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The Effects of China's Participation in the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP): A Quantitative Assessment

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Abstract: This paper aims to quantify the effects of China's participation in the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP), in particular by focusing on the possible productivity effects through the endogenous assignment of skills to technologies. In this paper, we develop a large-scale global computable general equilibrium (CGE) model in which firms are heterogeneous in technologies and workers are heterogeneous in individual skill levels so that equilibrium skill–technology assignments are endogenously determined. This study contributes to the literature with the new CGE modeling and application to the recent important issue in international trade. By calibrating the model to 23 countries and regions, we quantify the effects of China's participation in the CPTPP. Due to the positive real productivity effects and the reallocation of workers, the results show that China's participation in the CPTPP may generate significantly higher productivity, GDP, and welfare effects compared to previous conventional CGE models based on simplistic representative agent frameworks at a given productivity. Globally, on average, the real productivity of the manufacturing sector, the number of exporting firms, real GDP, and welfare increase by 0.52%, 19.62%, 1.36%, and USD 3.41 billion, respectively.

Keywords: mega-FTA; Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP); China; skill–technology assignment; firm and worker heterogeneity; computable general equilibrium (CGE) model

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1. Introduction

As global competition intensifies, many countries have been pursuing regional free trade agreements for economic development and sustainable economic growth. In particular, as today's globalization process is occurring at a much finer level of disaggregation and increasingly complexifying by including many different countries to form a global supply chain, the regional free trade agreements have also been increasing in size and complexifying in contents (see, e.g., [1–3]).

As a part of such a movement, the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP) was signed on 8 March 2018, effective 30 December 2018. The CPTPP is a mega-FTA formed among 11 countries in the Trans-Pacific region (Vietnam, Malaysia, Singapore, Brunei, Japan, Australia, New Zealand, Canada, Mexico, Peru, and Chile). As the US withdrew from the initial agreement, the size has been reduced, but the current 11-member states still account for about 13% of world GDP. In particular, with the CPTPP's intention to expand, currently, several countries are seeking entry to the CPTPP and are in negotiations. Among others, China has also submitted a formal application to join the CPTPP. China has been eagerly pursuing FTAs as a national strategy to achieve economic development and to lead the international trade system by signing a total of 19 FTAs with 26 countries and regions by the end of 2021.

Table 1 shows the bilateral trade in the manufacturing sector between 23 countries and regions, where the 11 countries from (9) to (19) are current member states of the CPTPP (see Table 2 for country code descriptions). We can observe a close trade relationship between CPTPP member countries and China. China is the largest exporter of all member countries except only for Canada and Mexico, for which the US is the first exporter by the implementation of the United States–Mexico–Canada Agreement (USMCA). The portion of import from China accounts for about 26% of the total import of the CPTPP member countries. These countries are also important exporters for China, accounting for almost 30% of the total import of China. Overall, the current 11 CPTPP member countries account for about 15% of the world trade, and this portion increases to about 32% when China is included.

China is not only one of the two biggest economies in the region with the US, but also a core country in the global value chain perspective. After the withdrawal of the US from the Trans-Pacific Partnership (TPP), China is eager to strengthen its influence in the region by participating in the CPTPP. Though it is said that the negotiation would not be easy due to the high standards and high degree of openness of the CPTPP, it would be no doubt that China's participation in the CPTPP would largely affect the international trading system as well as individual countries. In particular, given the complex and highly disaggregated global supply and value chains in the region, as well as the key role of China in the region's manufacturing system, how China's participation in this new Mega-FTA system will affect the global economy through induced productivity effects is of great interest and needs to be studied in depth.

Using CGE approaches, numerous works have tried to assess the economic effects of the Trans-Pacific Partnership agreement, and few recent works have also attempted to assess the possible effects of China's participation in the CPTPP (see, e.g., [4,5]). Previous evaluations are, however, mostly based on conventional CGE models in which firms and workers are identical in their technology and skill level, which cannot capture important productivity effects coming from the interaction between technology and skill (see [6] and references therein). On the other hand, based on the heterogeneous agent framework, recent trade literature has been highlighting important productivity gains due to the selection effects of globalization: exporting firms are more productive and use higher technologies than domestic competitors (see, e.g., [7–12]). Closely related to this literature, recent research in international trade has also highlighted globalization-induced real productivity gains due to the worker-side selection effects (see, e.g., [13–19]). In such an environment, it should be of great interest to assess how China's participation in the CPTPP would affect global productivity and quantify the induced effects.

Faced with rising global challenges such as international trade conflicts and disruptions in global supply chains, we require systematic impact evaluations which enable us to study various economic transformations through technological changes and the allocation of workers to different technologies. Many countries have adopted free-trade-oriented strategies and actively pursued FTA negotiations for economic development and growth, and at the core of such policies lie the induced and expected productivity effects. In particular, when assessing the effects of a huge economic integration such as CPTPP, such potential productivity effects, and the resulting various micro and macro performance should be the key question to be addressed and studied in depth.

The aim of this paper is to quantify the effects of China's participation in the CPTPP using a CGE model incorporating heterogeneous firms and workers. This study extends the previous conventional CGE model by explicitly modeling heterogeneous firms and workers. Firms are heterogeneous in technologies with exporting firms using higher technologies. Furthermore, workers are heterogeneous in individual skill levels so the sorting of workers into different technologies occurs endogenously based on workers' respective comparative advantages. Thus, in our framework, workers' productivity reflects both individual skill level and assigned technology, and assignments of skills to different technologies are endogenously determined within the model.

