also imply that the country imports more and exports less, which may lead to a rise in welfare on the consumer side. Indeed, it is shown that despite real productivity losses in the manufacturing sector in some countries, in terms of the aggregate welfare, all of them gain too, e.g., when measuring the welfare effects by the equivalent variation (EV), Mexico has an increase of welfare by around $15 billion.

4.2. Market Structure Effects

We now investigate the effects of the RCEP on the market structure of each country/region. Given our model specification and assumption of monopolistic competition with heterogeneous firms in technologies, the number of each firm type is endogenous. By putting the focus on the technological differences and assuming sector-specific technologies, in general, variations of the skill/technology thresholds tend to induce the expected changes in the magnitude of each technological activity: All other things being equal, a decrease of the threshold z^* should lead to a decrease of the number of low-tech domestic firms and an increase of the number of high-tech exporting firms. However, note that the changes in the total number of each firm type would not necessarily coincide with the variations of z^*: The dominance of each firm type would be determined not only by the intra-industry competition, but also by the inter-industry competition, as well as by the inter-country/region competition. Once we depart from a highly stylized simple theoretical model, a priori, it is not possible to predict the potential outcomes. By developing a large-scale global CGE model incorporating recent theoretical advances in international trade, this paper aims to quantify the possible effects.

Tables 6 and 7 show the percentage changes of each firm type in each country/region under the RCEP. Concerning the variations of the low-tech domestic firms among the RCEP member states, it is shown that domestic firms decrease the most in Laos with a decrease of 96.68%. The decreases are also considerable in Australia, Viet Nam, Myanmar, and New Zealand, with decreases of 74.14%, 64.57%, 63.80%, 57.80%, respectively. Outside the RCEP, it is shown that India, Chile, and the EU also experience large decreases in domestic firms with decreases of 79.53%, 71.00%, 64.93%, respectively. On the other hand, with rises of the skill/technology thresholds, it is shown that the low-tech domestic firms increase in the Philippines, Canada, and Mexico by 5.12%, 15.96%, 67.96%, respectively.

Table 6. Effects on the domestic firms (% changes).

KOR	**CHN**	**THA**	**IDN**	**PHL**	**KHM**	**LAO**	**MMR**
−29.098	−36.253	−27.851	−35.328	5.118	−49.336	−96.676	−63.796
VNM	**MYS**	**SGP**	**BRN**	**JPN**	**AUS**	**NZL**	**CAN**
−64.567	−40.791	−35.242	−40.090	−32.076	−74.138	−57.797	15.961
MEX	**PER**	**CHL**	**USA**	**IND**	**EU**	**RoW**	**Mean**
67.959	−2.018	−70.999	−9.850	−79.525	−64.933	−27.858	−36.921

Table 7. Effects on the exporting firms (% changes).

KOR	**CHN**	**THA**	**IDN**	**PHL**	**KHM**	**LAO**	**MMR**
−27.374	25.683	10.130	19.396	−18.886	−39.194	7.018	29.683
VNM	**MYS**	**SGP**	**BRN**	**JPN**	**AUS**	**NZL**	**CAN**
25.352	33.625	27.904	−5.207	5.736	33.833	28.434	−33.405
MEX	**PER**	**CHL**	**USA**	**IND**	**EU**	**RoW**	**Mean**
−98.515	−0.544	70.353	7.169	65.109	57.046	9.653	10.130

Concerning the variations of the high-tech exporting firms among RCEP member states, it is shown that exporting firms increase the most in Australia with an increase of 33.83%. There are also significant increases in exporting firms in China, Myanmar, Viet Nam, Malaysia, Singapore, and New Zealand, with increases of 25.68%, 29.68%, 25.35%, 33.63%, 27.90%, 28.43%, respectively. Outside the RCEP, it is also shown that Chile, India, and the EU experience considerable increases in exporting firms in response to large decreases of domestic firms.

