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Evaluating the Impact of the U.S.-China Trade War

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Evaluating the Impact of the US – China Trade War

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April 8, 2019

Abstract

We evaluate the impact of the US-China trade war using a recursively dynamic computable general equilibrium (CGE) model of the global trade. We conduct ex ante simulation analysis exploring three scenarios how the trade war affects the import tariffs in 2018 and in 2019. Escalation of the trade war in 2019 results in the largest welfare loss, -0.5% for China and -0.4% for the US. The trade war tariffs reduce all imports to the US and China. Sectoral industrial outputs are lowered, except for machinery, electric equipments and petrochemical production in the US. Private consumptions decrease as the trade war intensifies, thereby leading to the welfare loss. To reflect the role of Global Value Chain, we modify the dynamic CGE model with agent specific import demand, and we explore difference between the models for the impact on welfare and bilateral imports. The welfare impacts tend to be smaller in the modified model, and the negative impact on bilateral imports are more consistent with the impact on sectoral outputs. These results suggest that the GVCs plays substantial role in determining import responses at the disaggregated level.

JEL Code: F13, F14, F17
Keywords: Trade War, CGE model, GVC

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1 Introduction

In 2018, the two world largest economies exchanged rounds of the imposition of import tariffs against each other, and it escalated into the US-China trade war. As the US levied import tariffs on steel and aluminum in March 2018, China retaliated in April with tariffs on aluminum, meat, fruit, and wine imported from the US. Other countries exporting steel and aluminum to the US also raised import tariffs against the US in retaliation. The trade dispute intensified between the US and China, and the US imposed additional 25% tariffs on $50 billion dollars worth of imports from China; $34 billion in July and $16 billion in August. In tit-for-tat, China reciprocated with 25% tariffs on imports from the US worth $50 billion dollars. In September, further escalation led the US to impose 10% tariffs on additional $200 billion of imports from China. In response, China levied tariffs on additional $60 billion US imports. Late in 2018, the US announced that the 10% tariffs on $200 billion imports from China would increase to 25% in January 2019, but it has been pending as of March 2019. Also, China has been holding back the additional tariffs on $50 billion dollars worth of the US exports.

While there has been a truce in the US-China trade war since December 2018, it is not clear that the import tariffs implemented over the course of 2018 will remain at the current level, or they will return to the level before the trade war, or they will further increase by the amount already announced. Our aim in this paper is to evaluate the potential economic effects of the US-China trade war by simulating three counterfactual scenarios on how the import tariffs will change. We use a recursively dynamic computable general equilibrium (CGE) model of global trade to quantify the economic impacts. In our CGE model, we explore two different import demand specifications to shed light on the impacts of the trade war between the US and China on other countries through Global Value Chains (GVCs), or intermediate input trade. The first specification is based on the conventional trade model in which the import demand is represented by country. The second specification allows agent specific import demand in which agents are producers, consumer and government. With the latter specification, we attempt to analyze the impact on bilateral imports. As Bown et al. (2018) report that the trade war tariffs are concentrated on intermediate inputs and capital equipments, the impact of the trade war would be more notable for production and investment using the intermediate inputs affected by the tariffs. In our simulation experiments, we conduct three scenarios by changing the import tariffs in 2018 and in 2019. The results we obtained are ex ante estimates of the US-China trade war.

A number of recent studies provides ex ante estimates of the trade war. Balistreri et al. (2018) find that the US-China trade war results in negative welfare effects on US and China, -1.02% and -1.7% respectively, while other countries observe small but positive welfare impacts arising from trade diversion. Balistreri et al. (2018) explore three different trade specifications in their CGE model. In the first specification, the conventional trade model of Armington (1969) assumes perfectly competitive markets and constant returns to scale production. The second specification is based on Krugman (1980) which assumes imperfect competition and increasing returns to scale. The third specification extends the second for extensive margin of trade. When the first and the second specifications are used in their simulation, the negative welfare impacts become smaller than the third; -0.20% for the US and -0.34% for China under the first specification, and -0.22% and -0.63% under the second. Balistreri et al. (2018) use the database developed by Li (2018) for quantifying the increases in import tariffs, and we use the same database for our computation.

Bollen & Rojas-Romagosa (2018) show that the US-China trade war following the steel and aluminum tariffs and retaliations lowers GDP by -0.4% for the US and -1.2% for China. They estimate the increases in import tariffs by collecting the official documents specifying targeted products at the Harmonized System at the 4 and 8 digit levels and aggregating them up to the industry level. Their method is basically same as the one used for the tariff database construction by Li (2018).

Walmsley & Minor (2018) estimate the impact of trade war involving not only US and China but also Canada, Mexico, EU, Russia, Japan, India, and Korea. It reports that the trade war reduces the US GDP by -1.78% in 2019 and -1.25% in 2030. The large loss in the GDP can be attributed to the broad scope of trade war and the bigger increases in import tariffs simulated in their study. Walmsley & Minor (2018) use a recursively dynamic CGE model with GVCs. We follow their modeling strategy to incorporate GVCs.

Devarajan et al. (2018) simulate trade war of the US against EU, China, Mexico, Canada, and Japan, considering developing countries' possible response to the trade war. Developing countries have choices whether or not they participate in the trade war, or they make regional trade agreements without the US. The effect of the trade war on GDP is -0.3% for the US and -0.1% for China. The impact on Asian countries are reported in a few regional aggregates in Devarajan et al. (2018).