Table 1. Bilateral trade (manufacturing, millions USD; exports from row to column).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)
(1)	0	191,611	8864	12,835	9355	592	149	783	24,102	7582	9300	306	30,785	9842	2008	7118	14,099	1401	2267	63,290	13,387	49,370	107,630
(2)	106,213	55,377	41,558	37,495	23,164	3935	1900	9166	65,518	50,393	26,935	1597	183,634	50,153	6853	61,458	79,626	8869	15,495	443,567	67,483	418,050	558,635
(3)	4714	34,941	0	9482	5759	4493	3291	4902	7945	12,663	4500	89	20,136	9972	1429	2664	3523	548	691	23,666	6050	22,506	33,026
(4)	4395	13,221	4608	0	2898	386	2	550	2241	5841	6445	90	12,257	3611	517	1347	1104	243	210	17,598	6416	16,036	23,710
(5)	1972	15,479	2617	735	0	4	0	15	661	1201	2680	3	8845	939	52	1110	629	23	50	8958	451	7273	4714
(6)	176	308	474	15	21	0	0	0	304	121	68	0	735	108	5	853	101	9	20	3187	11	4319	556
(7)	14	447	754	41	0	5	0	0	497	0	6	0	66	1	3	13	0	0	0	26	2	246	38
(8)	541	12,126	107	52	4	1	0	0	17	82	29	0	780	20	0	9	8	0	1	130	41	456	176
(9)	7135	18,802	3633	2614	1652	2293	382	331	0	2953	1406	3	13,152	2192	362	2754	1439	208	453	27,862	2851	26,211	19,897
(10)	5436	53,570	11,117	7017	3414	231	20	613	4166	0	15,903	616	12,733	5094	914	2321	2837	124	253	24,805	7644	23,214	26,505
(11)	8429	36,576	7885	21,391	3477	499	61	1458	6469	20,693	0	1063	8904	8143	1135	867	498	21	25	12,434	5869	12,805	23,198
(12)	40	46	27	19	6	0	0	0	9	15	43	0	21	6	0	5	0	0	0	24	6	121	39
(13)	53,557	221,813	36,745	16,434	9186	226	132	1195	13,388	16,163	11,569	122	0	16,825	2905	13,247	18,816	1049	2215	124,103	9249	79,260	125,385
(14)	2893	12,283	2626	2359	472	16	22	27	1122	4190	1430	14	5185	0	4632	940	212	117	158	6227	2602	5609	16,706
(15)	895	5995	591	643	586	1	0	18	416	728	263	1	1834	5341	0	358	280	119	105	2233	120	1846	6182
(16)	2420	14,046	770	1416	282	3	10	13	381	634	814	11	4407	1455	360	0	7932	379	659	209,768	1545	26,335	17,162
(17)	1732	6725	567	156	130	1	0	8	190	318	1525	4	2573	1484	190	24,960	0	1845	2155	237,158	527	15,035	29,829
(18)	259	2074	65	32	4	0	0	2	83	5	21	0	535	88	20	2184	190	0	811	3926	106	2357	8078
(19)	2709	11,837	279	199	24	0	0	1	375	137	60	0	2343	863	77	1165	1088	1188	0	6737	239	5871	10,141
(20)	36,411	128,211	11,855	4941	6610	291	14	139	4486	10,327	25,990	185	47,415	23,295	4708	231,409	188,891	7085	13,647	0	16,502	240,259	298,350
(21)	4321	15,264	3109	3445	1074	142	33	858	3369	3693	3509	22	6671	2940	374	3021	3354	780	609	38,457	0	48,891	113,821
(22)	49,695	244,382	18,254	11,496	8272	301	182	604	7507	17,596	26,007	386	66,380	37,345	6771	49,061	37,150	4052	9235	356,945	37,236	2,955,828	977,505
(23)	45,584	275,832	26,821	20,822	9824	840	17	495	18,684	22,656	32,242	51	63,374	15,706	2076	25,028	16,976	5976	7938	212,653	77,397	560,329	642,144

Note: (1) KOR (2) CHN (3) THA (4) IDN (5) PHL (6) KHM (7) LAO (8) MMR (9) VNM (10) MYS (11) SGP (12) BRN (13) JPN (14) AUS (15) NZL (16) CAN (17) MEX (18) PER (19) CHL (20) USA (21) IND (22) EU (23) RoW. Source: GTAP 10 Data Base, 2014.

Table 2. Countries and regions.

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

Given this basic setup, we construct a large-scale 23-country/region 3-sector global CGE model and investigate the possible effects of China's participation in the CPTPP in this framework. In particular, we investigate the effects on real productivity, exporting firms, real GDP, and welfare by comparing two cases: CPTPP11 vs. CPTPP11+China. The considered region is highly related to each other, particularly in the manufacturing system with China as a core country, and the international division of labor is occurring at a highly disaggregated level. Thus, China's participation in the CPTPP will cause a big impact on the region's international manufacturing system, and in particular, will induce various country-wide productivity effects through a large reallocation of labor across technologies and tasks. As will be shown later, differently from conventional CGE models based on simplistic representative agent frameworks at a given productivity, our model is capable of capturing such productivity effects through the endogenous assignment of skills to technologies. This study contributes to the literature with the new CGE modeling and application to the recent important issue in international trade of the CPTPP expansion and China's participation. Given the economic size and the core position in the global manufacturing system, China's participation in the CPTPP may affect the global economy in both magnitude and direction. Overall, it is shown that China's participation in the CPTPP generates significantly higher productivity, GDP, and welfare effects, whereas some countries may be affected negatively.

