The Economic Consequences of the 2018 US-China Trade Conflict: A CGE Simulation Analysis[*]

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Abstract

This paper aims at evaluating the economic consequences of the 2018 US-China trade conflict. The potential impact of the proposed tariff increases is calculated using a global CGE model. Capital deepening and technological spillover induced by trade are also taken into account to explore the long-run influence. We can derive the following implications.

First, the additionally imposed tariffs on goods alone declines the GDP in the US and China by 0.1% and 0.2%, respectively. The equivalent variation in the US and China is reduced by 9.8 billion and 35.2 billion USD, respectively. Although other countries gain from trade diversion, losses exceed gains globally.

Second, considering the effect from capital deepening and technological spillover induced by trade makes the situation worse. The GDP in the US and China declines by 1.6% and 2.5%, respectively. The equivalent variation in the US and China is reduced by 199.5 billion USD and 187.1 billion USD, respectively. Again, the trade diversion is not large enough to recover losses in these countries.

Third, the imposed tariffs distort relative prices, resulting in changes to the global production structure. Both the US and China lose their comparative advantage in transport, electronic, and machinery equipment production, while other countries expand their production in these sectors.

Finally, China's retaliatory tariff increases worsens the US economy to some extent, but it comes at a cost to the Chinese economy. In the long run, retaliation is not an appropriate policy response.

Key words: the US, China, Tariff, Trade Policy, Retaliation, CGE model

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1. Introduction

In 2018, the United States announced that it would raise tariffs on imports from China. It is said that there are several reasons for these actions—the continuously large trade deficits, unfair trade practices and treatment of foreign firms in China, and a lack of adequate legal and institutional infrastructure to protect intellectual property rights. The Office of the US Trade Representative (USTR) justified the grounds for the actions by citing article 301 of the 1974 Trade Act.

The two countries have attempted to resolve these issues in several rounds of negotiations, but the US decided to impose additional tariffs on Chinese imports anyway to show its serious intentions. China immediately retaliated with tariff increases on imports from the US. This situation is now a typical "trade war."

Many economists and researchers have expressed their concerns over its repercussions on the regional and global economy using indicative model simulations based on various assumptions. In line with these studies, this paper aims at exploring the quantitative consequences of the US-China trade war using a GTAP CGE (Global Trade Analysis Project-Computable General Equilibrium) model.

2. Measures taken by the US and China

2.1. Tariff increases by the US

According to information released by the US government, the US will impose additional tariffs on 50 billion USD of imports from China (the sum of 34 billion USD announced on July 6 2018 and 16 billion USD announced on August 23, 2018), followed by the second round of tariff increase on 200 billion USD of imports from China announced on September 24, 2018 (Figure 1). It is also said that President Trump could impose additional tariffs on the rest of targeted imports—267 billion USD—depending on the retaliatory actions taken by China.

The additional tariff rate will be set at 25%. The US imports from China was about 505.5 billion USD in 2017, accounting for 21.6% of total US imports. The tariff increases will raise import prices by 2.7% (25%*49.5%*21.6%), decreasing the GDP deflator by 0.3%. This short-term impact reflecting a negative economic outlook is well known among economists. Bown, Jung, and Lu (2018) carefully compared targeted commodities in the first and second bullets and found that the second bullet contains more consumer goods than the first, resulting in a further negative impact on consumer prices.

2.2. China

In response to US' actions, China announced retaliatory measures (Figure 2). The first round contains tariff increases on 50 billion USD imports from the US (the sum of 34 billion USD imports announced on July 6 2018 and 16 billion USD imports announced on August 23, 2018).

The second round of actions contains tariff increases on 60 billion USD imports from the US.[1]

The additional tariff rate of the first action is set at 25%, which is the same as the rate imposed by the US, but the rate for the second action is lower and ranges between 5 and 10%. According to the analysis by Bown, Jung, and Lu (2018), the lower rate for the second retaliatory action could reflect the Chinese government's concern that tariffs would raise intermediary input costs for domestic firms. The second round of retaliatory action affects capital and investment commodities, in addition to intermediate input commodities, while the first round of retaliatory action mainly affects consumer commodities, such as automobiles and food or processed food.

3. Evaluation method

3.1. Previous studies

Previous studies on the US-China trade conflict in 2018 relied on a scenario analysis, due to the ambiguity in policy decisions and implementation. The International Monetary Fund (IMF, 2018) demonstrated four consecutive scenarios in the US-China trade conflict and its spillover effects on the world economy. The first two scenarios are based on announced tariff increases by the US and China, the third scenario includes imaginary additional tariff increases on automobile imports, and the forth scenario includes negative shocks on the markets or investor sentiment in general. The first two realistic scenarios indicate that the GDP in the US and emerging Asian economies, including China, would fall by 0.2 % in the first year, while the GDP in Japan and EU would increase slightly.[2]

Similar to the IMF's simulation, Kobayashi and Hirono (2018b) ran a macroeconomic model to simulate the potential impact of 10% or 25% tariff increases on the GDP, with two different fiscal response assumptions—revenue neutral and revenue surplus. The GDP in the US falls by 0.00-0.15% in the 10% increase scenario and by 0.00-0.28% in the 25% increase scenario. The Chinese GDP falls by 0.01-0.17% in the 10% increase scenario and by 0.05-0.22% in the 25% increase scenario. They also projected that the GDP in Japan would drop by 0.00-0.02%.

In general, a macroeconomic model simulation helps to understand how tariff increases affect prices, including exchange rates and final demand. Further, it would be possible to trace a possible overshoot impact on financial variables by taking into account a reasonable scenario in investor sentiment, albeit *ad hoc*. However, a macroeconomic model fails to capture industry-level change due to data aggregation. It also has a limitation in assessing the long-run impact on supply capacity. A general equilibrium model with a trade matrix has the comparative advantage in dealing with these aspects; therefore, it is more appropriate for use in quantification of trade issues.

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[1] The first and second measures by China are addressed in the following announcements. For the first action, see http://gss.mof.gov.cn/zhengwuxinxi/zhengcefabu/201806/t20180616_2930325.html. For the second action, see http://gss.mof.gov.cn/zhengwuxinxi/zhengcefabu/201808/t20180808_2983770.html.

[2] Kobayashi and Hirono (2018a) compares projections by international organizations and their institute.

For example, Rosyadi and Widodo (2018) conducted a simulation using a standard GTAP model with dataset version 9.0, to evaluate the US-China trade dispute. Their simulation shows comparative statics, with labor mobility among sectors within a country. In the first scenario, US import tariffs are raised by 45% on all imports from China and Chinese import tariffs are raised by a certain level to reach an ex-post rate of 45%.[3] The second scenario excludes agricultural products from the first scenario. Since the US had already announced the additional tariff rate would be 25%, the assumed rate of 45% lost its meaning. However, we can still use the result as a multiplier as long as the results are linear with tariff increases. In the first scenario, both the US and China's GDP falls by 1.22% and 5.4%, respectively. Thus, we can speculate that a 25% hike in tariffs would decrease their GDP by 0.7% and 3.0%, respectively.