The studies cited above provide estimates of the impacts of trade war by conducting counterfactual simulation with CGE model. Although there exist differences in their CGE models, they utilize the same global economic database, the GTAP database, developed by the Center for Global Trade Analysis. We use the GTAP database and the model for the conventional specification of import demand represented by country. As for the agent specific import demand, we modify the database and the model to introduce GVCs. We bring the most recent GVCs data from the OECD into our analysis.

Unlike the ex ante estimates based on counterfactual simulations, Amiti et al. (2019) show an ex post estimate of the impact of the US-China trade war in 2018 on US prices and welfare. They find that the welfare loss from the trade war is $1.4 billion dollars per month, and it would be less than 0.1% of the US GDP. Although their estimate is based on partial equilibrium analysis, their results are comparable to those obtained from the CGE analysis. As more data describing the year of 2018 becomes available, we will be able to have more ex post empirical studies on the trade war.

2 Tariffs in the Trade War 2018–2019

The CARD Trade War Tariffs Database (Li 2018) stores information on the increases in import tariffs by the US and the countries which have retaliated against the US in 2018. The database begins with the steel and the aluminum tariffs imposed by the US in March, 2018, and it covers the top 20 countries exporting steel and/or aluminum to the US.[1] The retaliatory tariffs against the US steel and aluminum tariffs are reported by China, Canada, EU, India, Mexico and Turkey. The increase in tariffs scheduled in January 2019 but not implemented are also available for the US and China.

The Harmonized System at 6 digit codes are used to aggregate the raw data on tariff increases. Then, the resulting tariffs at the HS6 level are further aggregated to the GTAP's traded commodities. When we aggregate the tariff increases from the disaggregated level, we apply trade-weighted average. In this study, we aggregate the 57 sectors in the GTAP database (Aguiar et al. 2016) to the 14 sectors, and the 140 regions to 19 regions (Table A1 and Table A2).

Table 1 reports the increase in import tariffs for 2018 and 2019. The US raised tariffs on imports from China over the course of 2018 by the amounts ranging from 1.8 percentage point on textile and wearing apparel imports (TextApparel) to 21.2 percentage point on machinery imports. In retaliation, China imposed extra tariffs on top of the existing tariffs on imports from the US. The amounts of the tariff increase in China are larger, for example the additional tariff of 34 percentage points is levied on automobile imports (Auto) from the US. Responding to the imposition of steel and aluminum tariffs

[1] They are United Arab Emirates, Argentina, Australia, Bahrain, Brazil, Canada, China, E.U., India, Japan, Korea, Mexico, Qatar, Russia, South Africa, Thailand, Turkey, Taiwan, Venezuela, Viet Nam, and rest of the world.

by the US, which is reported in Table 2, India raised tariffs on agricultural products from the US. Canada and Mexico are aggregated with Chili and Peru as the TPP member countries in the Western Hemisphere (WHTPP), and they retaliated with the import tariffs. EU and the rest of the world (ROW) implemented retaliatory tariffs against the US in 2018. For 2019, the US and China have not implemented the increase in import tariffs, and the last two columns in Table 1 show the potential increases.

2.1 Simulation Scenarios

We use the tariff increases in Table 1 and Table 2 as the key inputs to our simulation analysis. To identify the impact of changes in import tariffs, we need to construct a baseline scenario, which is a hypothetical future state of the global economy absent from the trade war. The baseline scenario is used as the basis of the comparisons against the counterfactual scenarios of the trade war which is described by the changes in import tariffs in 2018 and in 2019.

For our baseline construction, we begin with the Global Trade Analysis Project (GTAP) Data Base version 9 (Aguiar et al. 2016). The GTAP Data Base records the entire global economy with detailed information on 57 industrial sectors in 140 regions. With this database, we are able to observe the economic structure of production, international trade and protection, and consumption, benchmarked at the year 2011. The GTAP Data Base is supplemented with international factor income flows due to domestic and foreign asset holdings. To reflect the current and prospective states of the global economy, we rely on projections from the United Nations (2017) and International Monetary Fund (2018). United Nations (2017) provides projections for the total population and working age population. Projections for the growth rates of real GDP and gross investment are obtained from International Monetary Fund (2018). The baseline scenario includes the regional trade agreements which has been in effect. The regional trade agreements in the baseline scenario are ASEAN FTA, ASEAN-China, ASEAN-Korea, ASEAN-Japan, ASEAN-Australia-New Zealand, ASEAN-India, EU-Korea, Korea-US, China-Korea, Australia-Japan, Australia-Korea, Australia-China, and TPP sans the US.

The baseline scenario is constructed for 2011–2035. Three scenarios for the US-China trade war are designed for our simulation experiments, and they are implemented in 2018 and in 2019.

Scenario 1: (Truce) Import tariffs are increased in 2018 by the amount listed in Table 1 and Table 2, and they are kept throughout the simulation period to 2035.

Scenario 2: (Peace) Import tariffs are increased in 2018 by the amount listed in Table 1 and Table 2, but they return to the level before the trade war.

Scenario 3: (Escalation) Import tariffs are increased in 2018 and in 2019 by the amount listed in Table 1 and Table 2.

In Scenario 1, the US, China, India, Canada and Mexico (WHTPP), EU, and the rest of the world (ROW) raise the import tariffs in 2018, by the amount listed under the columns "2018" in Table 1. Two columns under "2019" are not included. Also, in 2018, the US implements steel and aluminum tariffs in Table 2. We keep the increased import tariffs to the end of simulation period 2035. Scenario 2 is same as Scenario 1 for 2018, but the import tariffs are returned to the level before the trade war, in other words, to the baseline level. Scenario 3 share the same implementation for 2018 as Scenario 1 and 2, but the US and China impose additional tariffs which are listed in two columns under "2019" in Table 1.