The rest of the paper is organized as follows. In Section 2, we describe briefly the basic theoretical model and explain the endogenous skill–technology assignment mechanism. In Section 3, we describe the data and model calibration for the CGE application. In Section 4, we study the effects of the CPTPP and the expansion of the CPTPP with China's participation on real productivity, exporting firms, real GDP, and welfare. Section 5 provides a brief discussion and concludes with some concluding remarks.

2. Model Description

Recent theoretical developments in international trade have highlighted various selection effects of trade stemming from heterogenous agents. In many aspects, firms are largely different even within narrowly defined industries. In particular, there is now ample evidence that firms are largely heterogenous in their productivity and used technologies. Many systematic links between firms' productivity (technology) and their internationalization status have been uncovered. Among others, it is now widely documented that exporting firms are more productive and use higher technologies than non-exporting domestic firms; in other words, more productive firms self-select into export markets and experience technological upgrading. See for example Bernard and Jensen [20] for the US, Bernard and Wagner [21] for Germany, Clerides et al. [11] for Colombia/Mexico/Morocco, Aw et al. [10] for Taiwan/Korea, Sun and Hong [22] for China, and Girma et al. [12] for Ireland. Research on this firm-side heterogeneity and the associated effects are referred to as firm heterogeneity literature in international trade.

Closely related to this literature, recent theoretical advances in international trade also emphasize worker-side heterogeneity. Workers are heterogeneous in their skill (or ability) level and more productive workers self-select into higher technologies (or tasks). Thus, workers' productivity reflects not only their own skill level but also the technology they are attached to. Such equilibrium skill–technology assignment would generate considerable implications for market structure and economic performance. We incorporate such endogenous assignment of skills to technologies into a large-scale global CGE model. In this section, we describe briefly the new modeling structure.

2.1. Technologies

Firms are free to enter the market and there are two types of firms: exporting and domestic firms. Choosing either type requires a strategy-specific technology $j \in \{L, H\}$: exporting firms employ high-technology H, whereas domestic firms employ low-technology L. Adopting either technology is associated with technology-specific fixed costs with

$f_H > f_L$. With free entry in monopolistic competition, markup revenues exactly cover the fixed costs in equilibrium. By expressing the fixed setup costs in terms of foregone outputs, we have:

$$\frac{1}{\sigma}p_L x_L = c_L f_L \text{ and } \frac{1}{\sigma}p_H x_H = c_H f_H, \tag{1}$$

$$p_L = \frac{\sigma}{\sigma-1}c_L \text{ and } p_H = \frac{\sigma}{\sigma-1}c_H, \tag{2}$$

where σ is the elasticity of substitution between varieties, and c_L and c_H are the unit production costs. We will drop the country and industry index when no confusion can arise.

2.2. Skills

Workers are heterogeneous in their individual skill level z. Workers' productivity reflects both individual skill level and assigned technology. Let us denote $\varphi_j(z)$, $j \in \{L,\ H\}$, the technology-augmented labor productivity of a worker with skill level z. The existence of increasing returns to scale between skill and technology implies that there would be a sectorial skill threshold (z^*): workers sort into two different firm types using two different technologies. Workers choose technologies (tasks) based on their comparative advantage, so that higher skilled workers are assigned to high technology whereas lower skilled workers are assigned to low technology. Workers are paid their marginal product and the equilibrium sectorial skill thresholds are endogenously determined in each country. Following no-arbitrage conditions should be satisfied:

$$w_L \varphi_L(z^*) = w_H \varphi_H(z^*), \tag{3}$$

where w_L and w_H denote technology-specific efficiency wage rates which will be determined in the labor market.

2.3. Assignment of Skills to Technologies

Conventional CGE models are based on a representative agent framework and international trade is mainly driven by demand-side forces. The conventional Armington framework assumes that firms are identical under perfect competition and goods are differentiated only by region of origin [23]. More recently, the Krugman framework with imperfect competition and increasing returns to scale assumes that goods are differentiated at the firm level, but firms are still identical in technology [24].

Our main departure from previous conventional frameworks is that firms are not homogeneous in their technology and workers are not identical in their skill level, and the assignment of skills to technologies is endogenously determined. Such a new feature may generate new important implications for economic integration, in particular in terms of aggregate productivity and the related effects. A leftward movement of the skill threshold (z^*) in a sector implies that more workers are allocated to high technology in that sector, which leads to an improvement in average productivity in that sector. Conversely, a rightward movement of the skill threshold (z^*) in a sector implies an expansion of low technology and a contraction of high technology in that sector. However, following any policy change in the real world where all countries and sectors are highly interdependent, it is a priori not possible to predict how such a change will affect each country and each sector: the variations of z^* will be different country by country, as well as sector by sector, which may yield new important productivity implications that were not captured by conventional models.