Li, He, and Lin (2018) calibrated their original CGE model to calculate welfare changes caused by tariff increases by the US and China. Their model has 29 countries/regions with tradable and non-tradable goods and 2013 as the benchmark year. When respective tariffs on imports between the US and China are increased by 15%, the GDP in the US increases by 0.007% while in China, it falls by 0.667%. In the scenario where respective tariffs on imports are increased by 30%, again, the GDP in the US increases by 0.037% while in China, it falls by 1.152%. Although it is not clear why the GDP in the US increases, one could conjecture that a higher price of tradable goods might stimulate domestic production, which would generate an additional income effect for non-tradable goods. From these simulation exercises, they concluded that the US-China trade conflict is a non-cooperative Nash equilibrium, indicating the US can gain from unilateral tariff increases, and China can reduce its losses by retaliating.

Bollen and Rojas-Romagosa (2018) demonstrated seven scenario simulations using the WorldScan CGE model developed by the Netherlands Bureau for Economic Policy Analysis. One of the seven scenarios includes the US-China tariff increases. According to their results, the GDP in the US and China falls by 0.1% and 1.4%, respectively, due to tariff increases. Note that their simulation only considers the tariff increases announced in July 2018 and does not take into account the additional measures announced in September.

3.2. Data and Model

3.2.1. Data

In this paper, we use GTAP data version 9.0. This is the same data set used in the two previous studies—Rosyadi and Widodo (2018) and Bollen and Rojas-Romagosa (2018). The benchmark year varies by data series, but the national accounts data and trade statistics are adjusted to replicate the balance among regions.[4] The original database consists of 140 countries/regions and 57 commodities/ industries. For our analytical purposes, it is aggregated into 16 countries/regions and 12 commodities/industries (see Appendix 1 and Appendix 2). There are five initial

[3] Authors argue that a large trade diversion and deterioration of terms of trade happen, however, it is not explicitly shown how much China will raise its tariffs on imports from the US to achieve the ex-post rate of 45%.

[4] For detailed account of this issue, see GTAP technical paper series on data construction.

endowments for production—land, unskilled labor, skilled labor, and natural resources.

3.2.2. Model

Our model is version 6.2 of the GTAP models, with an additional equation to link trade openness and technological changes. The following section briefly explains the basic structure of the model.[5]

In our model, there is a social welfare function composed of private consumption, government consumption, and national savings. Since the function takes the form of Cobb-Douglas, each share is held constant. Each commodity demand of private consumption is driven by income, relative prices, and initial quantity of demand. Domestic demand is comprised of domestic supply and aggregate imports, which are elastic to relative price changes.

Firms are assumed to produce commodities by mixing value-added inputs and intermediary inputs. The value-added inputs are land, labor, capital, and natural resources, and their composition weights vary by industry. The intermediary inputs are determined by fixed proportion to output—the Leontief structure. The intermediary inputs are also composed of domestic supply and aggregate imports.

Substitution between domestic goods and import goods is determined by the fixed elasticity of substitution. Among the import destinations, the same substitution structure with different elasticity is assumed (Appendix 3).

The national savings rate is fixed by the Cobb-Douglas type social utility function. While national investment is derived from production activities, the gap between savings and investment equals net imports. To solve the model, it is assumed that national investment is allocated to equalize the expected rate of return on capital among regions.

In this exercise, one equation is added to the standard model. That equation is a link between trade openness and nationwide technological change. It aims at capturing the economic impact argued in the previous studies on trade and technological spillover effects. It is often claimed that trade openness nurtures innovation through creating a competitive environment for firms, meaning a higher degree of diversity in goods and firms in the markets. For example, Lee et.al (2004) analyze a relation between per capita growth and trade openness and conclude that a 10% point hike in trade openness brings 0.27% growth. Also, Wolszczak-Derlacz (2014) show a positive relationship between TFP and trade openness through competitive environment by panel data of OECD countries. Although this is an *ad hoc* treatment, it is worth taking the explicit link between trade and technology into account (Appendix 4).[6]

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[5] For detailed account of models and data of the GTAP, see the latest website information on https://www.gtap.agecon.purdue.edu/models/current.asp. Note that the latest version of the model is 7.

[6] The formula is AOREG=0.15＊(gross trade change – GDP change). See Tsutsumi (2017) or Government Headquarters for the TPP, Japan (2015) for detailed account of this issue.

3.3. Simulation plan

The economic impact of the US and China's tariff increases is calculated using different macroeconomic closures to analyze the three causes of changes. The primary cause is tariff increases. Kobayashi and Hirono (2018b) and Bown, Jung, and Lu (2018) used the information released by government and trade statistics to construct a data set at HS code (Harmonized Commodity Description and Coding System) 2- or 6- digit levels. Based on their studies and the tariff data in GTAP version 9.0, the effective additional changes in tariff rates and import prices are calculated in Table 1. According to this exercise, the effective additional tariff rates in China are uneven by commodity, reflecting a difference in the first and second round of retaliation. The average change rate is not too different from that of the US, although China targets a larger portion of total imports compared to the US.

The second cause is capital accumulation. The primary change by tariff increases influences commodity prices and quantity, and renews income, savings, and investment. Changes in savings are, by definition, changes in capital accumulation in the long-run. The third cause is the technological change induced by trade. As noted in the previous section, an *ad hoc* equation is incorporated to capture the trade induced technological change on the whole economy.

4. The economic consequences of trade war

4.1. Impact of tariff increases

4.1.1. Key macroeconomic indicators

The changes in key macroeconomic indicators by tariff increases alone are presented in Table 2. The imports and exports in both the US and China drop significantly, while trade diversion effects allow the imports and exports in other countries and regions to grow to some extent. The world trade volume drops by 0.6%. The terms of trade (export price/import price) of China deteriorates, while that of the US is not significantly affected. A small improvement in terms of trade with Canada and Mexico is found.

The changes in the terms of trade also influence the domestic economic variables—production and income. The GDP in the US and China drops by 0.1% and 0.2%, respectively, while other countries and regions slightly gain through trade diversion effects. The world GDP declines slightly by 0.03%. Looking at the equivalent variation, losses in the US and China amount to 9.8 billion USD and 35.2 billion USD, respectively, resulting in 23.9 billion USD losses globally.

In this simulation, the expected return on capital in each country is equalized to the global rate of return on capital such that the IS gap would change. The trade deficits in the US and the trade surplus in China shrinks, as was intended by the US administration. However, it is just by 15 billion USD, which accounts for 3.5% of Chinese surplus or 1.9% of the US deficits. It is suggested that changing the trade balance through tariffs does not make sense given the large cost incurred.