Figure 1 illustrates the three scenario over the simulation period for the US and China. Figures for the US tariffs on imports from China are placed in the first row in the panel. Three figures in the second row are for the Chinese tariffs on imports from the US. Figure 1 highlight the difference among the three scenarios. Scenarios 2 is just one time hike in 2018, and Scenario 3 shifts up the tariff levels. It should be noted that the increase in import tariffs is measured by percent changes relative to the baseline.[2]

3 Overview of the CGE Models

3.1 Dynamic GTAP model

For our simulations in this study, we use the dynamic GTAP model developed by Ianchovichina & McDougall (2001) and updated by Ianchovichina & Walmsley (2012). Ianchovichina & McDougall (2001) extended the comparative static standard GTAP model (Hertel 1997, McDougall 2003) by introducing international capital mobility and capital accumulation. In the standard GTAP model, capital is assumed to be mobile across sectors in a country but not across borders. The dynamic GTAP model preserves all the main features of the standard GTAP model: constant return to scale of production technology, perfectly competitive markets, and product differentiation by origin, known as the Armington assumption (Armington 1969).

[2]For example, if 15% tariff rate in the baseline is increased by 25 percentage points, the resulting tariff rate is 40%, which is 21.7% change relative to the baseline.

The structure of the model is summarized in Figure 5. Tree at the left-hand side illustrates producer's nested demand structure. To produce an output O_{js}, the Leontief production function combines the value-added composite VA_{js} and intermediate inputs X_{ijs}. The value-added composite consists of skilled and unskilled labor, capital and specific factors such as land and natural resources. Sectoral output is supplied to domestic market D_{ijs} for producers' intermediate input use, and for private household's consumption, and for government's public use. Sectoral output also serves to foreign markets as export.

In the righthand tree, representative household's utility U_s, the basis of welfare measure, is derived from sub-utilities of private household U_s^P, government U_s^G and savings U_s^S, with a Cobb-Douglas-type function. The private household's utility is, then, determined by the constant difference elasticity function of the composite goods X_{is}. For the government, the CES function is applied. Because of the non-homotheticity in the private household's sub-utility, the adjustment parameter to sift expenditure is introduced by McDougall (2003).

At the bottom of the tree diagram, import demand M_{is} is defined for country s. At the border of country s, imports from different countries Q_{irs}, are aggregated into an import composite M_{is} by the CES function. Then, the import composite is aggregated with domestically produced good D_{is}. Thus, there are two stages of aggregation; first at the bottom of diagram, aggregation from each import source to a composite, and then aggregation of the composite with domestic good. This is the double-nest Armington import demand structure implemented in the GTAP model, and the CES function is used for the aggregation.

In the dynamic GTAP model, each region is endowed with a fixed physical capital stock, and physical capital is accumulated over time with new investments. Investment is sourced from regional households' savings. Investment is a composite of domestic investment and foreign investment. Incentives for investments are governed by rates of return, which would be equal across regions if capital were to be perfectly mobile. However, this equalization of the rates of return seems impractical, at least in the short run. Further, there are empirical observations of the so-called home bias in savings and investment. The dynamic GTAP model allows interregional differences in rates of return in the short run, which are eventually equalized in the long run. With this feature in the dynamic GTAP model, we assume perfect capital mobility applies only in the long run. We conduct long-run simulations for the period 2011 to 2035 with the dynamic GTAP model.

3.2 Modification with GVCs

We modify the import demand in the dynamic GTAP model to reflect the Global Value Chains (GVCs) in which each agent determines demand for imports. Our modifications to reflect GVC structure in the dynamic GTAP model does not change the mechanism of capital accumulation and international capital mobility. To capture the GVCs with data, we rely on multi-regional input-output tables for a consistent way to disentangle the internationally connected production structure, by distinguishing the source and the destination of goods in details. A typical MRIO table can show how much of one industry's intermediate inputs are sourced from other industries in foreign countries as well as domestic industries. Similarly, the sources of final demands can be traced back to the origin where an industry produces that goods. Thus, in a MRIO table, imports are uniquely recorded by source, destination, and agents who are producers, consumers, and governments.

We use the Inter-Country Input-Output (ICIO) Tables, which were recently published by Organization for Economic Co-operation and Development (2018). With the ICIO tables, we are able to incorporate agent specific import demand into the dynamic GTAP model, following the modeling strategy in Itakura & Oyamada (2015). Import demand is defined for each agent, rather than defined for each country, and the corresponding price indices as well as the trade flows are also defined as agent specific in the database and the model. In Figure 5, at the bottom nest, import composite M_{is} aggregates Q_{irs} over the sourcing countries. For the agent specific import demand, we define the bottom nest aggregation of import composite for each agent. To highlight the role of agent specific import demand, we implement Scenario 1 up to 2020 with the modified model.

4 Simulation Results

We obtain simulation results by running the three counterfactual scenarios. Once the US-China trade war and the US steel and aluminum tariffs and the retaliatory tariffs are implemented in 2018, all import volumes fall below the baseline in the US and in China. Import volumes are measured in 2011 constant US dollar, and percent changes relative to the baseline are computed. Figure 2, 3, and 4 present the impact on the import volume in the US and in China for the three scenarios. Because of the steel and aluminum tariffs, the US import of metals show the largest decrease. Although the US-China trade war tariffs are removed in 2019 in Scenario 2, the steel and aluminum tariffs and the retaliatory tariffs are left unchanged, thereby metal imports remain lowered below the baseline in Figure 3. For import volumes in China, transport equipments (TransEquip) and agricultural imports are mostly affected in all scenarios.

