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< Special Research Report >

A CGE Analysis on Trade War
— Grave Divide in Future Paths of the World Economy —

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Abstract

The U.S. has been implementing steep tariffs on imports from around the world, particularly China. This paper aims to analyze the possible impacts of these protectionist policies on the global economy. Running simulations in a CGE framework based on the GTAP model, results show that on a global level, GDP shrinks by 0.2%. Scenarios include trade policies that have already been implemented, as well as those that are still being considered. In the event that all four scenarios occur, U.S. and China's GDPs drop by 0.8% and 0.7%, respectively, while Japanese GDP is barely affected, with a 0.0% decrease. The U.S. is hit the hardest by the scenario of them imposing tariffs on motor vehicles and parts, whereas U.S.-China trade friction scenarios, including both policies already in effect and currently under consideration, have a significantly negative impact on the Chinese economy.

貿易戦争の CGE モデル分析：世界経済の明暗を分ける関税引き上げ

要旨

米国トランプ政権の保護主義的な通商政策は、日本をはじめ世界的な懸念事項となっている。これらの政策の中でも、本稿では、すでに発動されている鉄鋼・アルミニウムに対する関税（シナリオ 1）と米国による総額 2500 億ドル相当の中国輸入品への課税（米中関税第 1 弾から第 3 弾、シナリオ 2） が経済に及ぼす影響を CGE（計算可能な一般均衡）モデルを用いてシミュレーションした。さらに、検討されている政策として、米中第 4 弾（シナリオ 3）と自動車・自動車部品関税（シナリオ 4）についても推計した。分析の結果、シナリオ 1 から 4 がすべて実施された場合、世界の GDP は 0.2%減少し、米国は 0.8%、中国は 0.7%減少する。日本への影響は 0.0%減少とわずかであった。米国の減少はシナリオ 4 によるものが大きい一方、中国の減少はシナリオ 2 と 3 によるものが大きい。

Introduction

U.S. President Donald Trump has shaken the foundations of free trade, pushing for protectionist policies, slapping steep tariffs on billions of dollars' worth of goods from around the world, particularly China. Protectionism is trying to use restrictions such as tariffs (tax on a product made abroad) to boost a country's industry, and shield it from foreign competition. On March 1, 2017, the Office of the U.S. Trade Representative (USTR) released the 2017 Trade Policy Agenda. The report outlines the Trump Administration's four trade priorities: (i) promoting U.S. sovereignty, (ii) enforcing U.S. trade laws, (iii) leveraging American economic strength to expand U.S. goods and services exports, and (iv) protecting U.S. intellectual property rights.

In theory, taxing items coming into the country means people are less likely to buy them as they become more expensive. The intention is that they buy cheaper local products instead, boosting the country's economy. However, given the rapid globalization that has been occurring over the course of about two decades, many American companies also use imported intermediate inputs from abroad. This implies that the prices of final goods that these affected firms produce could increase, negatively affecting households.

This paper aims to estimate the possible worldwide impacts of trade policies the U.S. has put into effect as well as those that have been announced to be considered. We use Computable General Equilibrium Analysis (CGE) to simulate and analyze various scenarios of tariff increases and their possible effects on the world economy by adopting the Global Trade Analysis Project (GTAP) model.

Methodology

This study uses GTAP 9 Data Base from Center for Global Trade Analysis, Purdue University. The database covers 140 regions and 57 sectors with reference years 2004, 2007 and 2011. The latest reference year is used in our model calibration.

Countries were mapped into the U.S., China, Japan, EU, Canada, Mexico, ASEAN and NIES, as well as countries that have imposed direct retaliatory tariffs against the U.S. (see Table 1). Factors of production were aggregated into "Skilled Labor," "Unskilled Labor," "Land," "Capital" and "Natural Resources" (see Table 2). Land and natural resources are set to be immobile across sectors, while capital goods are also assumed to have limited mobility in order to achieve short-run simulation results (Burfisher, 2011). As for sectors, we follows the default GTAP database sector aggregation (see Table 3).