4.1.2. Production by industry

The changes in industrial production are presented in Table 3. In the US, the light-manufacturing sector (LightMnfc), and electronic and machinery equipment sector (ElecMach) expand, while the agriculture and processed food sector (Primary), and motor vehicles and parts, transport equipment sector (MoterTran) declines. In China, the opposite changes occur—expansion in the agriculture and processed food sectors (Primary) and contraction in the electronic equipment, machinery, and equipment sector (ElecMach).

There are several steps for effecting change from tariff increases to industrial production. First, in the country that raises the tariffs, the import prices from the targeted country increase so the relative import prices from other countries are lowered. As a result, imports from other countries substitute the imports from the targeted country. Second, even if substitution works, the average import price inevitably increases, so the domestic prices are relatively lowered to the average import price level. This drives domestic products to substitute imports, allowing an expansion in domestic production. The reduced demand for aggregate imports is then reallocated among the trading countries. Thus, the final effect of tariff increases contains not only a direct substitution among competitive exporters, but also an indirect substitution with domestic producers.

It is also important that changes in intermediary input price affect domestic production. In this case, the Chinese motor vehicles and parts, transport equipment (MoterTran) sector is slapped with additional 23.7% tariffs on its products by the US, but the output expands by 0.5%. On the contrary, when the US motor vehicles and parts, transport equipment (MoterTran) sector is imposed with additional 12.1% tariffs on its products by China, the output declines by 1%. At a glance, the protection levels are not consistent with output results in both countries. One of the reasons why the US "MoterTran" production declines could be the higher tariffs on intermediary inputs for the "MoterTran" sector—steel and metal (Metals), and electronic machinery and general machinery equipment (ElecMach). While additional tariff on steel and metal imports in China is 4%, it is 16.2% in the US. Further, additional tariffs on electronic machinery and general machinery equipment imports is 5.1% and 11.8% in China and the US, respectively. The domestic production of both in the US expand, but the "MoterTran" sector in the US has to use the intermediary inputs at higher prices, resulting in losing competitiveness in the global market.

The changes in production are not affected by a direct substitution with the third country caused by tariff increases in the US and China, but are affected by changes in production cost caused by tariff increases in other sectors. The relative price changes induced by tariffs also affect the comparative advantage of each country, resulting in an expansion and contraction at the sectoral levels.

4.1.3. Trade volume and price by industry

In Table 4, the changes in bilateral trade volume and prices in transport equipment are presented to show how changes in intermediary input costs and production are related. According to the simulation results for 8 countries out of the total 16 countries, the exports from China to the US falls by more than 70%, while the exports to other countries, on average, increase by 7–9 %. Whereas, the exports from the US not only falls by 50% to China, but also to other countries as well.

The reason the export performance of transport equipment in the two countries differs is because of changes in prices. The price of transport equipment from China in the US increases by 22% due to a hike in tariffs, but the price of the same products in other countries decreases thanks to a fall in production cost within China. Hence, an improved price competitiveness expands exports. On the contrary, the price of transport equipment from the US not only increases by 11% in China due to a hike in tariffs, but also increases in other countries due to a hike in production cost. Hence, the worsened price competitiveness contracts exports.

4.2. Impact of capital deepening and trade induced technology

4.2.1. Key macroeconomic indicators

The simulation exercise to demonstrate the effect of tariff increases alone shows that the bilateral measures to raise tariffs alter the comparative advantage among sectors in both countries with losses from distortion. It also proves that tariff increases do not change the levels of trade balance much and its spillover effect to the third country is marginal.

Although the short-term impact would not be significant, the changes in production and income should affect the long-term growth potential through savings and technological spillover induced by trade. In Table 5, the simulation results including capital deepening and trade induced technological changes are presented. As expected, the trade volume in the US and China decreases further and trade diversion effects become larger. The world trade declines by 0.6%, which is almost the same as in the previous case. The changes in the terms of trade become smaller, since a part of price changes are absorbed by the changes in real variables— capital stock and production. The GDP in the US and China declines by 1.6% and 2.5%, respectively.

In the third country, trade diversion effects allow it to boost income and investment, resulting in growth of capital stock, but the world GDP falls by 0.45%. The changes in equivalent variation in the US and China worsen by 199.5 billion and 187.1 billion USD, respectively, while the third countries gain marginally. The world total remains negative, recording losses of 287.2 billion USD. Since the real variables move more, the changes in trade balance are smaller than in the previous case.

4.2.2. Production by industry

The output changes by industry are shown in Table 6. Capital stock in the US and China falls by 2.7% and 3.3%, respectively due to a fall in income and investment. The long-term growth potential is lost permanently because of tariff increases.

In the US, only the light manufacturing sector production expands. Among the other sectors, the worst affected is the transport equipment, contracting by 2.5%. In China, only two sectors—

fuel and textile and apparel expand, while others contract. The worst affected is electronic machinery and general machinery, contracting by 3%.

These changes are generated by a dynamic mechanism between income, investment, and capital accumulation. In the long run, decreased investment weakens capital accumulation, resulting in a lower capital-labor ratio in the two countries. Further, a smaller trade volume brings poorer technological innovation to the economy as a whole, decreasing the growth potential.

4.2.3. Contribution of endogenous growth mechanisms

The two simulation cases suggest that the indirect effects from capital deepening and trade induced technological change are more significant than the direct effects from tariff increases. In Table 7, the contribution rate of four factors—tariffs, capital change, technological change, and cross-term—to total changes are shown.

In many countries, among four factors, "trade induced technological changes" contributes the maximum towards a change in the GDP. The contribution rate of "trade induced technological change" reaches 50% in Australia and China. It reaches 40% in the US and 30% in Hong Kong and Canada. "Capital deepening" contributes significantly in Mexico, almost 80%. It is also contributes more than 50% in the Asian countries, excluding Japan and Hong Kong. The level of contribution from these two factors are affected by the initial conditions in the respective countries.

As equivalent variations contain the effect from price changes, the contribution from "tariff increases" rises. In Hong Kong, East Asia, and Canada, 50% of total changes are attributable to "tariff increases." The contribution from "capital deepening" is again high in Mexico, East Asia, Southeast Asia, and South Asia. "Trade induced technological change" contributes significantly in Oceania, China, Japan, the US, Middle and South America, the EU, Middle East, and North Africa. The combination of source of changes varies by region.

5. Conclusion

5.1. Efficacy of retaliation

We examined the economic consequences of trade measures taken by both the US and China and confirmed that tariff increases would negatively affect both economies. Did China have to retaliate against the US this time? Is its action effective in mitigating the negative impact of the action taken by the US, or in preempting the US from taking further punitive actions? These questions are answered here based on the simulation results.