2.4. Measurement of Real Productivity

Based on our model specification, real labor productivity can be measured as the technology-augmented efficiency units of labor at a given labor supply and at a given skill distribution:

$$\int_{z_{min}}^{z^*} \varphi_L(z)g(z)dz + \int_{z^*}^{z_{max}} \varphi_H(z)g(z)dz. \quad (4)$$

As explained before, in our framework workers' productivity reflects both individual skill level and assigned technology: with an equilibrium threshold z^*, workers with $z \in (z_{min}, z^*)$ are matched with low technology, whereas workers with $z \in (z^*, z_{max})$ are matched with high technology. Thus, Equation (4) represents the total technology-augmented efficiency units of labor in the sector, which varies with the equilibrium threshold z^* in each country.

This study incorporates the above features into a large-scale CGE model and investigates the effects in the case of the CPTPP and its expansion with China. A full system of equations for a simple two-country case can be found in Jung [25].

3. Data and Calibration

For a large-scale CGE application, we need first to construct a global social accounting matrix (SAM), which represents all the flows of economic transactions between countries and sectors. It is necessary that we require a comprehensive and huge data set covering all such transactions. In this study, we construct the global SAM for the model using the GTAP 10 Database [26]. Due to its comprehensive coverage, the GTAP database has been used most widely for global multi-country/region CGE models. The most recent GTAP database (version 10) covers 141 countries/regions and 65 sectors and reports various macroeconomic variables including bilateral trade information between all the countries and regions.

Given our objective, countries/regions are aggregated as in Table 2. Currently, two mega-FTAs are ongoing: the CPTPP and the RCEP. The two large multilateral free trade agreements have competitively been pursued in the region, and numerous countries participate in both the CPTPP and the RCEP. Given the possibly close interactions, this study considers all the countries participating in any of the two mega-FTAs. In Table 2, 15 countries (#1–15) are current member countries of the RCEP, whereas 11 countries (#9–19) are current member countries of the CPTPP. A total of 7 countries (Vietnam, Malaysia, Singapore, Brunei, Japan, Australia, and New Zealand) are participating in both the CPTPP and the RCEP. In the current GTAP Database (version 10), the data for Myanmar includes East Timor too. With the very small economic size of East Timor, however, its inclusion would not affect the main results of this study.

Industries have been aggregated into three main sectors: primary, manufacturing, and service. Following conventional practice, perfect competition has been assumed in primary and service sectors, whereas our endogenous skill–technology assignment framework has been applied to the manufacturing sector.

We specify the technology schedules by assuming linear technologies:

$$\varphi_j(z) = c + a_j z, \;\; j \in \{L,\, H\}, \quad (5)$$

and based on empirical evidence (see, e.g., [20]), we set $c = 1$ and $a_H/a_L = 1.18$. There is a continuum of skill levels, which is uniformly distributed on a normalized support [0, 1].

All the necessary elasticity information has been taken from the GTAP 10 Database. We calibrate the fixed setup costs f_j, $j \in \{L,\, H\}$ so that initially the shipments of exporting firms are 58% larger than non-exporting domestic firms. We exactly reproduce the initial SAM by calibrating all the other parameters and fixed variables to the data.

4. Results

Given our model construction and calibration, in this section, we investigate the effects of China's participation in the CPTPP. For comparison purposes, the effects of CPTPP 11 formation are also reported using our endogenous skill–technology assignment framework.

4.1. Effects on Real Productivity

As described before, the main difference between our framework from conventional CGE models is that in our model the skill/technology thresholds (z^*) are endogenous. Following trade policy changes, how the thresholds are affected in each country and how such variations affect the overall productivity of each country are of great interest.

We measure the real productivity using Equation (4). Figure 1 shows first the effects of the CPTPP 11 formation on real productivity, whereas Figure 2 shows the effects when China joins the CPTPP. We can observe first the overall positive impact of China's participation on global productivity. It is shown that the CPTPP 11 formation increases the global average productivity by 0.14%, whereas it increases by 0.52% when China joins the CPTPP too. Some countries may be affected negatively. In Figure 1, numerous countries/regions are affected negatively. Among them, it is shown that Vietnam and Canada are affected the most negatively, by −0.70% and −0.93%, respectively.

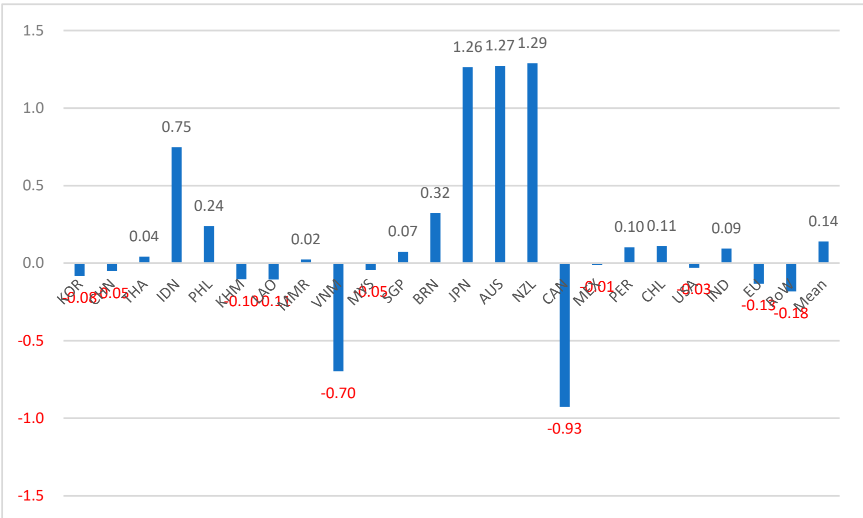

Figure 1. Effects on real productivity (% changes): CPTPP 11.