Table 3 reports the impact on sectoral output in the US and in China for 2035, measured in percent changes relative to the baseline for that year. The US increases output of machinery, electric equipments, and petrochemical production, largely because their domestic sales increase due to the higher import tariffs. Imported intermediate inputs become expensive for all sectors, and the factor prices of capital and labor rise, hence forcing transport equipment and auto sectors to contract their production. On the other hand, China decrease output of machinery and electric equipment as their exports to the US drastically fall.

Table 4 present the impact on private consumption in the US and in China for 2035. The US and China decrease private consumption for almost all goods. The fall in imports are so large to overwhelm substitution effects toward domestic products. A few exceptions are observed in the US agriculture and mining where the substitution effects exceed. There is effectively no change in Chinese private consumption in Scenario 2.

Table 5 provide the impact on welfare for 2035. We take the representative regional household's utility for the welfare measure in percent change relative to the baseline, and it corresponds to U_s in Figure 5. Equivalent variation is used for the economic welfare based on real income evaluated in constant 2011 US dollar.

When the US-China trade war escalate under Scenario 3, China has the largest welfare loss in 2035 by -0.52% below the baseline, which amounts to -131 billion dollars in real income. The US also lose economic welfare by -0.42%. However, the welfare loss occurred in China and the US becomes substantially smaller under Scenario 1, and which clearly suggest that avoiding the escalation of the trade war serves to their economic welfare. Above all, it is obvious that Scenario 2 is the best outcomes in economic welfare as the US and China end the trade war.

Table 6 provides a model comparison for welfare impact under Scenario 1, evaluated in 2020. We compare the welfare results obtained from the dynamic GTAP model with the modified dynamic GTAP model with GVCs. Welfare impact tends to be smaller in the modified model with GVCs which treats import demand as agent specific. It suggests that the negative effects are disseminated through GVCs. In fact, Taiwan, Singapore, and India turn the positive welfare impact to be negative, although they are small, when GVCs are introduced.

Table 7 provides another comparison for the impact on bilateral import of China from Japan under Scenario 1 in 2020. Difference in the results between the models is more pronounced at disaggregated level. The bilateral import of China from Japan is an aggregate of agents' response to the trade war tariffs. Thus, in the dynamic GTAP model, one representative agent in China determines the import demand response with respect to Japan. However, in the modified dynamic GTAP model with GVCs, there are producers, a representative consumer, and a government, who are jointly affecting the import response. If Chinese producers have larger share in the bilateral trade with Japan, which is likely to be the case with the close production relations between China and Japan, the negative impact on production in China may directly translate into the import demand. The results from the modified model in Table 7 seem to be consistent with the negative impact on sectoral output reported in Table 3.

5 Conclusion

We evaluate the impact of the US-China trade war using a recursively dynamic computable general equilibrium (CGE) model of the global trade. We conduct ex ante simulation analysis exploring three scenarios how the trade war affects the import tariffs in 2018 and in 2019. Escalation of the trade war in 2019 results in the largest welfare loss, -0.5% for China and -0.4% for the US. The trade war tariffs reduce all imports to the US and China. Almost all sectoral industrial outputs are lowered, except for machinery, electric equipments and petrochemical production in the US. Private consumptions decrease as the trade war intensifies, thereby leading to the welfare loss. To reflect the role of Global Value Chain, we modify the dynamic CGE model with agent specific import demand, and we explore difference between the models for the impact on welfare and bilateral imports. The welfare impacts tend to be smaller in the modified model, and the negative impact on bilateral imports are more consistent with the impact on sectoral outputs. These results suggest that the GVCs plays substantial role in determining import responses at the disaggregated level.

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Table 1: Increase in Import Tariffs
(percentage point)

		2018					2019*	
(importer)	US	China	India	WHTPP	EU28	ROW	US	China
(exporter)	China	US	US	US	US	US	China	US
Agric	8.2	22.5	11.4	0.3	0.8	0.2	12.3	0.6
Mining	9.9	10.2	0	0	0.6	5.0	14.8	9.8
FoodProd	8.6	24.7	0.6	2.9	5.1	0.1	12.9	3.3
TextApparel	1.8	6.2	0	0.1	2.8	0	2.7	7.1
PetroChem	7.1	8.5	0	0.2	0.1	0.1	7.9	3.6
Metals	10.4	22.8	0	4.5	1.9	0.02	8.8	4.5
Machinery	21.2	8.0	0	0.1	0.7	0.04	8.3	6.1
ElecEquip	8.6	4.8	0	0	0	0	5.8	6.8
Auto	11.1	34.0	0.07	0	0.02	0	12.9	0.2
TransEquip	16.4	10.4	0.3	1.2	2.5	0	6.0	6.5
OthMnfct	2.1	10.8	0	0.5	2.7	0.2	3.2	4.9
ConstUtil	10.0	3.0	0	0	0	0	15.0	0
TradeTrans	0	0	0	0	0	0	0	0
Services	0	0	0	0	0	0	0	0

Note: * Tariff increases has been announced but not implemented.
Source: Author's calculation from Li (2018).

Table 2: Increase in US Import Tariffs on Metals
(percentage point)

	Metals
Japan	9.4
China	10.4
HongKong	0
Korea	0.2
Taiwan	6.6
Singapore	0
Indonesia	0
Philippines	0
Malaysia	0
Thailand	4.0
VietNam	7.4
RoASEAN	0
Australia	0
NewZealand	0
India	9.2
WHTPP	5.8
EU28	7.8
ROW	7.0

Source: Author's calculation from Li (2018).