The effect of China's retaliatory measures and their effect, including capital deepening and trade induced technological changes are shown in Table 8 and Table 9, respectively. The GDP in the US falls by 0.00% points or 0.24% points, while the GDP in China falls by 0.11% points or 0.88% points. The equivalent variation in the US worsens by 11.4–40.4 billion USD, while in China it worsens by 3.6–55.9 billion USD.

At first glance, the retaliation induces losses of 11.4 billion USD in the US at the cost of 3.6 billion USD loss in China. Although this is not a welfare enhancing case as Li et. al. (2018) argue, it does seem to be a cost-effective measure according to the relative changes in equivalent variations. Having said that, one would find that another long-run simulation would show different results. The retaliation not only decreases the US GDP by 0.24% and equivalent variations by 40.4 billion USD, but it also decreases the Chinese GDP by 0.88% and equivalent variations by 55.9 billion USD. Eventually, China will lose more than the US.

5.2. Concluding remarks

This paper aims at evaluating the economic consequences of the 2018 US-China trade conflict. The potential impact of the proposed tariff increases is calculated using a global CGE model. Capital deepening and technological spillover induced by trade are also taken into account to explore the long-run influence. We can derive the following implications.

First, the additionally imposed tariffs on goods alone declines the GDP in the US and China by 0.1% and 0.2%, respectively. The equivalent variation in the US and China is reduced by 9.8 billion and 35.2 billion USD, respectively. Although other countries gain from trade diversion, losses exceed gains globally.

Second, considering the effect from capital deepening and technological spillover induced by trade makes the situation worse. The GDP in the US and China declines by 1.6% and 2.5%, respectively. The equivalent variation in the US and China is reduced by 199.5 billion USD and 187.1 billion USD, respectively. Again, the trade diversion is not large enough to recover losses in these countries.

Third, the imposed tariffs distort relative prices, resulting in changes to the global production structure. Both the US and China lose their comparative advantage in transport, electronic, and machinery equipment production, while other countries expand their production in these sectors.

Finally, China's retaliatory tariff increases worsens the US economy to some extent, but it comes at a cost to the Chinese economy. In the long run, retaliation is not an appropriate policy response.

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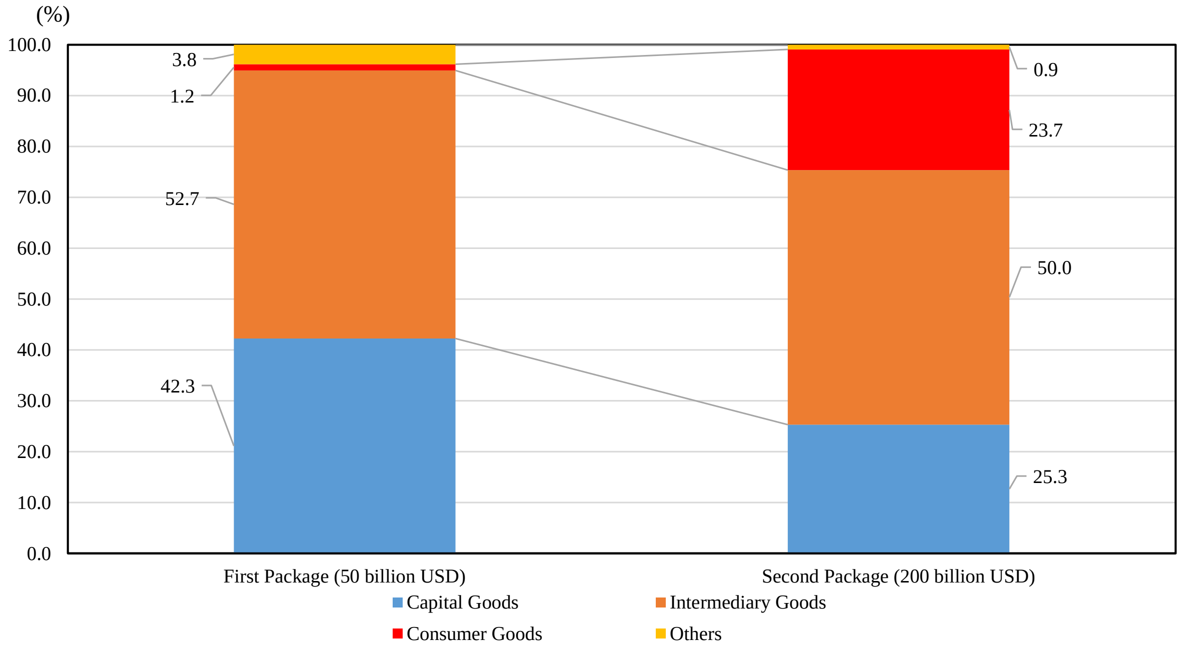
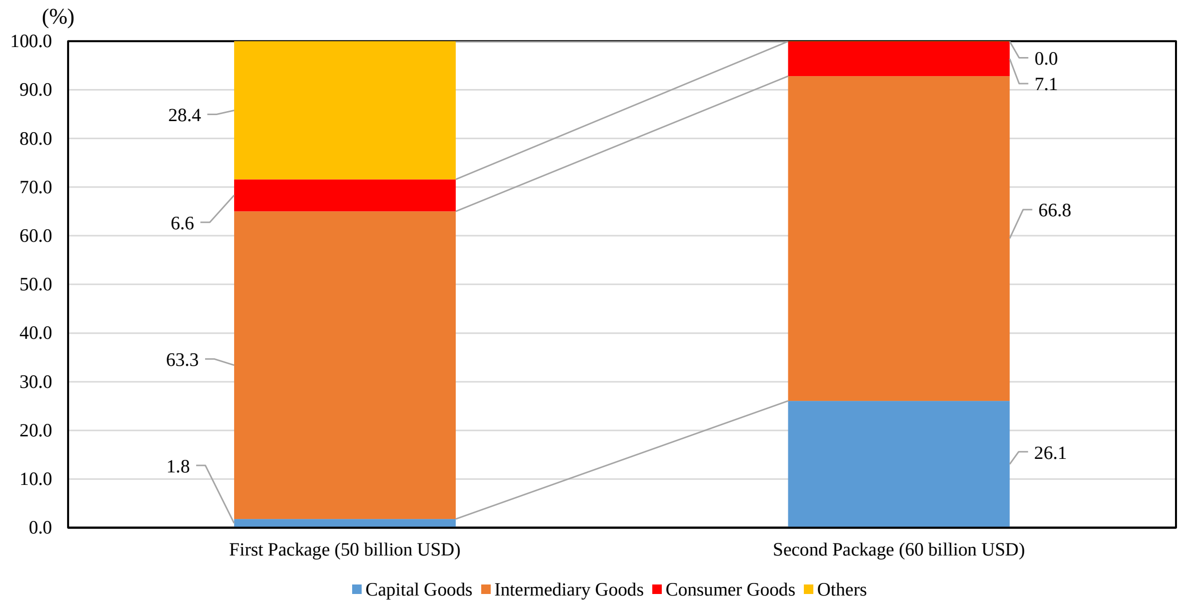
Figures and Tables

Figure 1　Outline of Tariff Increases by the US



(Source) Data from Bown, Jung, and Lu (2018).