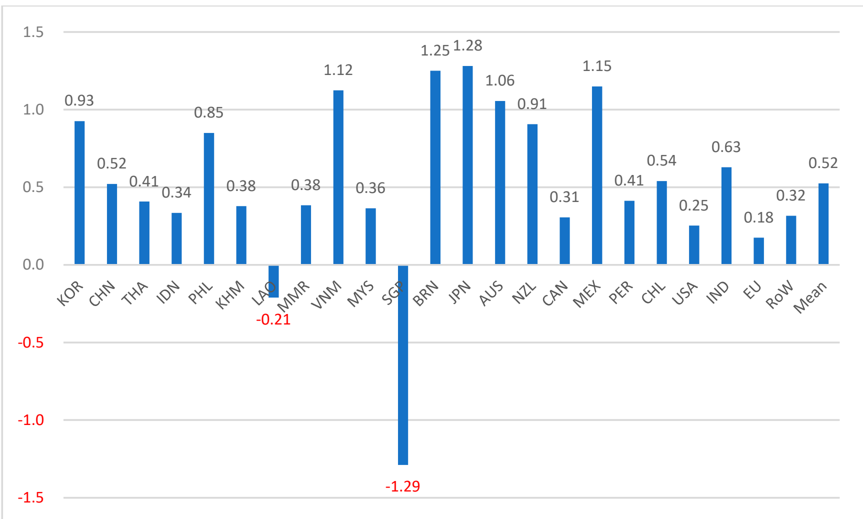

Figure 2. Effects on real productivity (% changes): CPTPP 11 + CHN.

On the other hand, as can be seen in Figure 2, China's participation in the CPTPP generates in general positive real productivity gains except only for Laos and Singapore. In particular, Singapore's real productivity measure is shown to decrease by 1.29%. However, it should be noted that the real productivity effects in the manufacturing sector would not necessarily coincide with other macroeconomic effects. Even though the manufacturing sector may be contracted, the country's GDP may increase if other sectors will be affected more positively. As will be shown soon, it is indeed the case for Laos and Singapore.

4.2. Effects on Exporting Firms

As explained before, one of the main departures of our model from the conventional CGE model in the framework of Armington or Krugman is the incorporation of heterogeneous firms using different technologies. Exporting and domestic firms compete in the national and global markets and the number of each firm type is determined endogenously. A leftward shift of the threshold z^* implies, other things being equal, an expansion of exporting firms using high technology and a contraction of domestic firms using low technology. Thus, in general, changes of the skill/technology thresholds tend to induce similar effects on the number of firm types.

Figure 3 shows the effects of the CPTPP 11 formation on the exporting firms, whereas Figure 4 shows the effects when China joins the CPTPP. Overall, Figures 3 and 4 show similar patterns as shown in Figures 1 and 2. As before, it is shown that Singapore is affected the most negatively in terms of the number of manufacturing exporting firms. However, looking at the other variables more in detail, it is shown that Singapore's service sector expands considerably so that Singapore transforms into a more service-oriented economy. Though quite similar patterns might be observed, it should, however, be noted that the effects on the total number of each firm type would not necessarily coincide with the changes in z^*. The equilibrium market structure with different firm types will be simultaneously determined by all the intra-industry, inter-industry, and inter-country/region competitions. Such heterogeneous firm and worker links through endogenous technology-skill assignments cannot be captured by conventional CGE models assuming homogeneous firms and workers.

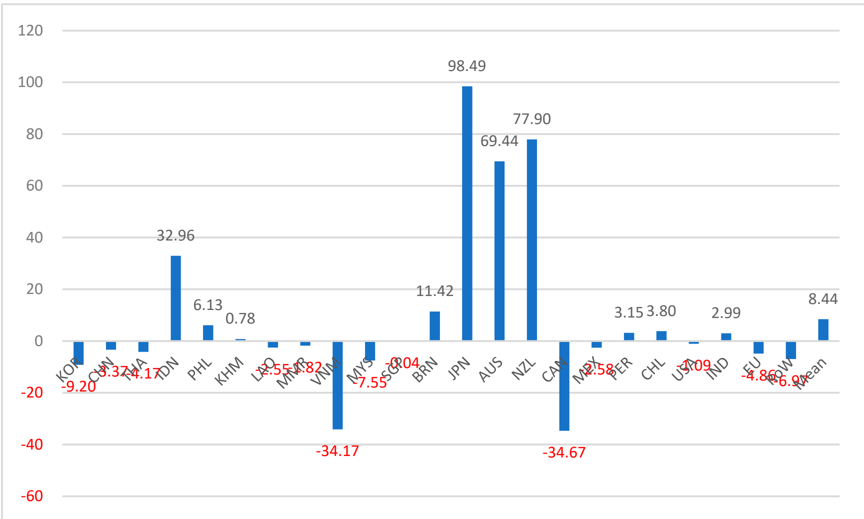

Figure 3. Effects on exporting firms (% changes): CPTPP 11.

