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Economic Effects of a (hypothetical) UK-Korea-Japan FTA on GDP, Trade, and Welfare of UK, Korea, Japan, China, and the EU: a CGE Analysis

*Chae-Deug Yi*¹

Abstract

This paper examines the effects of the existing UK–Korea Free Trade Association (FTA) and the UK–Korea–Japan FTA (to be created) on member and non-member countries' real GDP, welfare, and trade, using a general equilibrium model. For (potential) members, a trilateral UK–Korea–Japan FTA will be the more beneficial compared to the bilateral UK-Korea FTA. Such a trilateral FTA will increase GDP and exports; however, non-member countries will see a decrease of manufactured product exports to the UK, Korea, and Japan. The trilateral FTA provides greater welfare gains than the UK-Korea FTA. Although the trilateral FTA members will observe big trade creation effects for imports, China and the EU 27 countries will possibly face a decrease of imports due to this FTA.

Keywords

Free Trade Agreement, UK–Korea–Japan, Welfare, Export, Trade Creation

JEL Classification

F10, F11

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1. Introduction

The European Union (EU)–South Korea Free Trade Agreement (FTA) was formally ratified in December 2015. The EU-Japan Economic Partnership Agreement (EPA) was implemented in 2019. The United Kingdom (UK) finally implemented Brexit in January 2020, which was followed by a transition period until the end of 2020. The UK-Korea FTA was signed in August 2019 and entered into force in January 2021. The EU–Korea FTA will form the basis of economic and trade relations between the UK and Korea. However, the current rules on trade, travel, and business for the UK and the EU continue to apply during the transition period. The Withdrawal Agreement outlined how the UK would continue to be covered by EU–third country trade agreements until December 2020.

Following the UK–Korea FTA signed in 2019, Japan tried to establish the UK–Japan FTA to overcome the threat of trade shrinkage between the UK and Japan. The UK–Japan FTA was finally signed in October 2020. Both FTAs entered into force in January 2021. Of course, given the current political conflict between Korea and Japan, the UK–Korea–Japan FTA is unlikely to bear immediate fruit. For evaluating the effects of FTAs on an economy, the Computable General Equilibrium (CGE) models have been among the main tools since the late 1980s.

As the UK–Korea FTA was only enforced in 2019, and the UK–Japan FTA in 2020, most previous studies could not take these FTAs into account. Therefore, as there are currently few studies that analyze the UK–Korea, UK–Japan, and UK–Korea–Japan FTAs, this study is crucial and timely. In this study, we include China and the EU 27 countries, as China is Korea’s and Japan’s neighbouring trade competitor and the EU 27 countries may feel the effects of the UK–Korea–Japan FTA.

Thus, we use CGE models to assess the effects of the UK–Korea and (hypothetical) UK–Korea–Japan FTAs on member and non-member countries’ real GDP, welfare, and exports as follows.

First, this study sheds light on the economic impact of the UK–Korea and UK–Korea–Japan FTAs on the GDPs of the UK, Japan, Korea, China, and the EU 27 countries. Second, this study includes the economic impact of these FTA scenarios on UK, Japan, Korea, China, and EU 27 exports using CGE models and simulation scenarios.

Third, using simulation scenarios, this study investigates how the removal of import tariffs in manufactured product sectors by the UK, Korea, and Japan will affect welfare levels. Fourth, this study analyses how the removal of import tariffs induces trade creation and trade diversion effects for these several bilateral or trilateral FTAs. Finally, this study provides policy implications and scope for future work.

The paper is organized as follows. Section 2 provides an overview of previous studies, while Section 3 explains the methodology used to assess the data and create simulation scenarios. The fourth Section analyses the results of the simulation scenarios and Section 5 concludes the paper and discusses the study's limitations.

2. Literature Review

Since the discussion on and implementation of FTAs, several studies related to trade and export expansion were conducted. The CGE model has been one of the common tools used to examine the economic effects of FTAs.

Lee, Roland-Holst, and Van der Mensbrugge (2001) dealt with the general equilibrium assessments of trade liberalization in Asia-Pacific Economic Cooperation (APEC) countries. Dixon and Rimmer (2002) used dynamic general equilibrium modelling for forecasting and policy development. Dixon (2006) examined evidence-based trade policy decision-making and the development of CGE modelling in Australia. Brown, Deardorff, and Stern (1996, 2001), Lee and Roland-Holst (1998), and Ackerman and Gallagher (2014) used CGE models to analyse the effects of FTAs on economies, such as those in the Pacific Basin and East Asia.

Balistreri and Rutherford (2013) used the CGE theories of monopolistic competition and heterogeneous firms associated with the Melitz (2003) model. Zhai (2008) introduced firm heterogeneity in a global CGE model of trade, using the

Armington (1969) and Melitz (2003) models. Hertel (2013) and Akgul (2017) examined globally applied general equilibrium analysis, using the global trade analysis framework. Walmsley and Minor (2015) estimated the benefits of improved customs efficiencies within the World Trade Organization's (WTO) Trade Facilitation Agreement, using CGE models.

Norsten and Burlutska (2012) analysed interviews and trade statistics data from a Swedish manufacturing company. Lakatos and Nilsson (2017) examined uncertainty about the EU–Korea FTA as well as its impact. Nilsson (2018) studied the economic modelling of FTAs. Dixon *et al.* (2018) incorporated the Armington (1969), Krugman (1979, 1980, 1981), and Melitz model as a special case of an encompassing model. Yi (2020) analysed the impact of the EU-Korea FTA's removal of tariff and non-tariff measures.

With the UK–Korea FTA being enforced in 2019 and the UK–Japan FTA in 2020, the above studies have not been able to analyse these FTAs, as well as the hypothetical UK–Korea–Japan FTA. Thus, unlike previous studies, this study investigates the economic effects of the removal of import tariffs using CGE models.

Although many studies examined import tariffs in this context, this study also investigates the trade creation and trade diversion effects of FTAs. Further, this study will be the first to analyse the economic effects of the UK–Korea, UK–Japan, and the (potential) UK–Korea–Japan FTAs associated with the realization of UK's Brexit in January 2020.