Figure 2　Outline of Tariff Increases by China



(Source) Data from Bown, Jung, and Lu (2018).

Table 1 Additional Tariffs and Estimated Impact on Prices by Commodity/Industry

The US

Commodity/ Industry	Imports	Targeted Imports	Additional Tariffs	Effective Tariff Rate	Changes in Import Price
Primary	7,013	5,346	1,337	19.1	18.6
EnerSourc	657	530	132	20.1	20.1
TextWapp	38,979	3,449	862	2.2	2.0
PetChem	33,523	17,658	4,413	13.2	12.8
LightMnfc	102,132	43,469	10,868	10.6	10.1
Mineral	11,921	6,158	1,539	12.9	12.4
Metals	25,423	16,504	4,126	16.2	15.9
MoterTran	15,839	14,987	3,748	23.7	23.3
ElecMach	269,983	127,175	31,795	11.8	11.7
Util_Cons					
TransComm					
OthServices					
	505,470	235,276	58,820	11.6	

China

Commodity/ Industry	Imports	Targeted Imports	Additional Tariffs	Effective Tariff Rate	Changes in Import Price
Primary	21,930	21,842	5,136	23.4	22.4
EnerSourc	7,279	7,279	1,724	23.7	23.7
TextWapp	1,841	1,837	310	16.8	15.7
PetChem	22,268	20,879	2,847	12.8	12.1
LightMnfc	11,491	8,018	561	4.9	4.8
Mineral	9,293	9,292	805	8.7	8.3
Metals	5,480	3,159	219	4.0	3.9
MoterTran	29,231	15,017	3,525	12.1	10.7
ElecMach	45,628	28,433	2,323	5.1	4.9
Util_Cons					
TransComm					
OthServices					
	154,442	115,756	17,450	11.3	

(Remarks)

1. "Imports" data year is 2017 (Million USD). The US data are from USITC, and Chinese data are from ITC. "Targeted Imports" and "Additional Tariffs" are cited from Kobayashi and Hirono (2018b).
2. The "Effective Tariff Rate" is defined as "Additional Tariffs" divided by "Imports". "Changes in Import Price" is defined as ("Additional Tariffs" + imports including preexisting tariffs) / (imports including preexisting tariffs)-1.

(Source) USITC, https://dataweb.usitc.gov/, ITC, http://www.intracen.org/, and Kobayashi and Hirono (2018b).

Table 2 Changes in Key Indicators (by Tariff Increases)

	GDP	EV	ToT	Exports	Imports	TB
	% point	Million USD	% point	% point	% point	Million USD
Oceania	0.00	151	0.12	0.14	0.23	72
China	-0.21	-35,217	-1.23	-3.46	-4.94	-15,194
Hong Kong	0.00	158	0.11	0.13	0.24	4
Japan	0.00	2,280	0.30	0.24	0.66	-660
Korea	0.03	1,271	0.23	0.22	0.53	-72
E Asia	0.00	526	0.19	0.19	0.43	235
SE Asia	0.01	2,281	0.22	0.29	0.48	666
S Asia	0.01	900	0.16	0.28	0.34	-65
Canada	0.02	2,349	0.47	0.58	1.11	-346
USA	-0.09	-9,816	0.09	-3.61	-3.04	15,335
Mexico	0.03	3,107	0.93	0.56	1.69	27
L America	0.02	1,775	0.20	0.27	0.45	265
EU_25	0.01	4,645	0.07	0.08	0.16	-772
MENA	0.01	554	0.05	0.12	0.16	204
SSA	0.02	561	0.10	0.14	0.22	1
RoW	0.01	557	0.07	0.08	0.14	299
World Total	-0.03	-23,919		-0.56	-0.56	0

(Remarks) EV, ToT, and TB stand for “Equivalent Variation”, “Terms of Trade”, and “Trade Balance” respectively. Note that changes in TB are calculated from GTAP data which is not always same with actual figures in official statistics.
(Source) Author’s calculation.

Table 3 Changes in Production (by Tariff Increases)

	Oceania	China	Hong Kong	Japan	Korea	E Asia	SE Asia	S Asia
Primary	0.55	0.72	0.27	-0.04	-0.04	-0.01	0.05	0.07
EnerSourc	-0.03	0.60	0.06	-0.10	-0.11	-0.11	-0.15	-0.05
TextWapp	-1.46	2.04	-0.22	-1.05	-1.51	-2.17	-0.93	-0.77
PetChem	0.03	0.38	0.77	-0.05	0.03	0.00	-0.28	0.00
LightMnfc	-0.04	-1.68	1.06	-0.15	0.00	0.83	0.51	0.62
Mineral	-0.65	0.28	-0.01	-0.07	-0.03	-0.37	-0.40	-0.27
Metals	-0.15	-0.23	-0.05	-0.28	-0.24	-0.17	-0.44	-0.13
MoterTran	0.14	0.52	0.07	0.31	0.19	0.32	-0.13	0.04
ElecMach	0.11	-1.33	0.67	0.12	0.35	0.26	1.01	-0.17
Util_Cons	0.00	-0.21	0.01	0.06	0.13	0.11	0.07	0.03
TransComm	0.00	0.03	-0.16	-0.03	-0.18	-0.06	-0.08	-0.02
OthServices	0.00	-0.10	0.11	0.01	0.01	-0.03	-0.03	-0.01
	Canada	USA	Mexico	L America	EU_25	MENA	SSA	RoW
Primary	-0.42	-1.07	-0.66	0.15	0.06	0.05	0.12	0.07
EnerSourc	-0.38	-0.05	-0.65	-0.12	-0.04	-0.03	-0.04	-0.03
TextWapp	-1.82	-0.26	-2.70	-0.55	-1.09	-0.76	-0.89	-1.09
PetChem	0.02	-0.39	-1.13	0.05	0.09	0.10	-0.01	0.21
LightMnfc	1.49	1.30	0.69	-0.02	-0.08	0.91	-0.01	-0.04
Mineral	-0.52	0.12	-0.51	-0.43	-0.01	-0.08	-0.33	-0.13
Metals	0.15	0.44	-1.33	-0.05	0.01	-0.08	-0.09	-0.04
MoterTran	-0.16	-0.97	-2.51	-0.12	0.27	0.10	0.14	0.07
ElecMach	2.54	1.10	4.46	0.26	0.08	-0.05	-0.35	0.04
Util_Cons	0.15	-0.46	0.43	0.03	0.03	0.02	0.03	0.02
TransComm	-0.07	-0.04	-0.07	-0.01	-0.07	-0.02	-0.04	-0.03
OthServices	-0.10	0.03	-0.04	0.00	0.01	0.01	0.02	0.01

(Remarks) Figures are %.
(Source) Author’s calculation.