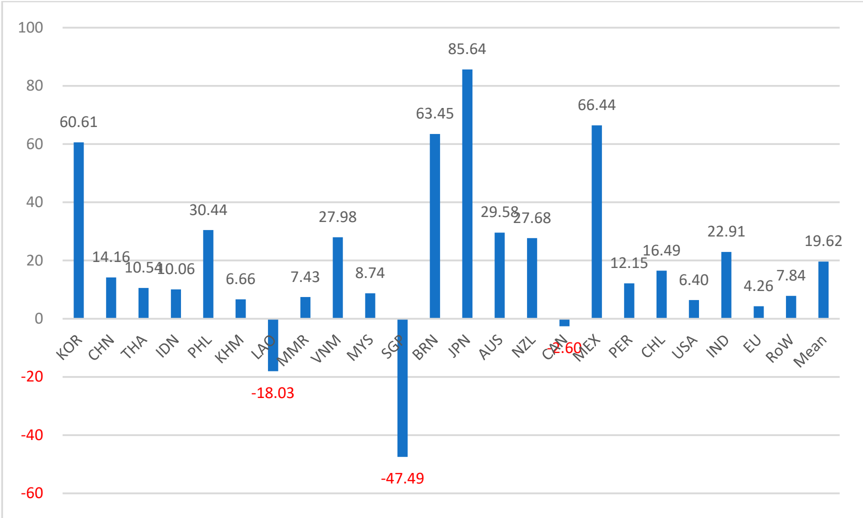

Figure 4. Effects on exporting firms (% changes): CPTPP 11 + CHN.

4.3. Effects on Real GDP

We now investigate the effects on real GDP of each country and region. Figure 5 shows the effects of the CPTPP 11 formation on the real GDP, whereas Figure 6 shows the effects when China joins the CPTPP. We can observe as before the overall positive impact of China's participation on global GDP. It is shown that the CPTPP 11 formation increases the average global GDP by 0.44%, whereas it increases by 1.36% when China joins the CPTPP too. Figure 6 shows that China's participation in the CPTPP increases significantly GDP of all the countries and regions except for Brunei that faces a slight fall of −0.27%.

In particular, in Figure 6, we can see that the GDP of Laos and Singapore increases significantly, though they were the two countries whose manufacturing sector was shown to have some negative impacts with China's participation. As mentioned before, the impacts on the manufacturing sector do not necessarily coincide with the general effects on GDP. Laos and Singapore have comparative advantage in the agricultural and service sectors, respectively. In the base data, Laos' share of primary sector production is 47.3% and Singapore's share of service sector production reaches 68.1%. China's participation in the CPTPP strengthens further their comparative advantage so that they realize the most positive GDP effects. Figure 6 shows that Singapore's GDP increases the most with an increase of 6.10%, and Laos' GDP increases by 2.48% after Vietnam, whose GDP increases by 5.32%.

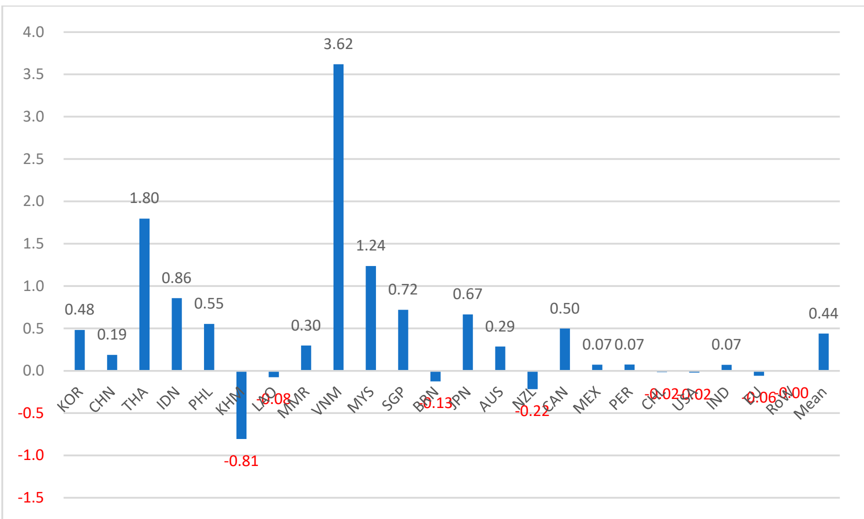

Figure 5. Effects on real GDP (% changes): CPTPP 11.

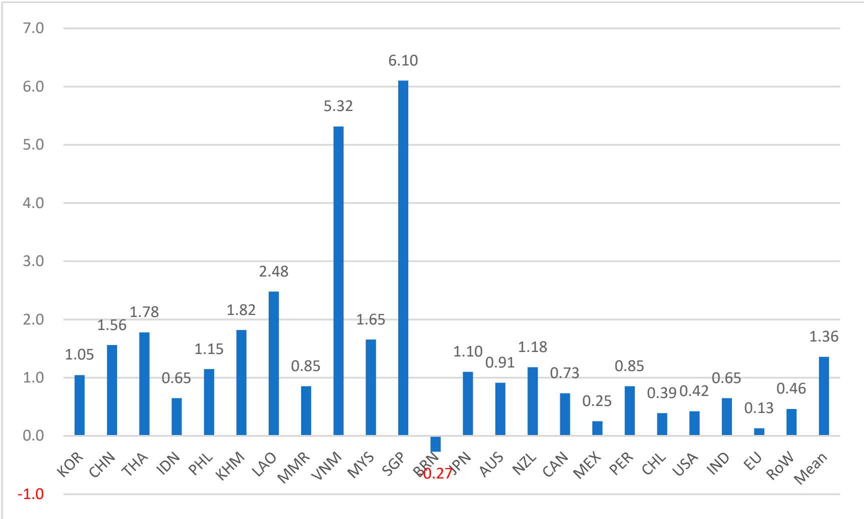

Figure 6. Effects on real GDP (% changes): CPTPP 11 + CHN.