Table 1. Regional Aggregation Mapping

Region	Members
Japan	Japan
United States	United States
China	China
European Union	Austria, Belgium, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, United Kingdom
Canada	Canada
Mexico	Mexico
ASEAN	Brunei Darussalam, Cambodia, Indonesia, Lao People's Democratic Republic, Malaysia, the Philippines, Thailand and Vietnam
NIES	South Korea, Taiwan, Hong Kong and Singapore
Brazil	Brazil
Russia	Russia
India	India
Turkey	Turkey
RoW	Other countries not specified above

Source: Authors' specification based on GTAP 9 Data Base

Table 2. Factor Endowment Aggregation Mapping

Factor Endowments Aggregation Mapping

Factor Endowment	Aggregation Group
Officials and managers Technicians	Skilled Labor
Clerks Service / shop workers Agricultural and unskilled workers	Unskilled Labor
Land	Land
Capital	Capital
Natural resources	Natural resources

Source: Authors' specification based on GTAP 9 Data Base

Table 3. Sector Aggregation Mapping

GTAP Code	Description	Aggregation Group After Simulation
PDR	Paddy rice	Agriculture, forestry and fishing
WHT	Wheat	
GRO	Cereal grains nec	
V_F	Vegetables, fruit, nuts	
OSD	Oil seeds	
C_B	Sugar cane, sugar beet	
PFB	Plant-based fibers	
OCR	Crops nec	
CTL	Bovine cattle, sheep and goats, horses	
OAP	Animal products nec	
RMK	Raw milk	
WOL	Wool, silk-worm cocoons	
FRS	Forestry	
FSH	Fishing	
COA	Coal	Energy
OIL	Oil	
GAS	Gas	
ELY	Electricity	
GDT	Gas manufacture, distribution	
P_C	Petroleum, coal products	
CMT	Bovine meat products	Foodstuffs
OMT	Meat products nec	
VOL	Vegetable oils and fats	
MIL	Dairy products	
PCR	Processed rice	
SGR	Sugar	
OFD	Food products nec	
B_T	Beverages and tobacco products	
TEX	Textiles	Textiles and apparel
WAP	Wearing apparel	
LEA	Leather products	
LUM	Wood products	Wood and paper products
PPP	Paper products, publishing	
CRP	Chemical, rubber, plastic products	Chemicals, plastics and rubbers
OMN	Minerals nec	Minerals
NMM	Mineral products nec	
I_S	Ferrous metals	Steel
NFM	Metals nec	Metals
FMP	Metal products	
MVH	Motor vehicles and parts	Motor vehicles and parts
OTN	Transport equipment nec	Other transport equipment
ELE	Electronic equipment	Electronic equipment
OME	Machinery and equipment nec	Machinery and equipment
OMF	Manufactures nec	Manufactures
CNS	Construction	Construction
TRD	Trade	Trade
OTP	Transport nec	Transportation services
WTP	Water transport	
ATP	Air transport	
WTR	Water	Services
CMN	Communication	
OFI	Financial services nec	
ISR	Insurance	
OBS	Business services nec	
ROS	Recreational and other services	
OSG	Public Administration, Defense, Education, Health	
DWE	Dwellings	

Source: Authors' specification based on GTAP 9 Data Base

We employ tariff policy simulations using the GTAP CGE model. CGE analysis enables us to calculate likely future outcomes of the tariff policies via mathematical simulations. As both the U.S. and China are large economies, their trade policies could send repercussions to other countries. CGE models can capture these linkages through price mechanisms (Hosoe et al., 2010). The simulation is of general equilibrium in nature, meaning that it captures both direct and indirect effects stemming from linkages across different countries and markets.