Table 4 Changes in Trade Volume and Price ("MoterTran" sector)

Volume	Importer							
Exporter	China	Japan	Korea	SE Asia	Canada	USA	Mexico	EU25
China		7.37	7.03	7.27	9.17	-70.78	8.28	7.55
Japan	0.86		-0.82	-0.58	1.21	2.92	0.39	-0.37
Korea	1.18	-0.15		-0.27	1.53	3.25	0.71	-0.06
SE Asia	0.96	-0.36	-0.72		1.32	3.03	0.50	-0.27
Canada	-1.57	-2.88	-3.23	-3.01		0.50	-1.98	-2.82
USA	-47.75	-1.22	-1.56	-1.34	0.51		-0.32	-1.14
Mexico	-4.35	-5.65	-5.87	-5.70	-3.94	-2.29		-5.67
EU25	1.36	0.03	-0.32	-0.09	1.72	3.44	0.89	

Price	Importer							
Exporter	China	Japan	Korea	SE Asia	Canada	USA	Mexico	EU25
China		-0.95	-0.95	-0.95	-0.94	22.14	-0.94	-0.96
Japan	0.24		0.24	0.24	0.24	0.24	0.24	0.24
Korea	0.19	0.19		0.19	0.19	0.19	0.19	0.19
SE Asia	0.22	0.22	0.22		0.22	0.22	0.22	0.22
Canada	0.62	0.63	0.63	0.63		0.62	0.62	0.63
USA	11.14	0.36	0.36	0.36	0.35		0.35	0.36
Mexico	1.08	1.08	1.07	1.07	1.07	1.06		1.10
EU25	0.16	0.16	0.16	0.16	0.16	0.16	0.16	

(Remarks) Figures are %.
(Source) Author's calculation.

Table 5 Changes in Key Indicators (with Capital and Technology Effects)

	GDP	EV	ToT	Exports	Imports	TB
	% point	Million USD	% point	% point	% point	Million USD
Oceania	0.07	728	0.03	0.09	0.21	-276
China	-2.46	-187,060	-1.07	-4.20	-6.11	-8,204
Hong Kong	0.17	291	-0.03	0.24	0.24	-25
Japan	0.23	12,654	0.26	0.34	0.72	-495
Korea	0.27	3,052	0.17	0.42	0.66	236
E Asia	0.22	1,168	0.12	0.34	0.50	515
SE Asia	0.46	10,232	0.15	0.68	0.92	-27
S Asia	0.23	5,171	0.15	0.29	0.55	-1,599
Canada	0.29	5,282	0.25	0.63	0.99	-534
USA	-1.60	-199,473	0.35	-4.52	-3.53	14,735
Mexico	1.25	14,394	0.54	1.67	2.36	569
L America	0.22	9,780	0.13	0.28	0.55	-1,007
EU_25	0.15	24,244	0.06	0.19	0.29	-2,189
MENA	0.20	5,982	-0.04	0.23	0.29	-926
SSA	0.16	1,698	-0.01	0.24	0.29	-416
RoW	0.14	4,687	0.02	0.18	0.29	-358
World Total	-0.45	-287,172		-0.61	-0.61	0

(Remarks) EV, ToT, and TB stand for "Equivalent Variation", "Terms of Trade", and "Trade Balance" respectively. Note that changes in TB are calculated from GTAP data which is not always same with actual figures in official statistics.
(Source) Author's calculation.

Table 6 Changes in Production (with Capital and Technology Effects)

	Oceania	China	Hong Kong	Japan	Korea	E Asia	SE Asia	S Asia
Capital Stock	0.16	-3.32	0.24	0.43	0.54	0.50	0.77	0.44
Technological Change	0.01	-0.27	0.02	0.02	0.01	0.01	0.02	0.01
Primary	0.55	0.00	0.41	0.14	0.08	0.11	0.16	0.17
EnerSourc	-0.02	0.08	0.05	-0.10	-0.08	-0.10	-0.05	-0.03
TextWapp	-1.38	1.45	0.02	-1.00	-1.35	-2.00	-0.58	-0.72
PetChem	0.22	-0.89	0.90	0.18	0.31	0.24	0.30	0.30
LightMnfc	0.11	-3.02	1.46	0.07	0.29	1.10	1.05	0.85
Mineral	-0.89	-1.50	0.36	0.11	0.25	-0.35	-0.01	-0.17
Metals	0.24	-1.93	0.65	0.00	0.28	0.22	0.34	0.29
MoterTran	0.32	-1.72	0.45	0.46	0.56	0.61	0.56	0.40
ElecMach	0.54	-3.27	1.03	0.37	0.68	0.49	1.81	0.35
Util_Cons	0.12	-2.75	0.18	0.32	0.42	0.35	0.66	0.36
TransComm	0.06	-1.55	-0.10	0.15	0.00	0.12	0.35	0.21
OthServices	0.07	-1.88	0.30	0.21	0.22	0.16	0.40	0.19
	Canada	USA	Mexico	L America	EU_25	MENA	SSA	RoW
Capital Stock	0.58	-2.74	1.90	0.43	0.31	0.32	0.31	0.29
Technological Change	0.03	-0.38	0.02	0.01	0.01	0.00	0.00	0.01
Primary	-0.09	-2.29	0.17	0.24	0.14	0.17	0.19	0.13
EnerSourc	-0.30	-0.82	-0.42	-0.12	-0.04	-0.03	-0.06	-0.03
TextWapp	-1.55	-1.85	-1.61	-0.46	-1.05	-0.55	-0.78	-1.03
PetChem	0.54	-1.67	0.42	0.38	0.29	0.48	0.29	0.49
LightMnfc	1.83	0.26	2.20	0.22	0.09	1.16	0.23	0.12
Mineral	-0.25	-0.66	0.69	-0.41	0.14	0.16	-0.37	-0.02
Metals	0.60	-0.58	0.78	0.30	0.20	0.41	0.43	0.27
MoterTran	-0.22	-2.42	-1.07	0.19	0.37	0.50	0.52	0.28
ElecMach	3.04	-0.23	6.11	0.73	0.35	0.51	0.18	0.34
Util_Cons	0.44	-1.60	1.68	0.35	0.23	0.29	0.27	0.23
TransComm	0.15	-1.13	1.15	0.18	0.02	0.16	0.14	0.11
OthServices	0.11	-1.11	1.16	0.19	0.13	0.17	0.15	0.12

(Remarks) Figures are %.
(Source) Author’s calculation.