3. FTA Models, Data, and Scenarios

3.1. A framework of the CGE model

In international trade, we assume that domestic and imported goods are differentiated by region of origin and modeled as imperfect substitutes. According to the Armington model (1969), Constant Elasticity of Substitution (CES) specification is used to incorporate imperfect substitution of imported goods with respect to domestically produced goods. The equilibrium prices in world markets are determined to clear excess demand or excess supply in all markets. In this study, we briefly summarize the Brown,

Deardorff, and Stern model (2001). We define the notations and explain each equation in turn.

Consumers maximize their utilities that are allocated across the different broad product categories assuming a Cobb–Douglas utility function. Therefore, they are taken to:

$$\text{Max}_{\{C_{i1}, \dots, C_{im}\}} U_i = \prod_{j=1}^n C_{ij}^{\alpha_{ij}} \quad s. t. \quad \sum_{j=1}^n P_{ij} C_{ij} = E_i, \quad (1)$$

which yields the following demand equations:

$$C_{ij} = \frac{\alpha_{ij} E_i}{P_{ij}}, \quad \hat{C}_{ij} = \hat{E}_i - \hat{P}_{ij}. \quad (2)$$

where C_{ij} is the final demand for good j , E_i is the household income, E_{ij} is the household income spent on good j , P_{ij} is the price index of good j , and α_{ij} is the budget share of good j in country i . The circumflex indicates the change in percentage. Total demand is composed of intermediate and final demand. The intermediate demand for good j used in industry k is proportional to the output in industry k . Then, the proportionate change in total demand is simply the demand share weighted average of final and intermediate demands, that is:

$$\hat{D}_{ij} = v_{ijo} \hat{C}_{ij} + \sum_{k=1}^n v_{ijk} \hat{S}_{ik}, \quad (3)$$

where S_{ij} is total production, D_{ij} is final plus intermediate demand, v_{ijo} is final demand share of total demand, and v_{ijk} is intermediate demand by industry k share of total demand, for good j in country.

Demands for the output of individual firms are assumed to allocate expenditure between domestic and imported goods due to the preference for variety in equation (4). Consumers maximize their demands subject to the budget constraints. Equation (6) can be derived from the first order conditions in equation (5):

$$\text{Max}_{\{D_{ij}^i, D_{ij}^M\}} n_{ij}^{1+\mu} (D_{ij}^i)^\rho + (D_{ij}^M)^\rho + \lambda [E_{ij} - n_{ij} D_{ij}^i P_{ij}^i - D_{ij}^M P_{ij}^M], \quad (4)$$

$$\rho n_{ij}^\mu (D_{ij}^i)^{\rho-1} - \lambda P_{ij}^i = 0 \quad \text{and} \quad \rho (D_{ij}^M)^{\rho-1} - \lambda P_{ij}^M = 0. \quad (5)$$

$$D_{ij} = [n_{ij}^{1+\mu} (D_{ij}^i)^\rho + (D_{ij}^M)^\rho]^{1/\rho}, \quad (6)$$

where D_{ij}^i is demand for domestic good j , D_{ij}^M is demand for import good j , P_{ij}^M is import price index of good j in country i . $\rho = \frac{\sigma-1}{\sigma}$, where $\sigma = \frac{1}{1-\rho}$ is the elasticity of substitution among varieties of each good. n_{ij} is the number of firms in sector j in country i . μ is the parameter measuring substitutability among varieties produced by each firm. If we solve each of the first order conditions for their respective demands and substitute into the constraint, we can then eliminate the Lagrange multiplier. This yields the following demands in equation (7). Proportionately differentiating the demands given by (7) equation yields, we have the equations (8) and (9) as follows:

$$D_{ij}^i = \frac{E_{ij}(P_{ij}^i)^{-\sigma} n_{ij}^{\mu\sigma}}{n_{ij}^{1+\mu\sigma}(P_{ij}^i)^{1-\sigma} + (P_{ij}^M)^{1-\sigma}} \quad \text{and} \quad D_{ij}^M = \frac{E_{ij}(P_{ij}^M)^{-\sigma}}{n_{ij}^{1+\mu\sigma}(P_{ij}^i)^{1-\sigma} + (P_{ij}^M)^{1-\sigma}}. \quad (7)$$

$$\hat{D}_{ij}^M = \hat{D}_{ij} + \sigma\theta_{ij}^i(\hat{P}_{ij}^i - \hat{P}_{ij}^M) - \frac{\sigma(1+\mu\sigma)}{\sigma-1}\theta_{ij}^i\hat{n}_{ij}, \quad (8)$$

$$\hat{D}_{ij}^i = \hat{D}_{ij} + \sigma\theta_{ij}^M(\hat{P}_{ij}^M - \hat{P}_{ij}^i) - \frac{\sigma(1+\mu\sigma)}{\sigma-1}\theta_{ij}^i\hat{n}_{ij} + \mu\sigma\hat{n}_{ij}. \quad (9)$$

where σ is the elasticity of substitution among different varieties of each good, θ_{ij}^M is the fraction of expenditure to imports, and θ_{ij}^i is the fraction of expenditure on good j in country i .

3.2. Data on regions and product sectors

This study analyzes the effects of the UK–Korea FTA on the UK, Japan, Korea, China, the EU, and the rest of the world (ROW) using the multi-region and multi-sector CGE model. The model includes 6 regions and 12 sectors, based on the Global Trade Analysis Project (GTAP) database version 10, which was released in September 2019.

The database includes 141 countries of the world, and each region has 65 sectors. Bilateral trade flows among 46 countries/regions, composed of 12 sectors. Trade with the ROW is included to close the model. For the purpose of this study, the 141 regions are aggregated into 6 regions, and the 65 sectors into 12 sectors, as shown in Table 1.