4.4. Effects on Welfare

Finally, Figures 7 and 8 report the calculated Equivalent Variation (EV) welfare measures. Figure 7 shows the welfare effects of the CPTPP 11 formation, whereas Figure 8 shows the welfare effects when China joins the CPTPP too. Again, it is shown in general that China's participation in the CPTPP yields more positive welfare effects. It is shown that the CPTPP 11 formation increases the average consumer welfare by USD 2.56 billion, whereas it increases by USD 3.41 billion when China joins the CPTPP too. Overall, based on the endogenous skill–technology assignment and the induced technology-upgrading mechanisms, our model predicts significantly higher positive effects compared to previous conventional CGE models assuming homogeneous firms and workers without considering the close interactions between skills and technologies.

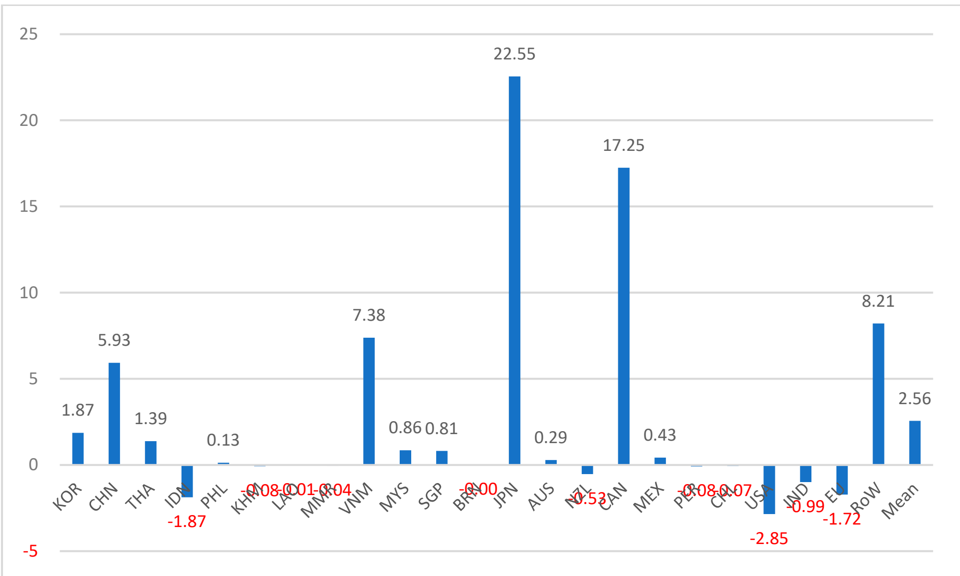

Figure 7. Effects on welfare (EV, billions USD): CPTPP 11.

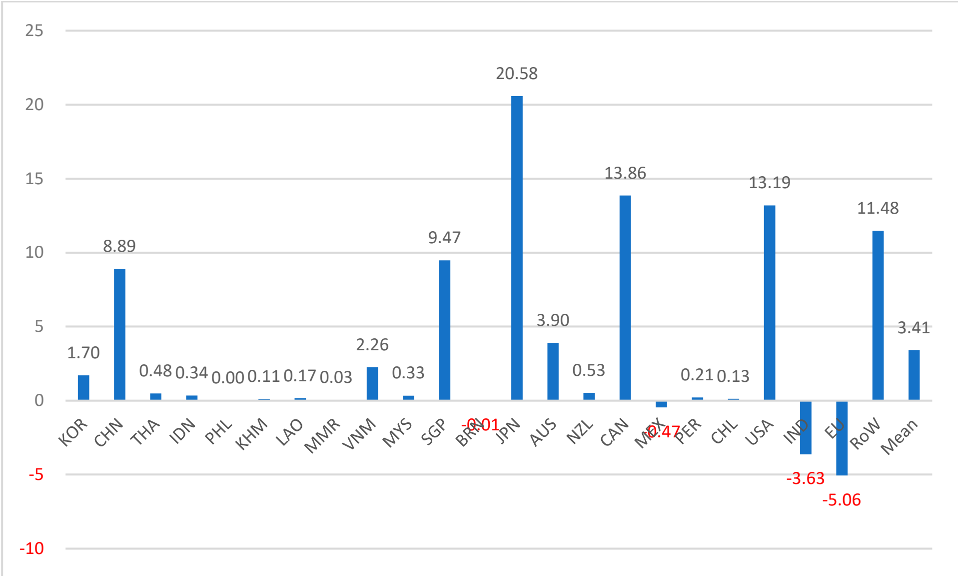

Figure 8. Effects on welfare (EV, billions USD): CPTPP 11 + CHN.