Table 7 Decomposition of Contribution to GDP and EV changes

GDP (%)	Tariffs	Capital	Technology	Cross term	Total
Oceania	0.0	14.3	46.4	39.3	0.07
China	8.5	20.7	53.8	17.0	-2.46
Hong Kong	0.0	23.5	35.0	41.5	0.17
Japan	0.0	30.4	22.6	46.9	0.23
Korea	11.1	48.1	14.7	26.1	0.27
E Asia	0.0	63.6	21.0	15.3	0.22
SE Asia	2.2	47.8	12.7	37.3	0.46
S Asia	4.3	39.1	21.8	34.7	0.23
Canada	6.9	44.8	31.1	17.1	0.29
USA	5.6	14.4	41.0	39.0	-1.60
Mexico	2.4	78.4	3.5	15.7	1.25
L America	9.1	31.8	20.4	38.7	0.22
EU_25	6.7	26.7	12.6	54.0	0.15
MENA	5.0	25.0	11.4	58.6	0.20
SSA	12.5	37.5	12.4	37.6	0.16
RoW	7.1	21.4	11.1	60.3	0.14
World Total	7.6	9.4	57.0	26.1	-0.45

EV (Million USD)	Tariffs	Capital	Technology	Cross term	Total
Oceania	20.7	-5.9	82.5	2.7	728
China	18.8	17.7	50.2	13.3	-187,060
Hong Kong	54.2	17.7	0.3	27.8	291
Japan	18.0	21.9	23.7	36.5	12,654
Korea	41.6	30.4	16.4	11.5	3,052
E Asia	45.1	38.8	20.9	-4.8	1,168
SE Asia	22.3	37.6	11.0	29.1	10,232
S Asia	17.4	32.7	16.3	33.7	5,171
Canada	44.5	25.8	35.5	-5.9	5,282
USA	4.9	10.2	51.8	33.1	-199,473
Mexico	21.6	64.8	4.2	9.4	14,394
L America	18.2	30.3	25.0	26.5	9,780
EU_25	19.2	22.4	14.6	43.9	24,244
MENA	9.3	17.2	33.6	39.9	5,982
SSA	33.1	25.5	28.1	13.3	1,698
RoW	11.9	17.5	28.7	41.9	4,687
World Total	8.3	7.8	62.2	21.7	-287,172

(Remarks) Figures in “Tariffs”, “Capital”, “Technology”, and “Cross term” are contribution rates (%) to “Total”.
(Source) Author’s calculation.

Table 8 Effect of Retaliation by China (Tariff Increases)

	GDP	EV	ToT	Exports	Imports	TB
	% point	Million USD	% point	% point	% point	Million USD
Oceania	-0.00	450	0.12	0.02	0.19	-190
China	-0.11	-3,594	0.18	-1.12	-1.18	-24
Hong Kong	-0.00	20	-0.00	0.05	0.07	-22
Japan	-0.00	920	0.06	-0.05	0.14	-1,037
Korea	0.04	826	0.07	0.06	0.18	-94
E Asia	-0.00	332	0.08	0.12	0.26	97
SE Asia	-0.00	600	0.04	0.01	0.05	28
S Asia	-0.01	208	0.02	-0.05	0.03	-405
Canada	-0.00	665	0.12	0.03	0.21	-296
USA	-0.00	-11,441	-0.44	-0.63	-0.98	5,993
Mexico	-0.00	222	0.07	0.03	0.17	-188
L America	0.00	883	0.08	0.02	0.15	-327
EU_25	0.00	1,418	0.01	-0.02	0.03	-2,602
MENA	-0.00	186	-0.01	0.00	0.03	-445
SSA	-0.00	-19	-0.01	0.00	0.03	-159
RoW	0.00	214	-0.00	-0.00	0.03	-327
World Total	-0.01	-8,108		-0.18	-0.18	0

(Remarks) EV, ToT, and TB stand for “Equivalent Variation”, “Terms of Trade”, and “Trade Balance” respectively. Note that changes in TB are calculated from GTAP data which is not always same with actual figures in official statistics.

(Source) Author’s calculation.

Table 9 Effect of Retaliation by China (with Capital and Technological Effects)

	GDP	EV	ToT	Exports	Imports	TB
	% point	Million USD	% point	% point	% point	Million USD
Oceania	0.07	1,213	0.08	0.05	0.22	-290
China	-0.88	-55,932	0.25	-1.40	-1.48	372
Hong Kong	0.12	191	-0.06	0.15	0.12	-16
Japan	0.07	3,817	0.04	0.05	0.15	-393
Korea	0.14	1,579	0.04	0.16	0.23	117
E Asia	0.17	960	0.05	0.27	0.36	282
SE Asia	0.11	2,586	0.02	0.12	0.18	-141
S Asia	0.04	1,104	0.01	-0.04	0.08	-793
Canada	0.08	1,462	0.07	0.07	0.21	-263
USA	-0.24	-40,414	-0.39	-0.77	-1.03	4,953
Mexico	0.19	1,997	0.01	0.21	0.26	-92
L America	0.09	4,542	0.06	0.06	0.22	-746
EU_25	0.06	10,091	0.01	0.06	0.09	-1,593
MENA	0.10	3,738	-0.02	0.07	0.12	-719
SSA	0.06	559	-0.03	0.05	0.07	-262
RoW	0.06	2,547	-0.01	0.06	0.10	-417
World Total	-0.09	-59,960		-0.16	-0.16	0

(Remarks) EV, ToT, and TB stand for "Equivalent Variation", "Terms of Trade", and "Trade Balance" respectively. Note that changes in TB are calculated from GTAP data which is not always same with actual figures in official statistics.

(Source) Author's calculation.

Appendix

Appendix 1 Regional Aggregation

No.	Country/Region	Countries and Regions in GTAP Data
1	Oceania	Australia, New Zealand, Rest of Oceania
2	China	China
3	Hong Kong	Hong Kong
4	Japan	Japan
5	Korea	Korea
6	E Asia	Mongolia, Taiwan, Rest of East Asia
7	SE Asia	Brunei Darussalam, Cambodia, Indonesia, Lao People's Democratic Republic, Malaysia, Philippines, Singapore, Thailand, Viet Nam, Rest of Southeast Asia
8	S Asia	Bangladesh, India, Nepal, Pakistan, Sri Lanka, Rest of South Asia
9	Canada	Canada
10	USA	USA
11	Mexico	Mexico
12	L America	Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, Uruguay, Venezuela, Rest of South America, Costa Rica, Guatemala, Honduras, Nicaragua, Panama, El Salvador, Rest of Central America, Dominican Republic, Jamaica, Puerto Rico, Trinidad and Tobago, Caribbean
13	EU_25	Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, United Kingdom
14	MENA	Bahrain, Iran Islamic Republic of, Israel, Jordan, Kuwait, Oman, Qatar, Saudi Arabia, Turkey, United Arab Emirates, Rest of Western Asia, Egypt, Morocco, Tunisia, Rest of North Africa
15	SSA	Benin, Burkina Faso, Cameroon, Cote d'Ivoire, Ghana, Guinea, Nigeria, Senegal, Togo, Rest of Western Africa, Central Africa, South Central Africa, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Mozambique, Rwanda, Tanzania, Uganda, Zambia, Zimbabwe, Rest of Eastern Africa, Botswana, Namibia, South Africa, Rest of South African Customs
16	RoW	Rest of North America, Switzerland, Norway, Rest of EFTA, Albania, Bulgaria, Belarus, Croatia, Romania, Russian Federation, Ukraine, Rest of Eastern Europe, Rest of Europe, Kazakhstan, Kyrgyzstan, Rest of Former Soviet Union, Rest of the World, Armenia, Azerbaijan, Georgia

(Source) GTAP Data version 9.0.