Table 1: Twelve sectors of the model

Product sector	Description
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1	MeatLstk	Livestock and Meat Products
2	ProcFood	Processed Food
3	Textile	Textile and Apparel
4	AutoTrans	Motor Vehicle and Parts, Transport Equipment, Airplane
5	Chemicals	Chemical products
6	OilGas	Petroleum and Gas, Gas manufacture, coal products
7	HeavyMnfc	other Heavy Manufacturing
8	EleandEq	Computer, Electronic and Electrical Equipment
9	Machinery	Machinery and Equipment
10	Metal	Metal and Metal Products
11	FinInsurance	Financial Service and Insurance
12	Others	Other Goods and Services

Source: Global Trade Analysis Project database version 10 (2019)

3.3. Scenarios of the FTAs and trade liberalization policies

This study simulates the policy scenarios, which include the elimination of bilateral tariffs with the FTAs as the trade liberalization deal. In this study, the baseline scenario supposes that there existed some tariffs before the implementation of the UK–Korea FTA in 2019, and the hypothetical UK–Korea–Japan FTA. This study aims to emulate trade liberalization agreements by simulating four policy scenarios for the UK–Korea and UK–Korea–Japan FTAs in eight manufacturing sectors, as shown in Table 1. Table 2 represents the four scenarios of the removal of bilateral or trilateral FTAs.

Table 2: Two FTA policy scenarios

FTA	Scenario	Types	Level of Trade Liberalization
FTA Scenario	Scenario 1	UK-Korea FTA only	100% Tariff Elimination in 8 manufactured sectors
	Scenario 2	UK-Korea-Japan FTA	100% Tariff Elimination in 8 manufactured sectors

In scenario 1, Korea and the UK adopt the bilateral UK–Korea FTA to mutually eliminate import tariffs on all imports. In scenario 2, the UK, Korea, and Japan adopt the trilateral UK–Korea–Japan FTA to mutually eliminate import tariffs among the UK, Korea, and Japan.

4. Simulation Results of the FTA Scenarios

Simulation results of the two scenarios are presented in terms of percentage changes of real GDP, welfare level, and trade creation and trade diversion effects for the UK, Korea, China, EU 27, and the ROW. Since the share of internationally traded manufactured goods is very large among the UK, Korea, and Japan, this study considers mainly manufacturing industries.

4.1. Effects on world GDP of UK-Korea FTA and UK-Korea-Japan FTA

(1) The UK-Korea FTA: Scenario 1

Table 3 shows the impact of the bilateral UK–Korea FTA, with a removal of mutual import tariffs for 12 sectors, on the GDPs of the UK, South Korea, Japan, China, EU 27, and the ROW.

With the removal of import tariffs between the UK and Korea, the GDPs of the UK and Korea will rise by US\$15.25 million and by \$10.63 million, respectively. However, they are not expected to lead to a significant rise in percentage change of GDP. Nevertheless, GDPs of non-member countries such as Japan, China, EU 27, and the ROW will decrease, but the decrease is not expected to be significant due to the UK–Korea FTA.

Table 3: Impact of the UK-Korea FTA on the world's GDPs (% , Million US\$)

Nation	% Change in GDP	Pre FTA	Post FTA	Changes
UK	0.001	2990186	2990201	15.25
Korea	0.001	1411312	1411323	10.63
Japan	0	4596162	4596161	-1
China	0	10351105	10351100	-5
EU 27	0	15542448	15542437	-11
Rest of World	0	43334900	43334896	-4

(2) The UK–Korea–Japan FTA: Scenario 2

Table 4 shows the impact of the trilateral UK–Korea–Japan FTA, with a removal of mutual import tariffs for eight sectors, on the GDPs of the UK, South Korea, Japan, China, EU 27, and the ROW. The GDP of the UK will rise by \$113.25 million (0.004%), that of Korea will rise by \$736 million (0.052%), and that of Japan will rise by \$899 million (0.02%). In particular, the GDPs of Korea and Japan will rise proportionally more than that of the UK.

Leaving aside the influence of political aspects, real GDP gains of the trilateral UK–Korea–Japan FTA would be larger than gains of the UK–Korea FTA. Thus, the UK, Korea, and Japan can take advantage of the synergy effects of the trilateral UK–Korea–Japan FTA.

Table 4: Impact of UK-Korea-Japan FTA on the world’s GDPs (% , Mln. US\$)

Nation	% Change in GDP	Pre FTA	Post FTA	Changes
UK	0.004	2990185.5	2990298.75	113.25
Korea	0.052	1411312.25	1412048.25	736
Japan	0.02	4596162	4597061	899
China	-0.004	10351105	10350696	-409
EU 27	-0.001	15542448	15542277	-171
Rest of World	-0.001	43334900	43334648	-252

Examining the effects of the UK–Korea–Japan FTA is meaningful because in our estimation it is not merely an imaginary FTA that will never bear fruit. If Korea and Japan can achieve economic cooperation in the near future, keeping aside the political tension, the gains from the UK–Korea–Japan FTA would be even larger if we include the intangible benefits of political aspects over time.

However, GDPs of non-member countries such as China, EU 27, and ROW will decrease slightly. The GDP of China will decrease by \$409 million (0.004%), the GDP of the EU 27 will decrease by \$171 million (0.001%), and the GDP of the ROW will decrease by \$252 million (0.001%).

Therefore, we can see that Korea, Japan, and the UK will benefit more from the UK–Korea–Japan FTA than from either the bilateral Korea–UK or the Japan–UK FTA.

With the UK–Korea–Japan FTA, the three countries can enjoy the relatively large gains from trade as the Heckscher–Ohlin trade theory implies.

Thus, although the UK’s GDP gains remain almost the same, Korea and Japan can take advantage of the largest increase in the respective GDP of each country within the UK–Korea–Japan FTA. From here on, I will focus on the most beneficial trilateral trade liberalization deal (UK–Korea–Japan FTA), rather than the bilateral UK–Korea FTA.