GTAP model is a CGE model developed by Center for Global Trade Analysis, Purdue University. The full model was introduced in Hertel (1997). It is a multi-region, multi-sector, computable general equilibrium model, with perfect competition and constant returns to scale. Aside from extensive modeling of inter-regional linkages, mainly via international trade, it models demand for domestic and foreign-produced goods. In brief, the model has the following properties (Lans and Rutherford, 2016; van der Mensbrugghe, 2018):

- It models the behavior of firms and three regional households (private household, government household and savings expenditure) in each region r.
- Firms minimize their cost of production subject to production technology represented in Constant Elasticity of Substitution (CES) functional form. Firms are assumed to be price takers.
- Regional households maximize their utility subject to income from net payments of factor use (for private household) or revenue of government distortionary measures (for government household).
- Private household expenditure is modeled using Constant Difference Elasticity (CDE) functional form to account for its non-homothetic preferences.
- Imports are differentiated by source and governed by Armington import substitution elasticity parameter.

The simulation scenarios presented in this paper are as follows.

Scenario 1: U.S. imposing tariffs on all trading partners of 25% on steel and 10% on aluminum. Other countries retaliate by imposing tariffs (countries, tariff rates and affected products are chosen based on official government statements).

Scenario 2: U.S. imposing 25% tariffs on USD250 billion worth of goods imported from China. China imposing retaliatory tariffs ranging from 5% to 25% on USD110 billion worth of imports from the U.S.

Scenario 3: U.S. imposing 25% tariffs on USD267 billion worth of imports from China. China imposing retaliatory tariffs of 25% on USD20 billion worth of imports from the U.S.

Scenario 4: U.S. imposing 25% tariffs on motor vehicles and parts worth USD360 billion. All other countries retaliate by imposing similar tariff rate increase on imports from the U.S.

Note that Scenarios 1 and 2[1] are policies that have already been put in place, as of January 2019. Scenarios 3[2] and 4 have been announced by the U.S. but are still under consideration.