Appendix 2 Commodity/Industry Aggregation

No.	Commodity/Industry	GTAP Data Classification
1	Primary	Paddy rice, Wheat, Cereal grains nec, Vegetables, fruit, nuts, Oil seeds, Sugar cane, sugar beet, Plant-based fibers, Crops nec, Cattle, sheep, goats, horses, Animal products nec, Raw milk, Wool, silk-worm cocoons, Forestry, Fishing, Meat: cattle, sheep, goats, horse, Meat products nec, Vegetable oils and fats, Dairy products, Processed rice, Sugar, Food products nec, Beverages and tobacco products
2	EnerSourc	Coal, Oil, Gas
3	TextWapp	Textiles, Wearing apparel
4	PetChem	Petroleum, coal products, Chemical, rubber, plastic prods
5	LightMnfc	Leather products, Wood products, Paper products, publishing, Manufactures nec
6	Mineral	Minerals nec, Mineral products nec
7	Metals	Ferrous metals, Metals nec, Metal products
8	MoterTran	Motor vehicles and parts, Transport equipment nec
9	ElecMach	Electronic equipment, Machinery and equipment nec
10	Util_Cons	Electricity, Gas manufacture, distribution, Water, Construction
11	TransComm	Trade, Transport nec, Sea transport, Air transport, Communication
12	OthServices	Financial services nec, Insurance, Business services nec, Recreation and other services, Pubic Admin. / Defense / Health / Education, Dwellings

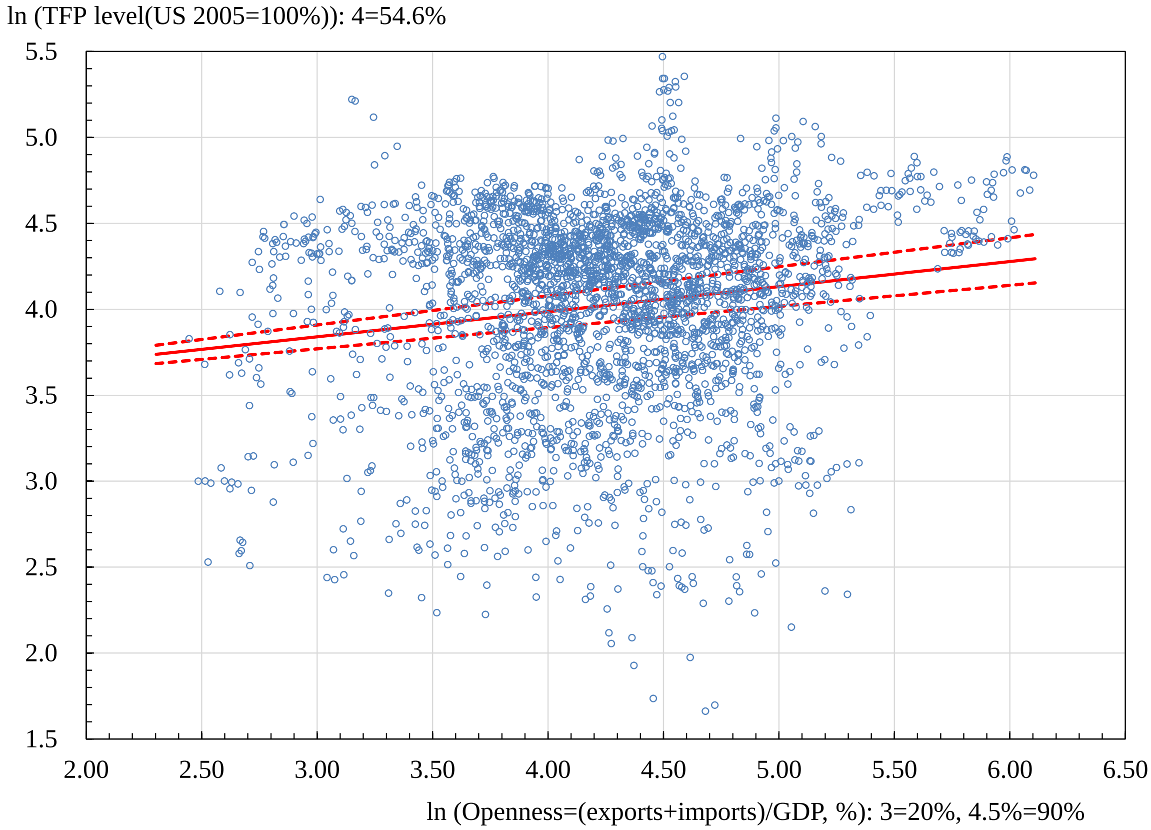
(Source) GTAP Data version 9.0.

Appendix 3 Substitution Parameters (Armington Parameters)

No.	Commodity/Industry	Domestic and Imports	Among Source of Imports
1	Primary	2.45	5.00
2	EnerSourc	6.96	13.98
3	TextWapp	3.73	7.46
4	PetChem	2.89	6.05
5	LightMnfc	3.36	7.02
6	Mineral	2.13	3.07
7	Metals	3.54	7.38
8	MoterTran	3.16	6.37
9	ElecMach	4.16	8.34
10	Util_Cons	2.10	4.60
11	TransComm	1.90	3.80
12	OthServices	1.90	3.80

(Source) GTAP Data version 9.0.

Appendix 4 Trade Openness and TFP



(Remarks)

1. Data are from Penn World Table and the World Bank. The sample size: 109 countries from 1980 to 2011.
2. Estimated correlation (red line): ln(TFP)＝7.20 +0.15*ln(Openness)-0.41*ln(population)+Country Dummy
   (26.31)(6.34) (-13.30)

Adjusted R2: 0.79

Note that dotted lines are sensitivity results of the "Openness" parameter (one standard deviation).

(Source) Figure 2-8 in Government Headquarters for the TPP, Japan (2015).