4.2. Impact on exports of UK, Korea, Japan, China, and EU

(1) UK’s exports

As shown in Table 5-1, UK’s exports to Korea within the UK–Korea–Japan FTA are expected to rise in MeatLstk by 0.24%, in ProcFood by 0.11%, in AutoTrans by 3.97% (\$40.3 million), in Machinery by 4.17% (\$30.58 million), and in FinInsurance by 0.27%. However, the UK’s exports to Korea are expected to decline in Textile by 0.42%, Chemicals by 1.61%, OilGas by 0.18%, HeavyMnfc by 1.88%, EleandEq by 1.37%, and Metal by 0.78%.

The UK’s exports to Japan are expected to rise in all 12 sectors due to the UK–Korea–Japan FTA. In particular, the UK’s exports to Japan will increase in Textile by 57.38%, Chemicals by 10.45%, OilGas by 10.29%, HeavyMnfc by 2.85%, and Metal by 6.79% because the increased exports to Japan will partially offset the UK’s exports to Korea in these product sectors.

Table 5-1: UK’s exports within the UK-Korea-Japan FTA (%)

UK’s Export	Korea	Japan	China	EU 27	Rest of World
MeatLstk	0.24	0.52	-0.12	-0.09	-0.08
ProcFood	0.11	0.53	-0.05	-0.04	-0.04
Textile	-0.42	57.38	-0.01	-0.08	-0.09
AutoTrans	3.97	0.67	0.11	0.04	0.14
Chemicals	-1.61	10.45	-0.05	0	0
OilGas	-0.18	10.29	-0.06	-0.05	-0.05

HeavyMnfc	-1.88	2.85	0.09	-0.02	0
EleandEq	-1.37	0.63	0.12	0	0.01
Machinery	4.17	1.12	0.34	0.06	0.13
Metal	-0.78	6.79	0.13	-0.01	0.07
FinInsurance	0.27	0.61	-0.05	-0.03	-0.03
Others	0.25	0.58	-0.04	-0.05	-0.04

The UK's exports to non-member country China are projected to decline in MeatLstk, ProcFood, Textile, Chemicals, OilGas, Insurance, and Others by 0.01%–0.12%, but are expected to rise in AutoTrans by 0.11%, HeavyMnfc by 0.09%, EleandEq by 0.12%, Machinery by 0.34%, and Metal by 0.13%. The UK's exports to other EU 27 countries are expected to decline in all sectors except in AutoTrans and Machinery. Further, their exports to the ROW are also expected to decline in eight sectors except in AutoTran, EleandEq, Machinery, and Metal due to the substitution effects of the UK–Korea–Japan FTA.

(2) Korea's Exports

As shown in Table 5-2, with the UK–Korea–Japan FTA Korea's exports to the UK are expected to rise, particularly in AutoTrans by 11.21% (\$219.14 million), Chemicals by 1.75% (\$6.73 million), OilGas by 0.41% (0.81 million US dollars), HeavyMnfc by 3.12% (\$8.4 million), and EleandEq by 1.15% (\$17.62 million). However, Korea's exports to the UK are expected to slightly decline in MeatLstk, Textile, Metal, FinInsurance, and Others.

Under the UK–Korea–Japan FTA Korea's exports to Japan are expected to rise in Textile by 42.8%, AutoTrans by 0.40%, Chemicals by 14.85%, OilGas by 14.02%, HeavyMnfc by 13.51%, EleandEq by 1.61%, Machinery by 1.06%, and Metal by 2.86%. However, the country's exports to Japan are expected to decline in other agricultural and service sectors.

Table 5-2: Korea's exports within the UK-Korea-Japan FTA (%)

Korea's Export	UK	Japan	China	EU 27	Rest of World
MeatLstk	-0.9	-0.31	-0.95	-0.93	-0.91

ProcFood	-0.38	0.18	-0.4	-0.39	-0.39
Textile	-0.01	42.8	0.11	0.04	0.03
AutoTrans	11.21	0.4	-0.15	-0.23	-0.13
Chemicals	1.75	14.85	0.95	1.01	1
OilGas	0.41	14.02	0.39	0.42	0.41
HeavyMnfc	3.12	13.51	0.49	0.39	0.4
EleandEq	1.15	1.61	0.86	0.73	0.74
Machinery	0.04	1.06	0.29	0	0.08
Metal	-0.3	2.86	-0.12	-0.25	-0.18
FinInsurance	-0.68	-0.06	-0.73	-0.7	-0.7
Others	-0.67	-0.05	-0.67	-0.69	-0.68

Korea's exports to non-member country China are expected to decline in MeatLstk by 0.95%, ProcFood by 0.40%, AutoTrans by 0.15%, Metal by 0.12%, FinInsurance by 0.73%, and Others by 0.67. Furthermore, although Korea's exports to other EU 27 countries and ROW are expected to decline in six sectors, AutoTrans, agricultural, and service sectors, they are expected to rise in other manufacturing sectors.

In particular, although the UK–Korea–Japan FTA leads to the largest increase in AutoTrans among Korea's exports to the UK by 11.21%, with very small increase in exports to Japan by 0.40%, it leads to a decline in Korea's exports in AutoTrans to non-member China, other EU 27 countries, and the ROW.

(3) Japan's exports

As shown in Table 5-3, with the UK–Korea–Japan FTA Japan's exports to the UK and Korea are expected to increase in all right manufacturing product sectors. As shown in Table 5-3, Japan's exports to Korea are expected to rise substantially in Textile by 59.23% (\$257.03 million), AutoTrans by 29.43% (\$908.92 million), Chemicals by 22.07% (\$2,639.22 million), OilGas by 64.53% (\$901.20 million), HeavyMnfc by 31.52% (\$1,462.84 million), EleandEq by 24.58% (\$3,350.14 million), Machinery by 35.46% (\$2,694.98 million), and Metal by 8.31% (\$814.63 million).