Table 3: Impact on Sectoral Output in the US and China, 2035
(percent changes relative to the baseline)

	US			CHN		
	S1	S2	S3	S1	S2	S3
Agric	-0.2	0.0	-0.2	0.2	0.0	0.2
Mining	-0.1	0.0	-0.1	0.0	0.0	0.0
FoodProd	-0.4	-0.3	-0.5	-0.3	0.0	-0.5
TextApparel	0.2	0.2	1.0	-0.1	0.0	-0.2
PetroChem	0.8	0.2	1.2	-1.3	0.1	-2.1
Metals	-3.6	0.1	-3.9	-1.5	0.3	-1.9
Machinery	2.6	-0.1	2.4	-3.7	0.2	-4.2
ElecEquip	2.3	0.2	3.1	-3.6	0.1	-5.1
Auto	-1.2	0.1	-1.3	-0.9	0.2	-1.6
TransEquip	-3.5	-1.5	-4.3	-0.3	0.3	-0.1
OthMnfct	-0.8	-0.2	-0.6	-0.8	0.1	-1.5
ConstUtil	-0.5	0.0	-0.7	-1.2	0.1	-1.8
TradeTrans	-0.3	0.0	-0.4	-0.8	0.1	-1.1
Services	-0.3	0.0	-0.4	-0.4	0.0	-0.7

Note: Scenario 1: Import tariffs are raised in 2018 and kept thereafter. Scenario 2: Import tariffs are raised in 2018 and returned to the pre-trade war level in 2019. Scenario 3: Import tariffs are raised in 2018 and in 2019.

Source: Author's simulation results.

Table 4: Impact on Private Consumption in the US and China, 2035
(percent changes relative to the baseline)

	US			CHN		
	S1	S2	S3	S1	S2	S3
Agric	0.1	0.0	0.0	-0.2	-0.01	-0.2
Mining	0.3	0.0	0.3	-0.3	0.0	-0.5
FoodProd	0.1	-0.1	-0.1	-0.3	-0.01	-0.3
TextApparel	-0.4	-0.1	-0.9	-0.3	0.0	-0.4
PetroChem	-0.1	-0.1	-0.4	-0.4	0.01	-0.7
Metals	-1.9	-1.7	-2.0	-0.4	0.0	-0.7
Machinery	-1.9	-0.2	-2.1	-0.4	0.01	-0.7
ElecEquip	-2.3	-0.2	-3.2	-0.4	0.01	-0.7
Auto	-0.6	-0.2	-0.8	-0.5	0.01	-0.7
TransEquip	-0.6	-0.2	-0.7	-0.4	0.01	-0.6
OthMnfct	-0.5	-0.1	-0.9	-0.4	0.01	-0.6
ConstUtil	-0.1	0.0	-0.1	-0.3	0.01	-0.5
TradeTrans	-0.2	0.0	-0.3	-0.4	0.01	-0.7
Services	-0.3	0.0	-0.4	-0.3	0.01	-0.5

Note: Scenario 1: Import tariffs are raised in 2018 and kept thereafter. Scenario 2: Import tariffs are raised in 2018 and returned to the pre-trade war level in 2019. Scenario 3: Import tariffs are raised in 2018 and in 2019.

Source: Author's simulation results.

Table 5: Impact on Welfare, 2035
(percent changes relative to the baseline, constant 2011 $US)

	% changes			$US, billion		
	S1	S2	S3	S1	S2	S3
China	-0.31	0.00	-0.52	-78.1	0.8	-131.4
World	-0.06	-0.01	-0.11	-64.5	-6.8	-117.3
USA	-0.29	-0.06	-0.42	-50.3	-10.3	-71.6
Australia	-0.02	0.01	-0.01	-0.5	0.2	-0.1
RoASEAN	-0.02	-0.01	0.02	-0.1	0.0	0.1
HongKong	0.09	-0.02	0.14	0.2	0.0	0.3
NewZealand	0.18	0.08	0.17	0.3	0.1	0.3
Singapore	0.08	-0.04	0.11	0.3	-0.1	0.4
Indonesia	0.01	-0.03	0.05	0.2	-0.6	1.0
VietNam	0.16	-0.01	0.29	0.6	0.0	1.0
Taiwan	0.29	-0.02	0.36	1.6	-0.1	2.0
Philippines	0.63	0.09	0.81	1.9	0.3	2.5
Malaysia	0.42	0.04	0.56	2.1	0.2	2.8
Thailand	0.64	0.16	0.79	2.3	0.6	2.8
Japan	0.04	-0.04	0.05	2.1	-2.5	2.9
Korea	0.28	-0.02	0.32	3.8	-0.3	4.2
India	0.17	-0.04	0.18	8.8	-2.1	9.2
ROW	0.03	0.02	0.06	5.8	3.0	11.6
EU28	0.08	0.01	0.10	15.0	1.7	18.6
WHTPP	0.48	0.06	0.64	19.4	2.5	25.9

Note: Scenario 1: Import tariffs are raised in 2018 and kept thereafter. Scenario 2: Import tariffs are raised in 2018 and returned to the pre-trade war level in 2019. Scenario 3: Import tariffs are raised in 2018 and in 2019.

Source: Author's simulation results.