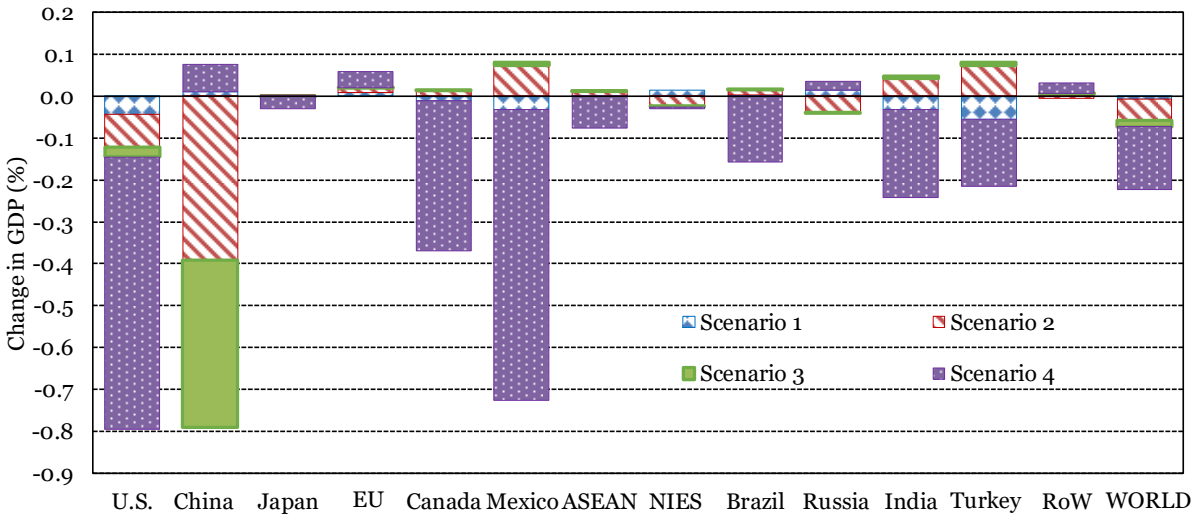
Results

Figure 1 shows the impact of each scenarios on the global economy. With all the scenarios combined, the U.S. is hit the hardest, with an 0.8% decrease in their GDP. The U.S. is followed by China, our results revealing a 0.7% decline in their GDP. USMCA members Canada and Mexico come next, due to the negative impact on the U.S. economy, with which they are highly integrated. When we observe the results by scenario, however, it is clear that the big decline for the U.S. is mainly contributed by the case of Scenario 4, which covers the protection of motor vehicles and parts industry. Our assumption here is that if the U.S. imposes tariffs on motor vehicles and parts against the whole world, all other countries will retaliate by increasing tariff rates on U.S. imports to the same degree. Therefore, the U.S. will be greatly affected by a 0.6% drop in Scenario 4 based on our current model. Just from Scenario 4, GDPs of USMCA members Canada and Mexico, which are highly integrated with the U.S., decrease considerably. Meanwhile, GDPs of Japan, ASEAN, NIES and Russia are barely affected, facing a mere change of under 0.1%. World GDP is estimated to drop by 0.2%.

Scenario 1 and Scenario 2, which replicate policies that have already been implemented, decrease GDPs of the world's economic giants China and the U.S. by 0.4% and 0.1%, respectively. This leads the world GDP to drop by 0.1% as well. Scenario 3 may take off if the talks between the U.S. and China fail to reach an economically peaceful agreement. The results of Scenario 3 shows that GDPs of China and U.S. will decrease by an additional 0.4% and 0.0%, respectively. Ultimately, results show that the Chinese economy will most likely take a bigger hit than the U.S.

[1] Technically, Scenario 2 has only partially gone into effect, with a 10% tariff, which was initially planned to increase to 25% on January 1, 2019.
[2] The U.S. has announced that it will refrain from imposing previously threatened tariffs on an additional USD267 worth of Chinese imports during a 90-day truce, which ends March 1, 2019.

Figure 1. Estimated Impact on GDP



Next, simulation results for the effects on Japanese production are presented in Figure 2. Scenario 1 causes steel production to decline the most, by 0.3%. This is consistent with the fact that in 2017 Japan's steel exports to the U.S. were USD 1.8 billion, and in 2018, Japanese exports of steel to the U.S. dropped by 0.2% year over year[3].

U.S.-China trade war, modelled in Scenarios 2 and 3, impacts textiles and apparel production in Japan to fall by 2.6%. Motor vehicles and parts as well as other transport equipment increase by 0.8% and 0.7% each. This indicates a diversion effect, caused by the U.S. restricting imports from their main exporter, China, drawing Japan to increase their production as a substitute.

Scenario 4 causes motor vehicles and parts production to drop by 8%, due to the 17% drop in their exports to the U.S. in. This is not surprising, since approximately 30% of Japan's exports to the U.S. consists of motor vehicles and parts. This negative effect also spreads to other industries linked to motor vehicles and parts such as electronic equipment and steel. Consequently, these sectors that suffer negative impacts reduce Japanese production by 0.5%.

[3] Source: U.S. Department of Commerce, Enforcement and Compliance and Trade Statistics of Japan, Ministry of Finance.