Table 5-3: Japan's exports within the UK-Korea-Japan FTA (%)

Japan's Export	UK	Korea	China	EU_27	Rest of World
MeatLstk	-1.64	-2	-2.04	-2.01	-2

ProcFood	-1.01	-1.16	-1.19	-1.18	-1.16
Textile	59.23	45.44	-1.25	-1.32	-1.33
AutoTrans	29.43	21.71	-1.43	-1.52	-1.41
Chemicals	22.07	29.84	-0.98	-0.94	-0.93
OilGas	64.56	5.35	-0.29	-0.27	-0.28
HeavyMnfc	31.52	16.22	-1.49	-1.63	-1.58
EleandEq	24.58	18.11	-1.82	-1.94	-1.93
Machinery	35.46	9.87	-1.91	-2.2	-2.12
Metal	8.31	4.6	-1.68	-1.83	-1.74
FinInsurance	-1.01	-1.29	-1.33	-1.31	-1.31
Others	-1.24	-1.54	-1.53	-1.57	-1.55

Japan's exports to the UK are also expected to rise noticeably in Textile by 45.44% (\$35.06 million), AutoTrans by 21.71% (\$908.69 million), Chemicals by 29.84% (\$220.82 million), OilGas by 5.35%, HeavyMnfc by 16.22% (\$104.89 million), EleandEq by 18.11% (\$415.93 million), Machinery by 9.87% (\$155.12 million), and Metal by 4.60% (\$45.97 million). However, Japan's exports to the UK will increase much less than those to Korea. Thus, with the UK–Korea–Japan FTA, Korea and Japan will benefit proportionally more than the UK due to the close trade structure between the two countries in these manufacturing sectors.

However, Japan's exports to Korea and the UK are expected to decline in four other agricultural and service sectors. Japan's FinInsurance exports to the UK are estimated to decline by 1.29%, due to a comparative disadvantage of the FinInsurance sector. Japan's exports to Korea will also see a decline in FinInsurance by 1.01%.

With the UK–Korea–Japan FTA Japan's exports to non-member China, the EU, and the ROW are expected to decline in all 12 product sectors by approximately 1.00%–2.00% due to the substitution effects of the trilateral FTA.

(4) China's Exports

China's exports to the UK are expected to decrease in most manufactured product sectors due to the substitution effects of the UK–Korea–Japan FTA. As shown in Table 5-4, China's exports to the UK will reduce mainly in AutoTrans by 0.60% (\$17.58 million), Chemicals by 0.39%, HeavyMnfc by 0.12%, EleandEq by 0.33% (\$89.77 million), and

Machinery by 0.25%. However, China’s exports to the UK are expected to rise slightly in MeatLstk, ProcFood, OilGas, FinInsurance, and Others by 0.04%–0.10% due to gains in UK’s trade creation stemming from the trilateral FTA.

Table 5-4: China’s exports within the UK-Korea-Japan FTA (%)

China’s Export	UK	Korea	Japan	EU_27	Rest of World
MeatLstk	0.1	0.43	0.69	0.08	0.08
ProcFood	0.04	0.2	0.61	0.03	0.04
Textile	0	-0.95	-0.26	0.05	0.04
AutoTrans	-0.6	-1.44	0.69	0.07	0.17
Chemicals	-0.39	-5.89	0.09	0.01	0.01
OilGas	0.02	-0.12	0.07	0	0
HeavyMnfc	-0.12	-6.15	0.42	0.05	0.07
EleandEq	-0.33	-2.57	0.66	0.05	0.06
Machinery	-0.25	-6.46	1.17	0.1	0.18
Metal	0	-1.26	0.48	0.05	0.12
FinInsurance	0.09	0.37	0.71	0.07	0.07
Others	0.08	0.36	0.68	0.06	0.06

China’s exports to Korea are expected to decrease significantly in all eight manufacturing product sectors except the slight increases in the four agricultural and service sectors, namely MeatLstk, ProcFood, FinInsurance, and Others, due to the substitution effects of the trilateral FTA. In particular, China’s exports to Korea will decline in AutoTrans by 1.44% (\$49.8 million), Chemical by 5.89% (\$416.77 million), HeavyMnfc by 6.15% (\$303.90 million), EleandEq by 2.57% (\$1,337.65 million), Machinery by 6.46% (\$376.39 million), and Metal by 1.26% (\$167.59 million).

In contrast, China’s exports to Japan are expected to increase slightly in most product sectors except for slight decreases in Textile due to gains from Japan’s trade creation. Thus, with the UK–Korea–Japan FTA, although China’s exports to Korea will decline substantially and those to the UK will decline in a small amount, China’s exports to Japan are expected to increase slightly for most products. Thus, the UK–Korea–Japan FTA will have asymmetrical and different trade-creating effects between China and the UK, Korea, or Japan. This will depend on the difference in bilateral trade structures between China and the UK, Korea, or Japan. Notably, even if Japan’s exports to China

decline, those to Japan will increase despite the UK–Korea–Japan FTA.

However, non-member China’s exports to non-member EU 27 and the ROW are all expected to increase slightly in all product sectors due to the substitution effects of the trilateral FTA.

(5) EU 27 countries’ exports

As shown in Table 5-5, the EU 27 countries’ exports to the UK and Korea with the UK–Korea–Japan FTA are expected to decrease in all eight manufactured product sectors due to the trilateral FTA’s negative substitution effects. However, the EU 27’s exports to Japan are expected to increase in all sectors except Textile.

Table 5-5: EU 27’s exports within the UK-Korea-Japan FTA (%)

EU 27’s Export	UK	Korea	Japan	China	Rest of World
MeatLstk	0.03	0.35	0.61	-0.03	-0.01
ProcFood	0.02	0.15	0.57	-0.01	0
Textile	-0.05	-1.01	-0.32	0.06	-0.02
AutoTrans	-0.64	-1.48	0.66	0.1	0.13
Chemicals	-0.43	-5.95	0.04	-0.09	-0.03
OilGas	-0.03	-0.16	0.07	-0.03	-0.03
HeavyMnfc	-0.15	-6.2	0.39	0.11	0.03
EleandEq	-0.35	-2.6	0.63	0.14	0.04
Machinery	-0.28	-6.5	1.13	0.35	0.14
Metal	-0.03	-1.31	0.45	0.15	0.09
FinInsurance	0.05	0.33	0.67	0	0.03
Others	0.04	0.31	0.65	0.03	0.02

With the trilateral FTA the EU 27’s exports to non-member China and the ROW are expected to increase in most manufacturing product sectors such as AutoTrans, HeavyMnfc, EleandEq, Machinery, Metal, and service sectors. However, the EU 27’s exports to China and the ROW are estimated to decline in agricultural product sectors such as MeatLstk and ProcFood and in manufacturing product sectors such as Chemical and OilGas.