Table 6: Model Comparison for Impact on Welfare under Scenario 1, 2020
(percent changes relative to the baseline)

	GDyn	with GVCs
Japan	0.06	0.02
China	-0.47	-0.45
HongKong	0.11	0.16
Korea	0.20	0.03
Taiwan	0.14	-0.01
Singapore	0.12	-0.12
Indonesia	0.10	0.03
Philippines	0.19	0.25
Malaysia	0.28	0.08
Thailand	0.32	0.15
VietNam	0.33	0.13
RoASEAN	0.13	0.08
Australia	0.10	0.04
NewZealand	0.20	0.05
India	0.01	-0.05
USA	-0.15	-0.11
WHTPP	0.30	0.13
EU28	0.05	0.03
ROW	0.12	0.07

Note: Scenario 1: Import tariffs are raised in 2018 and kept thereafter. We compare the dynamic GTAP model (GDyn) with the modified dynamic GTAP model with GVCs.

Source: Author's simulation results.

Table 7: Model Comparison for Impact on Bilateral Imports of China from Japan under Scenario 1, 2020
(percent changes relative to the baseline)

	GDyn	with GVCs
Agric	22.2	3.6
Mining	1.4	0.2
FoodProd	5.7	0.3
TextApparel	-1.1	-3.5
PetroChem	0.2	-2.3
Metals	2.2	-3.3
Machinery	-2.9	-5.5
ElecEquip	-3.9	-6.5
Auto	1.5	-2.2
TransEquip	9.2	-5.1
OthMnfct	3.0	-4.0
ConstUtil	-4.8	-3.7
TradeTrans	-3.7	-3.9
Services	-4.1	-4.6

Note: Scenario 1: Import tariffs are raised in 2018 and kept thereafter. We compare the dynamic GTAP model (GDyn) with the modified dynamic GTAP model with GVCs.

Source: Author's simulation results.

Table A1: Sectoral Aggregation

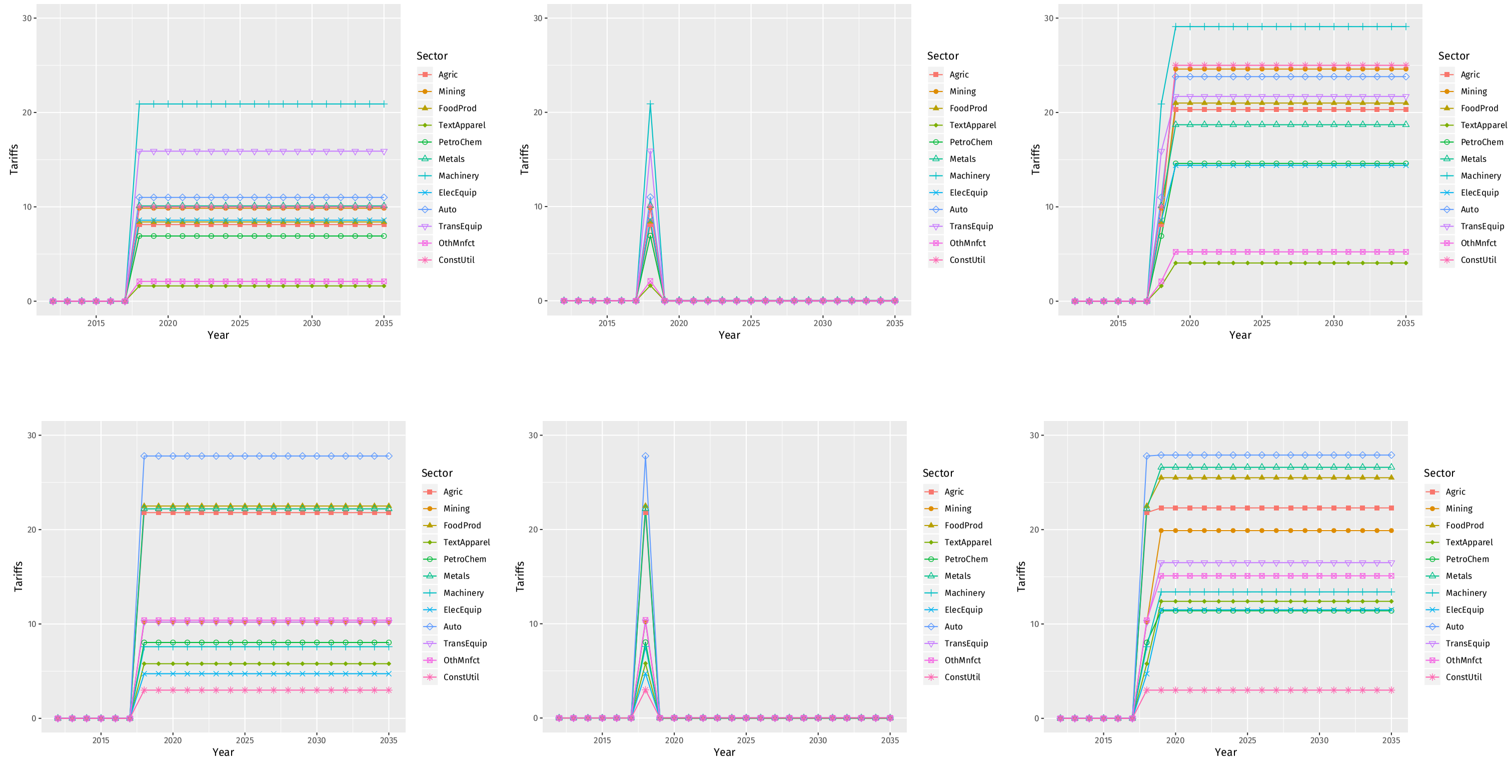
No.	Sector	GTAP 57 sectors
1	Agric	Paddy rice; Wheat; Cereal grains nec; Vegetables, fruit, nuts; Oil seeds; Sugar cane, sugar beet; Plant-based fibers; Crops nec; Cattle,sheep,goats,horses; Animal products nec; Raw milk; Wool, silk-worm cocoons; Forestry; Fishing.
2	Mining	Coal; Oil; Gas; Minerals nec.
3	FoodProd	Meat: cattle,sheep,goats,horse; Meat products nec; Vegetable oils and fats; Dairy products; Processed rice; Sugar; Food products nec; Beverages and tobacco products.
4	TextApparel	Textiles; Wearing apparel; Leather products.
5	PetroChem	Petroleum, coal products; Chemical,rubber,plastic prods.
6	Metals	Ferrous metals; Metals nec; Metal products.
7	Machinery	Machinery and equipment nec.
8	ElecEquip	Electronic equipment.
9	Auto	Motor vehicles and parts.
10	TransEquip	Transport equipment nec.
11	OthMnfct	Wood products; Paper products, publishing; Mineral products nec; Manufactures nec.
12	ConstUtil	Electricity; Gas manufacture, distribution; Water; Construction.
13	TradeTrans	Trade; Transport nec; Sea transport; Air transport.
14	Services	Communication; Financial services nec; Insurance; Business services nec; Recreation and other services; PubAdmin/Defence/Health/Educat; Dwellings.