However, as noted before, the changes in the total number of each firm type do not necessarily coincide with the variations of z^*. In other words, the variations of domestic and exporting firms do not necessarily go in opposite directions. Among the RCEP member states, it is shown that both domestic and exporting firms decrease in Korea, Cambodia, and Brunei. Decreases of both firm types in the manufacturing sector should, of course, not necessarily be understood as an indication of negative economic performance. It may be a result of economic transformation to a more service-oriented economy as most developed countries have experienced. The next subsection addresses this issue.

4.3. Economic Transformation Effects

As economies develop, there is a continuous process of resource reallocation from lower productivity sectors to higher productivity sectors. Typically, over time most developed countries have transformed their economies from primary or manufacturing intensive ones to more knowledge-intensive service-oriented economies. For developing economies in transition, successful and timely structural transformation is crucial for sustainable economic development. We now investigate the impact of the RCEP on the economic transformation of countries. In the following analysis, we consider two measures of sectoral intensity of each country/region.

Table 8 reports the effects of the RCEP on the sectoral share of total production for each county/region. Sectoral final production includes all the intermediate inputs. We find that most RCEP member states transform to a more service-oriented economy after the RCEP. In particular, it is shown that Korea, Cambodia, and Brunei, which have faced decreases of firms (both domestic and exporting) in the manufacturing sector, transform into more service-oriented economies. On the other hand, we find slight expansions of the manufacturing sector and contractions of the service sector in China, Malaysia, and Singapore.

Table 8. Effects on the share of sectoral production (%).

		Primary	Manufac.	Service	Total
Korea	Base	2.7	50.0	47.3	100.0
	RCEP	1.8	44.2	54.0	100.0
China	Base	9.3	50.3	40.4	100.0
	RCEP	9.8	50.7	39.6	100.0
Thailand	Base	10.3	48.6	41.1	100.0
	RCEP	10.4	47.8	41.8	100.0
Indonesia	Base	15.9	33.9	50.2	100.0
	RCEP	15.5	33.6	50.9	100.0
Philippines	Base	15.2	32.6	52.2	100.0
	RCEP	15.1	31.5	53.4	100.0
Cambodia	Base	22.6	41.4	36.0	100.0
	RCEP	20.4	34.6	45.0	100.0
Laos	Base	47.3	24.0	28.7	100.0
	RCEP	47.1	21.6	31.4	100.0
Myanmar	Base	27.3	30.9	41.8	100.0
	RCEP	27.1	30.5	42.4	100.0
Viet Nam	Base	18.1	53.8	28.1	100.0
	RCEP	17.3	51.2	31.6	100.0
Malaysia	Base	8.0	45.8	46.2	100.0
	RCEP	8.1	46.7	45.2	100.0
Singapore	Base	0.3	31.6	68.1	100.0
	RCEP	0.3	32.0	67.7	100.0
Brunei	Base	43.3	1.6	55.1	100.0
	RCEP	34.6	1.5	63.9	100.0
Japan	Base	1.7	35.1	63.2	100.0
	RCEP	1.5	34.0	64.5	100.0
Australia	Base	10.7	14.8	74.5	100.0
	RCEP	9.8	14.1	76.1	100.0
New Zealand	Base	9.5	20.8	69.8	100.0
	RCEP	9.0	20.2	70.8	100.0
Canada	Base	9.9	22.0	68.1	100.0
	RCEP	8.3	20.2	71.5	100.0
Mexico	Base	6.9	36.1	57.0	100.0
	RCEP	5.7	32.1	62.2	100.0
Peru	Base	17.1	43.0	39.9	100.0
	RCEP	17.0	42.6	40.4	100.0
Chile	Base	12.0	25.7	62.3	100.0
	RCEP	13.3	27.3	59.5	100.0
USA	Base	3.8	25.8	70.4	100.0
	RCEP	3.9	25.9	70.2	100.0
India	Base	14.1	34.7	51.1	100.0
	RCEP	15.1	35.7	49.2	100.0
EU	Base	3.2	29.9	66.9	100.0
	RCEP	3.5	31.0	65.5	100.0
RoW	Base	16.4	28.1	55.4	100.0
	RCEP	16.1	27.6	56.3	100.0

We find the same pattern when we measure sectoral share using the value-added of each sector. Table 9 reports the effects of the RCEP on the sectoral share of value-added for each county/region. As before, among RCEP member states, all the counties except China, Malaysia, and Singapore transform into more service-oriented economies. Outside the RCEP, it is shown that Canada, Mexico, Peru, and other Rest-of-World countries also transform into more service-oriented economies, while Chile, USA, India, and the EU face slight expansions of the manufacturing sector.