4.3. Welfare Effects of the FTA Scenarios

This section discusses the FTAs' welfare effects on the UK, Korea, Japan, EU, and the ROW, with the reduction of tariffs in the eight manufacturing product sectors. The welfare effects of the FTAs consist of allocative efficiency, terms of trade for goods and services, and terms of trade for investment and savings. The FTAs will increase allocative efficiencies owing to an increase in competition such as production efficiency, consumption, and trade efficiency. The FTA will also result in terms of trade effects in goods and services, changes in both export and import prices, and terms of trade effects in the investment-savings for capital investment goods.

(1) Welfare effects of UK–Korea FTA

First, as shown in Table 6-1, the welfare effects of the UK–Korea FTA of scenario A consist of allocative efficiency, terms of trade for goods and services, and terms of trade for investment and savings. The net welfare gain of the UK–Korea FTA with the removal of 100% tariff rate for eight manufactured product sectors will be \$3.37 million.

Table 6-1: Welfare effects of UK-Korea FTA (Millions of US \$)

Country	Allocative Efficiency	Terms of Trade in Goods and service	Terms of Trade in Invest-Saving	Total welfare
1 UK	15.34	25.31	3.31	43.96
2 Korea	10.58	37.25	-3.41	44.41
3 Japan	-0.8	-4.44	-0.07	-5.32
4 China	-5.14	-10.13	0.71	-14.56
5 EU 27	-11.22	-23.59	0.71	-34.1
6 Rest of World	-5.4	-24.38	-1.25	-31.03
Total	3.37	0	0	3.37

In this scenario, the UK and Korea experience positive allocative efficiency due to the increased trade effects under the FTA. Although the terms of trade effects for goods and services are positive for the UK and negative for Korea, those for investments and savings are positive for both the UK and Korea. However, Japan, China, EU, and the

ROW experience negative effects for allocative efficiency, the terms of trade effects for goods and services, and the terms of trade effects for investment and savings.

The expected total welfare gain is \$43.96 million in the UK and \$44.41 million in Korea. The calculated total welfare loss is \$5.32 million for Japan, \$14.56 million for China, \$34.1 million for the EU, and \$31.03 million for the ROW. The total welfare gains are negative for all non-member countries (Japan, China, EU, and ROW) due to the UK–Korea FTA. Thus, the net welfare gain of the UK-Korea FTA will be \$3.37 million.

(2) Welfare effects of UK–Korea–Japan FTA

The welfare changes in each country are shown in Table 6-2. In this scenario of the trilateral UK–Korea–Japan FTA, the UK will have positive allocative efficiency in economic resource allocations and the terms of trade effects in goods and services, but negative terms of trade effects in investment and savings. Korea will have positive allocative efficiency, but negative terms of trade effects in goods and services and terms of trade effects in investment-saving. Japan will have positive allocative efficiency, terms of trade effects in goods and services, and terms of trade effects in investment and savings.

However, the three countries, the UK, Korea, and Japan, will all have positive total welfare gains. With this trilateral FTA, the welfare gain will be \$117.80 million for the UK, \$502.37 million for Korea, and \$3,312.03 million for Japan. Thus, Japan can take advantage of the largest welfare gains among the three countries.

Table 6-2: Welfare effects of UK-Korea-Japan FTA (Millions of US \$)

Country	Allocative Efficiency	Terms of Trade in Goods and Service	Terms of Trade in Invest-Saving	Total welfare
1 UK	113.34	17.27	-12.82	117.8
2 Korea	736.03	-222.6	-11.06	502.37
3 Japan	898.79	2382.3	30.94	3312.03
4 China	-409.15	-663.8	43.8	-1029.16
5 EU 27	-171.38	-316.63	8.52	-479.49
6 Rest of World	-252.84	-1196.53	-59.38	-1508.75
Total	914.79	0	0	914.79

On the contrary, non-member China and the EU 27 countries will have negative effects in allocative efficiency and terms of trade effects in goods and services, but relatively small positive terms of trade effects in investment and savings. The ROW will have negative effects in allocative efficiency, terms of trade effects in goods and services, and terms of trade effects in investment and savings. Thus, the welfare loss will be \$1,029.16 million for China, \$479.49 million for the EU 27, and \$1,508.75 million for the ROW.

Thus, the worldwide net total welfare gains of the (projected) UK–Korea–Japan FTA are expected to be \$914.79 million. The net total welfare gains from this trilateral FTA will be much larger than those from the bilateral UK–Korea or UK–Japan FTAs.

4.4. Trade effects of the UK–Korea–Japan FTA

The FTA has two kinds of economic effects - the trade creation effect and the trade diversion effect. These effects of the UK–Korea–Japan FTA will be measured by the change in real imports valued in millions of US dollars for each country.

(1) UK's import effect

Table 7-1 reports the changes in real imports by the UK from Korea, Japan, China, the EU 27 countries, and the ROW. With the UK–Korea–Japan FTA, as shown in Table 7-1, first, the UK will experience trade creation effects in most manufacturing sectors such as AutoTrans, Chemicals, OilGas, HeavyMnfc, EleandEq, and Machinery importing from Korea except in the Textile, Machinery, and Metal sectors. In particular, there will be a big trade creation effect in the AutoTrans sector for Korean imports; the UK's imports from Korea in AutoTrans sector will be expected to rise by 11.21% (\$219.14 million).

Second, the UK will experience trade creation effects for all eight manufacturing sectors importing from Japan. The UK's imports from Japan will be expected to rise by 45.44% (\$35.06 million), 21.71% (\$908.69 million) in sector AutoTrans, 29.84% (\$220.82 million) in Chemicals, 16.22% (\$104.89 million) in HeavyMnfc, 18.11% (\$415.93 million) in EleandEq, 9.87% (\$155.12 million) in Machinery, and 4.60% (\$46.97 million) in Metal.