Source: Author's aggregation based on Aguiar et al. (2016)

Table A2: Regional Aggregation

No.	Country	GTAP 140 regions
1	Japan	Japan.
2	China	China.
3	HongKong	Hong Kong.
4	Korea	Korea.
5	Taiwan	Taiwan.
6	Singapore	Singapore.
7	Indonesia	Indonesia.
8	Philippines	Philippines.
9	Malaysia	Malaysia.
10	Thailand	Thailand.
11	VietNam	Viet Nam.
12	RoASEAN	Brunei Darassalam; Cambodia; Lao People's Democratic Republ; Rest of Southeast Asia.
13	Australia	Australia.
14	NewZealand	New Zealand.
15	India	India.
16	USA	United States of America.
17	WHTPP	Canada; Mexico; Chile; Peru.
18	EU28	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; Bulgaria; Croatia; Romania.
19	ROW	Rest of Oceania; Mongolia; Rest of East Asia; Bangladesh; Nepal; Pakistan; Sri Lanka; Rest of South Asia; Rest of North America; Argentina; Bolivia; Brazil; Colombia; Ecuador; Paraguay; 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; Switzerland; Norway; Rest of EFTA; Albania; Belarus; Russian Federation; Ukraine; Rest of Eastern Europe; Rest of Europe; Kazakhstan; Kyrgyztan; Rest of Former Soviet Union; Armenia; Azerbaijan; Georgia; Bahrain; Iran Islamic Republic of; Israel; Jordhan; Kuwait; Oman; Qatar; Saudi Arabia; Turkey; United Arab Emirates; Rest of Western Asia; Egypt; Morocco; Tunisia; Rest of North Africa; 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 ; Rest of the World.

Source: Author's aggregation based on Aguiar et al. (2016)



(a) Scenario 1

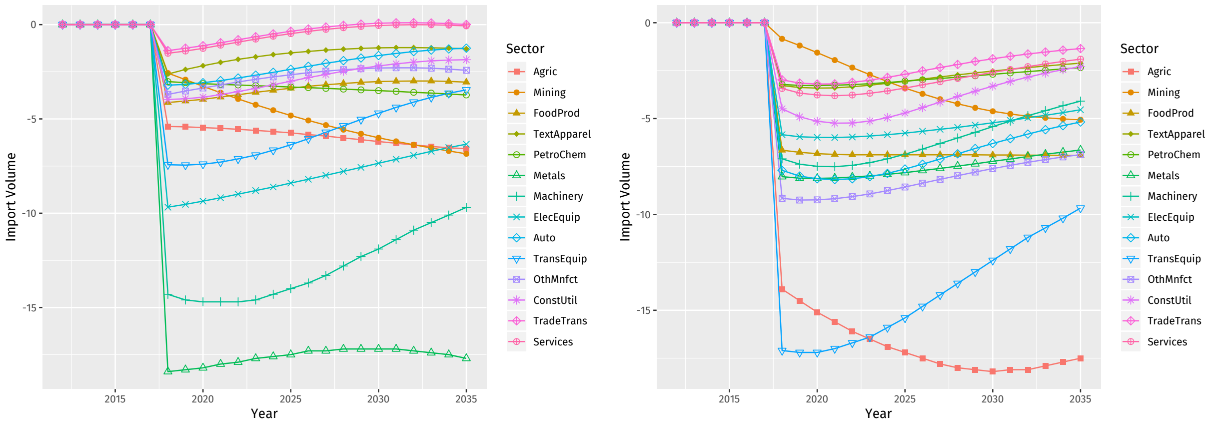
(b) Scenario 2

(c) Scenario 3

Note: Figures for the US tariffs on imports from China are in the first row and for Chinese tariffs on imports from the US in the second row. Scenario 1: Import tariffs are raised in 2018 and kept thereafter. Scenario 2: Import tariffs are raised in 2018 and returned to the pre-trade war level in 2019. Scenario 3: Import tariffs are raised in 2018 and in 2019.