Table 9. Effects on the share of sectoral value-added (%).

		Primary	Manufac.	Service	Total
Korea	Base	2.7	29.4	67.9	100.0
	RCEP	1.5	22.1	76.4	100.0
China	Base	15.1	28.3	56.6	100.0
	RCEP	16.3	28.6	55.1	100.0
Thailand	Base	13.2	27.0	59.9	100.0
	RCEP	13.3	26.1	60.6	100.0
Indonesia	Base	23.5	21.7	54.8	100.0
	RCEP	22.9	21.4	55.7	100.0
Philippines	Base	16.3	18.6	65.1	100.0
	RCEP	16.1	17.5	66.4	100.0
Cambodia	Base	32.2	26.5	41.3	100.0
	RCEP	27.5	18.6	53.9	100.0
Laos	Base	62.4	16.0	21.6	100.0
	RCEP	62.0	12.9	25.1	100.0
Myanmar	Base	40.1	9.4	50.5	100.0
	RCEP	39.5	9.0	51.5	100.0
Viet Nam	Base	28.3	31.7	40.0	100.0
	RCEP	25.9	28.2	45.9	100.0
Malaysia	Base	16.3	28.2	55.5	100.0
	RCEP	16.6	29.2	54.1	100.0
Singapore	Base	0.4	21.3	78.4	100.0
	RCEP	0.4	21.7	77.9	100.0
Brunei	Base	53.9	0.9	45.2	100.0
	RCEP	44.1	0.8	55.0	100.0
Japan	Base	1.4	17.8	80.7	100.0
	RCEP	1.2	16.7	82.1	100.0
Australia	Base	12.1	9.4	78.5	100.0
	RCEP	10.8	8.6	80.6	100.0
New Zealand	Base	8.7	13.5	77.8	100.0
	RCEP	8.1	12.8	79.1	100.0
Canada	Base	10.8	11.8	77.4	100.0
	RCEP	8.6	9.8	81.5	100.0
Mexico	Base	6.9	21.9	71.2	100.0
	RCEP	5.4	17.7	76.9	100.0
Peru	Base	20.6	33.6	45.9	100.0
	RCEP	20.4	33.1	46.5	100.0
Chile	Base	11.9	18.3	69.9	100.0
	RCEP	13.6	20.1	66.3	100.0
USA	Base	3.5	15.6	80.9	100.0
	RCEP	3.6	15.8	80.6	100.0
India	Base	19.9	13.8	66.4	100.0
	RCEP	21.8	14.7	63.6	100.0
EU	Base	3.6	17.1	79.3	100.0
	RCEP	4.0	18.3	77.6	100.0
RoW	Base	21.7	15.7	62.5	100.0
	RCEP	21.2	15.2	63.6	100.0

The technological quality of the service sector may be largely varied country by country. The entire service sector includes not only knowledge-intensive high-technology occupations, but also low-skill intensive manual occupations. In this sense, the expansion of the service sector in Korea might be understood differently (more favorably) from that of Cambodia and Brunei. Depending on the economic development stage, though some countries may put more focus on the development of the manufacturing sector, in general, we may conclude that the RCEP can be an effective policy option for most member states who want to transform their economy to a higher value-added service-oriented economy.