However, the UK's imports in the AutoTrans sector from the other non-member countries will be expected to decline by 0.60% (\$17.58 million) from China, by 0.64% (\$592.75 million) from EU 27 countries, and by 0.65% (\$213.39 million) from the ROW.

Table 7-1: UK's trade effect (%)

UK's Import	Korea	Japan	China	EU_27	Rest of World
MeatLstk	-0.9	-2	0.1	0.03	0.02
ProcFood	-0.38	-1.16	0.04	0.02	0.01
Textile	-0.01	45.44	0	-0.05	-0.06
AutoTrans	11.21	21.71	-0.6	-0.64	-0.65
Chemicals	1.75	29.84	-0.39	-0.43	-0.44
OilGas	0.41	5.35	0.02	-0.03	-0.02
HeavyMnfc	3.12	16.22	-0.12	-0.15	-0.16
EleandEq	1.15	18.11	-0.33	-0.35	-0.36
Machinery	0.04	9.87	-0.25	-0.28	-0.3
Metal	-0.3	4.6	0	-0.03	-0.04
FinInsurance	-0.68	-1.29	0.09	0.05	0.05
Others	-0.67	-1.54	0.08	0.04	0.03

Thus, in the AutoTrans sector, the UK will have significant trade creation effects on imports from Korea and Japan, but trade diversion effects on imports from the other non-members. The UK's imports in the Chemical, HeavyMnfc, EleandEq, and Machinery sectors from the non-member countries such as China, EU 27 countries, and the ROW, will also be expected to decline substantially.

2) Korea's import effect

With the UK–Korea–Japan FTA, Korea is expected to experience trade creation and trade diversion effects on sectors importing from the UK, as shown in Table 7-2. Korea will experience trade creation effects in AutoTrans by 3.97% (\$40.30 million) and in Machinery by 4.17% (\$30.58 million), but a small trade reduction effect on imports from the UK.

In contrast, Korea is expected to have large trade creation effects on imports from Japan for all manufacturing sectors such as Textile, AutoTrans, Chemicals, OilGas,

HeavyMnfc, EleandEq, Machinery, and Metal, but very small diversion effects in FinInsurance and other service sectors. As the UK has a comparative advantage over Japan due to its developed finance and insurance sectors, Korea will import more from these sectors of the UK than from those of Japan.

However, the UK–Korea–Japan FTA Korea is expected to create significant trade diversion effects from non-member countries to member countries for eight manufacturing sectors.

Table 7-2: Korea’s trade effect (%)

Korea’s Import	UK	Japan	China	EU_27	Rest of World
MeatLstk	0.24	-1.64	0.43	0.35	0.34
ProcFood	0.11	-1.01	0.2	0.15	0.15
Textile	-0.42	59.23	-0.95	-1.01	-1.01
AutoTrans	3.97	29.43	-1.44	-1.48	-1.49
Chemicals	-1.61	22.07	-5.89	-5.95	-5.94
OilGas	-0.18	64.56	-0.12	-0.16	-0.14
HeavyMnfc	-1.88	31.52	-6.15	-6.2	-6.2
EleandEq	-1.37	24.58	-2.57	-2.6	-2.61
Machinery	4.17	35.46	-6.46	-6.5	-6.51
Metal	-0.78	8.31	-1.26	-1.31	-1.32
FinInsurance	0.27	-1.01	0.37	0.33	0.33
Others	0.25	-1.24	0.36	0.31	0.3

(3) Japan’s Import Effect

With the UK–Korea–Japan FTA, Japan is expected to experience trade creation effects in all 12 sectors importing from the UK, see Table 7-3. Thus, Japan’s imports from the UK are expected to increase in all 12 sectors. Japan’s imports from Korea are also estimated to increase for all eight manufactured goods sectors, in particular Textile, Chemicals, OilGas, and HeavyMnfc.

However, Japan’s imports from Korea will decline in MeatLstk, FinInsurance and other service sectors due to the trilateral FTA. On the contrary, Japan’s imports from non-member countries such as China, the EU 27 countries, and the ROW are expected to increase slightly in all sectors except Textile due to the positive income effects from the

UK–Korea–Japan FTA.

Table 7-3: Japan’s trade effect (%)

Japan’s Imports	UK	Korea	China	EU_27	Rest of World
MeatLstk	0.52	-0.31	0.69	0.61	0.6
ProcFood	0.53	0.18	0.61	0.57	0.57
Textile	57.38	42.8	-0.26	-0.32	-0.32
AutoTrans	0.67	0.4	0.69	0.66	0.65
Chemicals	10.45	14.85	0.09	0.04	0.04
OilGas	10.29	14.02	0.07	0.07	0.08
HeavyMnfc	2.85	13.51	0.42	0.39	0.38
EleandEq	0.63	1.61	0.66	0.63	0.63
Machinery	1.12	1.06	1.17	1.13	1.11
Metal	6.79	2.86	0.48	0.45	0.44
FinInsurance	0.61	-0.06	0.71	0.67	0.67
Others	0.58	-0.05	0.68	0.65	0.63

(4) China’s Import Effect

As shown in Table 7-4, with the UK–Korea–Japan FTA, non-member China is expected to experience small trade diversion effects in seven sectors and small trade creation effects in five sectors importing from the UK, namely in AutoTrans, HeavyMnfc, EleandEq, Machinery, and Metal. However, China is expected to experience small import reductions in Textile, Chemicals, OilGas, agricultural, and service sectors.