Source: Author's simulation results

Figure 1: Three Scenarios: Changes in Import Tariffs in 2018 and in 2019 for the US and China (percent changes relative to the baseline)

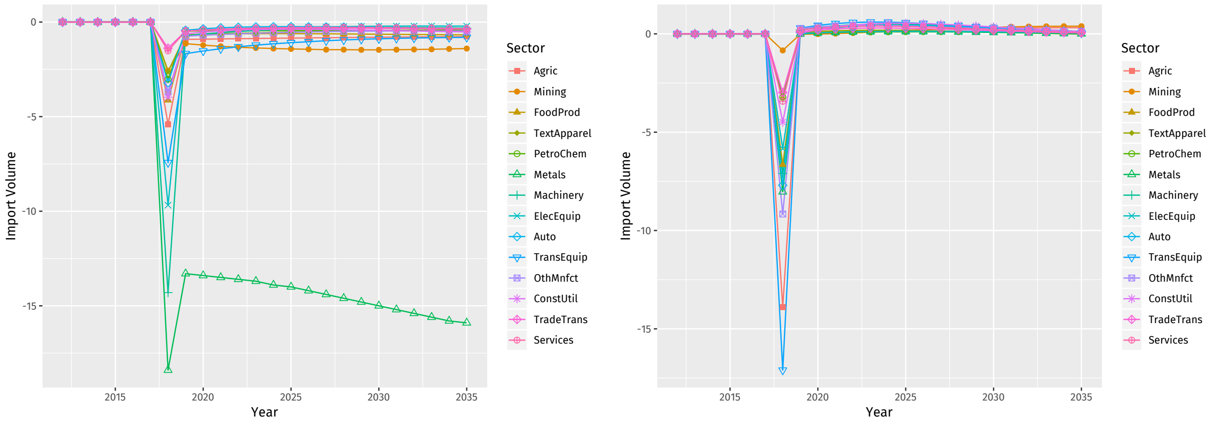


(a) US (b) China

Note: Scenario 1: Import tariffs are raised in 2018 and kept thereafter.

Source: Author's simulation results

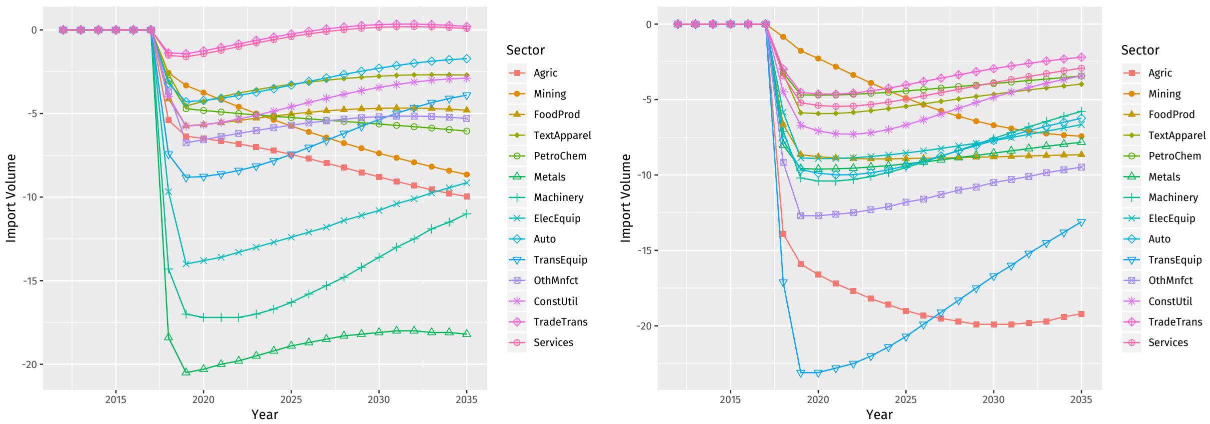
Figure 2: Scenario 1, Impact on Import Volume for the US and China (percent changes relative to the baseline)



(a) US (b) China

Note: Scenario 2: Import tariffs are raised in 2018 and returned to the pre-trade war level in 2019.
Source: Author's simulation results

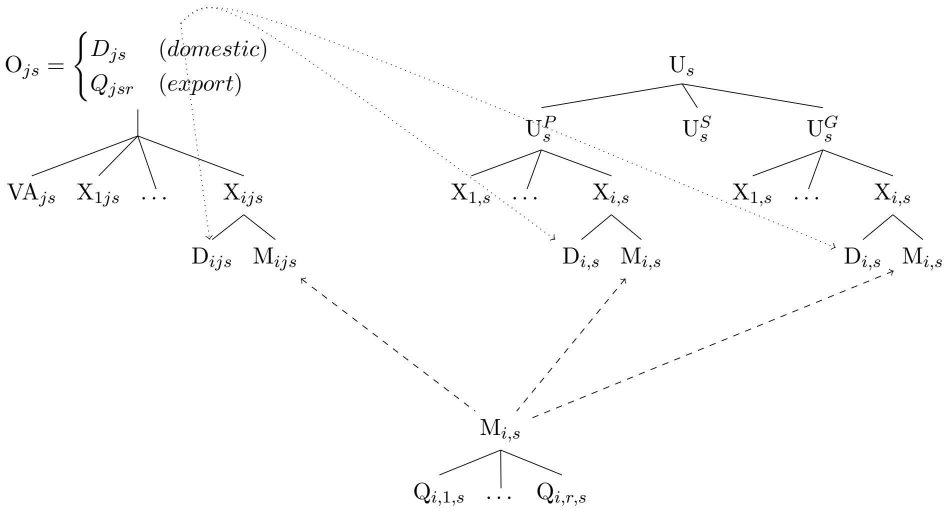
Figure 3: Scenario 2, Impact on Import Volume for the US and China (percent changes relative to the baseline)



(a) US (b) China

Note: Scenario 3: Import tariffs are raised in 2018 and in 2019.
Source: Author's simulation results

Figure 4: Scenario 3, Impact on Import Volume for the US and China (percent changes relative to the baseline)



Source: Author.

Figure 5: Schematic View of the GTAP Model Structure