Finally, it should be reminded that all the reported simulation results had been obtained under the assumption of technological differences between sectors. Differently, from conventional large-scale CGE models assuming homogeneous labor and perfect mobility of labor between sectors, our model incorporates sector-specific technologies and assumes a given stock of labor in each sector employing such sector-specific technologies. Allowing perfect mobility of labor between sectors, implying that technologies are homogeneous and/or there are no costs to acquire other skills and technologies, does not capture the real productivity effects through technological switching mechanism. Moreover, with perfect mobility of workers between sectors, the sectoral share variations could be unrealistically large even with a small policy change. This paper formalized different technologies both within and between sectors, as well as between countries.

The results of this paper highlight, among others, that if technology would exhibit any increasing returns to skill, the equilibrium skill-technology assignment itself could generate considerable impacts for economy-wide productivity and for economic transformation, even when labors are perfectly immobile between sectors. Given the large economic magnitude of multilateral free trade agreements, such as the RCEP, the highlighted technology-upgrading or -downgrading effects should be pervasive globally.

Before concluding, it is noteworthy again that here we report only limited effects of the RCEP implementation. Other than tariff reduction, the RCEP also includes various measures for service and investment liberalization among member states, which may create much larger and complex implications for the global economy as a whole due to the highlighted technology-upgrading effects. For any policy choice, considering such effects should be important for successful economic transformation and sustainable development.

5. Conclusions

It is widely documented that most developed countries have typically experienced economic transformations during the development period. Though the concept of economic transformation is not a new one, a continuous and successful economic transformation is crucial for sustainable economic development. In particular, for developing and emerging economies, how to facilitate and maintain a continuous process of resource shifting from low-productive activities to higher-productive ones has been at the center of concern.

Recent research advances in international trade highlighted the productivity effect at the macro-level, due to heterogeneity of economic agents at the micro-level. There is now a large consensus that trade liberalization (or, more broadly, globalization) reallocates resources from less productive firms to more productive firms; furthermore, as more workers are associated with higher technologies, the economy-wide aggregate productivity increases. In today's globalized world, understanding such technological transformations at the individual worker and firm levels should be essential to understand economic and/or structural transformations as a whole.

In this paper, we developed a large-scale global CGE model in which firms employ different technologies and heterogeneous workers endogenously sort into different technologies based on their comparative advantage, so that aggregate productivity is determined by skill-technology assignment in equilibrium. By applying the model in the case of the RCEP, we investigated how multilateral free trade agreements, such as the RCEP, affect individual member states, as well as outside countries and regions. Overall, the results show considerable real productivity gains and economic transformation effects, due to the technology-upgrading mechanisms.

To evaluate and quantify the highlighted technology-upgrading effects, we abstained from some other issues, and several interesting extensions may also be promising. For example, we assumed sector-specific technologies and a given stock of labor in each sector employing such sector-specific technologies. Though such assumption might be more reasonable and realistic when considering between primary and highest value-added service sectors, some mobility might be more realistic between high value-added manufacturing and service sectors. Moreover, the degree of such labor market flexibility might be largely different county by county. Furthermore, technology gaps might be largely different sector by sector, as well as a county by country. Needless to say, dealing with such issues and exact estimations of additional behavioral and technological parameters require vast and detailed data, which are not available at the present time. This should be investigated by other researchers in future works.

Funding: The present research was supported by the research fund of Dankook University in 2021.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Conflicts of Interest: The author declares no conflict of interest.

Appendix A

Table A1. Sensitivity analysis: Effects of the RCEP for alternative elasticities (% changes) [1].

		1.1 Times (7.7)	1.3 Times (9.1)	1.5 Times (10.5)	1.7 Times (11.9)
RCEP Members Average	(1)	−24.042	−24.745	−34.615	−53.760
	(2)	0.150	0.390	0.651	0.939
	(3)	−47.729	−36.954	−45.195	−66.576
	(4)	2.264	9.522	10.409	19.868
World Average	(1)	−16.730	−18.026	−27.130	−33.904
	(2)	−0.065	0.159	0.385	0.483
	(3)	−34.842	−28.811	−36.921	−43.982
	(4)	1.338	7.547	10.130	11.453

[1] (1) Average effects on the thresholds; (2) average effects on the real productivity; (3) average effects on the domestic firms; (4) average effects on the exporting firms.

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