5. Discussion and Conclusions

As the US withdrew from the initial Trans-Pacific Partnership (TPP) agreement, the current agreement of the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP) was signed in 2018 by the remaining 11 countries, which is also known as TPP11 for that reason. On the other hand, the TPP agreement and its negotiations had begun as an expansion of the previous Trans-Pacific Strategic Economic Partnership Agreement (TPSEP) among Brunei, Chile, New Zealand, and Singapore, which had been signed in 2005. Since the current CPTPP agreement has a long history of evolution in an ever-changing environment, though there have been many works studying possible economic effects of this movement, no studies are directly comparable to ours. Not surprisingly, most previous studies in the literature considers the TPP12 including the US. However, as the US officially withdrew from the TPP in 2017, the policy implications obtained from previous studies are already obsolete. Furthermore, it is only very recently that China submitted a formal application to join the CPTPP (on 16 September 2021) to replace the role of the US in the region and to lead the global trade system.

Nevertheless, two recent works were found which consider such an up-to-date environment. Using a CGE model added a monetary structure, Li and Whalley [5] analyze the effects of China's participation in the CPTPP. They consider both border tariff elimination and trade cost elimination. In the case of border tariff elimination, New Zealand, Peru, and Brunei are affected negatively, with decreases of GDP by 0.45%, 0.42%, and 7.80%, respectively, whereas in terms of utility, Australia, New Zealand, Singapore, and Peru are affected negatively, with decreases by 0.14%, 0.17%, 0.13%, and 0.04%, respectively. On the other hand, in the case of non-tariff trade cost elimination by assuming a decrease of 40%, they report that all member countries gain in GDP except for Brunei, whereas in terms of utility all member countries gain. They conclude that China's participation in the CPTPP will significantly increase other member countries' benefits as well as for China. Another recent research by Petri and Plummer [4] leads to a similar conclusion. Using a CGE model based on their previous work [27], they report the likely real income effects by 2030 when China participates in the CPTPP. They conclude that China's participation in the CPTPP would yield large economic and political benefits for all other member countries as well as for China. In particular, they estimate that global income gains would quadruple from USD 147 billion to USD 632 billion when current CPTPP and Chinese membership in the CPTPP are compared. Though the above two models lead overall to similar global effects, detailed predictions are different quantitatively and even qualitatively in some cases. In terms of the model structure, one obvious difference may lie in the production-side modeling. Whereas

Li and Whalley [5] use a representative producer framework, Petri and Plummer [4] adopt firm heterogeneity à la Melitz [7] for some sectors. On the other hand, both models do not consider the worker-side heterogeneity and the assignment of different skills to different technologies. Consequently, previous results do not reflect important productivity effects coming from the technology upgrading mechanism of individual workers and firms.

In this paper, we developed a large-scale 23-country/region 3-sector global CGE model in which firms employ different technologies, and heterogeneous workers in individual skill levels endogenously sort into different technologies (tasks/occupations) based on their individual comparative advantage. Differently from conventional CGE models based on simplifying representative agent frameworks, the endogenous skill–technology assignment framework of this paper has provided important implications for global productivity and the induced effects in the case of the CPTPP's expansion.

Overall, it was shown that China's participation in the CPTPP would generate significantly higher productivity, GDP, and welfare effects. In particular, due to the positive real productivity effects and the reallocation of workers, it was shown that China's participation in the CPTPP would significantly increase the GDP of all the countries and regions considered except for Brunei which might face a slight fall of −0.27%. It is remarkable that even non-member countries and regions may also be positively affected in terms of real productivity and GDP.

In general, our results show significantly higher positive effects compared to previous studies. Such results should be attributed to our new modeling which is firmly rooted in recent theoretical advances in international trade. Firms are heterogeneous in their technologies and workers are heterogeneous in their skill levels. The technology–skill matching is not exogenously determined, but it is a choice variable. Workers choose their occupations and/or technologies based on their comparative advantage, and at the same time, the skill demands of heterogeneous firms are also endogenously determined. Broadly said, globalization induces more efficient firms to expand, whereas inefficient firms are forced to exit from the market, which implies in turn more workers are attached to higher technologies. Such a technology-upgrading mechanism and the resulting productivity and growth effects should be at the center of concern for any policy consideration. The results of this study reveal that such a mechanism may generate important productivity gains which could not be captured by previous models.

Though this study has provided new implications on the productivity effects of economic integration in the case of the CPTPP expansion with China's participation, several limitations are noteworthy. In terms of the model parameters, the technology gaps between domestic and exporting firms should be crucial for the quantitative results as well as for qualitative implications in some cases. Currently, no unified estimates are available for each sector and each country. More elaborated and disaggregated estimates for the technological parameters would be required for further extension and disaggregation of the model for various policy scenarios. Similarly, in terms of the modeling, further elaboration of the worker-side heterogeneity by incorporating explicitly various skill distributions which are supported empirically would be another promising and valuable research direction. Additionally, in terms of the policy implications, this study focused on tariff elimination, which is obvious and visible during the integration process. However, the reduction in various non-tariff barriers is another important aspect of the free trade agreement. Considering those effects, though by estimations, might reinforce even further the previously highlighted productivity effects. Furthermore, the expansion of the CPTPP seems very likely to continue. Currently, the UK, Taiwan, Ecuador, and Costa Rica have also formalized their request to join the CPTPP. On the other side, to lead the international trade system against China, the US is seeking to form a new economic framework that goes beyond the CPTPP. All such movements will also largely affect the global economy through the skill–technology reassignments. I leave them for future research.

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