Table 7-4: China’s trade effect (%)

China’s Import	UK	Korea	Japan	EU_27	Rest of World
MeatLstk	-0.12	-0.95	-2.04	-0.03	-0.05
ProcFood	-0.05	-0.4	-1.19	-0.01	-0.02
Textile	-0.01	0.11	-1.25	0.06	0.05
AutoTrans	0.11	-0.15	-1.43	0.1	0.09
Chemicals	-0.05	0.95	-0.98	-0.09	-0.09
OilGas	-0.06	0.39	-0.29	-0.03	-0.02
HeavyMnfc	0.09	0.49	-1.49	0.11	0.1
EleandEq	0.12	0.86	-1.82	0.14	0.14
Machinery	0.34	0.29	-1.91	0.35	0.33
Metal	0.13	-0.12	-1.68	0.15	0.14
FinInsurance	-0.05	-0.73	-1.33	0	0
Others	-0.04	-0.67	-1.53	0.03	0.01

China’s imports from Korea will increase in six manufacturing sectors, namely, Textile,

Chemicals, OilGas, HeavyMnfc, EleandEq, and Machinery products. However, their imports from Korea will decline in AutoTrans, Metal, agricultural and service sectors. China's imports from Japan are expected to experience relatively large reduction effects for all 12 product sectors.

Although China's imports from the EU 27 and the ROW will increase in AutoTrans, HeavyMnfc, EleandEq, Machinery, Metal, and service sectors, they will decrease in Chemicals, OilGas and agricultural sectors. Thus, China's imports will experience mixed effects in different sectors due to the UK–Korea–Japan FTA.

(5) EU 27's import effect

With the UK–Korea–Japan FTA, as shown in Table 7-5, EU 27 countries are also expected to experience import reduction effects in all sectors except AutoTrans and Machinery from the UK. EU 27's imports from the UK will decline for eight sectors, namely, MeatLstk, ProcFood, Textile, OilGas, HeavyMnfc, Metal, FinInsurance, and others.

EU 27 countries are also expected to experience import reduction effects for all sectors from Japan. EU 27's imports from Korea will also decline in six sectors, namely, MeatLstk, ProcFood, AutoTrans, Metal, FinInsurance, and other sectors, but increase in Textile, Chemicals, OilGas, HeavyMnfc, and EleandEq.

Table 7-5: The EU's Trade Effect (%)

EU 27's Import	UK	Korea	Japan	China	Rest of World
MeatLstk	-0.09	-0.93	-2.01	0.08	-0.01
ProcFood	-0.04	-0.39	-1.18	0.03	-0.01
Textile	-0.08	0.04	-1.32	0.05	-0.02
AutoTrans	0.04	-0.23	-1.52	0.07	0.02
Chemicals	0	1.01	-0.94	0.01	-0.04
OilGas	-0.05	0.42	-0.27	0	-0.01
HeavyMnfc	-0.02	0.39	-1.63	0.05	0.01
EleandEq	0	0.73	-1.94	0.05	0.02
Machinery	0.06	0	-2.2	0.1	0.05
Metal	-0.01	-0.25	-1.83	0.05	0
FinInsurance	-0.03	-0.7	-1.31	0.07	0.03
Others	-0.05	-0.69	-1.57	0.06	0.01

However, EU 27's imports from Japan will decline in all 12 product sectors. In particular, EU 27 countries' imports will decline in AutoTrans by 1.52% (\$260.41 million), Chemicals by 0.94% (\$60.99 million), HeavyMnfc by 1.63% (\$76.36 million), EleandEq by 1.94% (\$407.6 million), Machinery by 2.20% (\$342.42 million), Metal by 1.83% (\$44.23 million), FinInsurance by 1.31% (\$39.51 million), and Other sectors by 1.57% (\$375.15 million), due to the negative trade diversion effects of the UK–Korea–Japan FTA.

Finally, EU 27's imports from China will increase in most manufacturing and service sectors except in the OilGas sector. EU 27's imports from the ROW will increase in AutoTrans, HeavyMnfc, EleandEq, Machinery, FinInsurance, and other service sectors, but will decline in the other sectors.

Thus, we can infer that EU 27 countries are expected to divert imports from the UK, Korea, or Japan to non-member countries such as China and the ROW due to the negative trade substitution effects of the UK–Korea–Japan FTA in some sectors such as AutoTrans, HeavyMnfc, EleandEq, Machinery, and FinInsurance.

5. Conclusion

This study has examined the effects of four scenarios involving the existing bilateral UK–Korea FTA and the trilateral UK–Korea–Japan FTA (to be created). The CGE simulation results are summarized below.

First, for the bilateral UK–Korea FTA, although the GDPs of the UK and Korea will increase slightly, those of non-member countries such as Japan, China, EU, and the ROW will decline.

Second, the trilateral UK–Korea–Japan FTA will increase the GDPs of the UK, Korea, and Japan. Thus, it is more beneficial for Korea, Japan, and the UK to establish a trilateral FTA, instead of the bilateral UK–Korea FTA. Although the UK, Korea, and Japan will increase their exports to other FTA partner countries for most manufactured goods, they will see a decrease of their exports of manufactured goods to non-member countries due to the UK–Korea–Japan FTA.

Third, the trilateral UK–Korea–Japan FTA will also lend much larger welfare gains to all three countries (UK, Korea, and Japan) than the UK–Korea FTA. However, the welfare gains seem to be negative in all non-member countries such as China, EU 27, and the ROW.

Fourth, with the UK–Korea–Japan FTA, although China will experience declining exports to the UK and Korea, China’s exports to Japan are expected to increase slightly for most products. Thus, China will have different trade effects with the UK, Korea, and Japan; it depends on the different bilateral trade structures between China and the UK, Korea, or Japan, separately.

Finally, the UK–Korea–Japan FTA will result in big trade creation effects from imports from Japan for both the UK and Korea. Japan will also experience substantial trade creation effects from the imports from the UK and Korea. However, China and the EU 27 countries are expected to experience a decrease in most imports from Japan due to the UK–Korea–Japan FTA.

Thus, the trilateral FTA will contribute to GDP, exports, welfare levels, and trade creation in a very substantial way. Japan, in particular, will be the greatest beneficiary of the projected trilateral UK–Korea–Japan FTA.

Our analysis is based on a static approach to examining the effects of the UK–Korea–Japan FTA. Only using tariff elimination may have underestimated the effects of the FTAs. In the future, we can improve the accuracy of our results by also considering foreign direct investments and elasticities of supply and demand.

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