Figure 2. Estimated Impact on Japanese Production

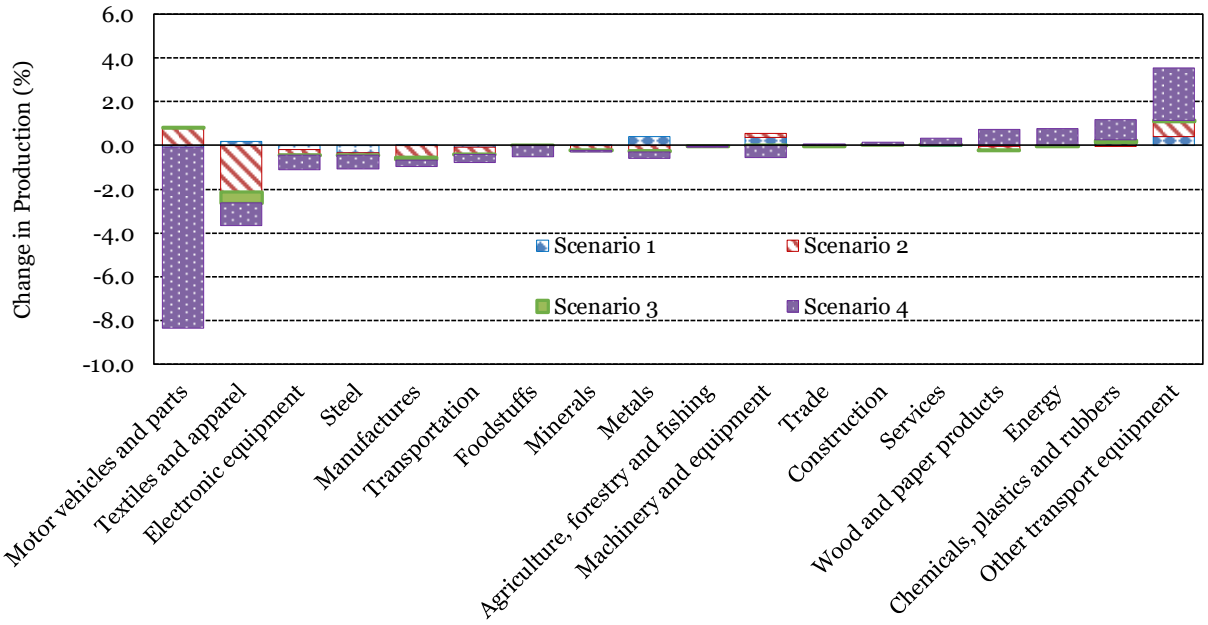
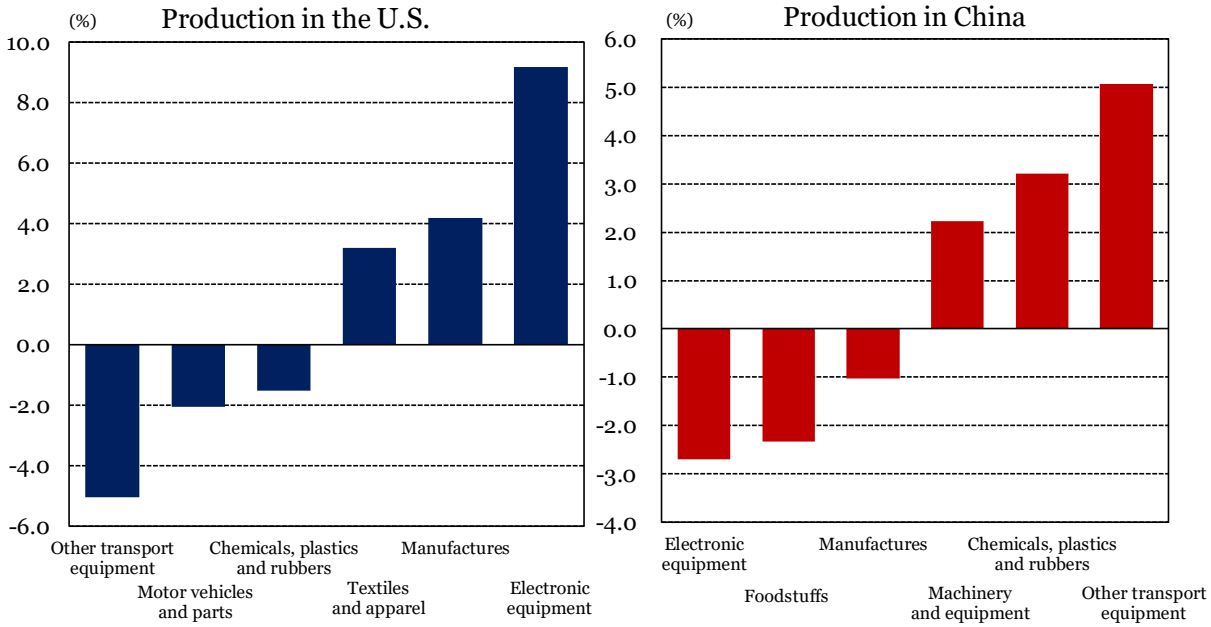


Figure 3 shows the impacts from Scenarios 2 and 3 on production in the U.S. on the left, and China on the right side. The graphs depict the top and bottom three industries that are affected the most. Positive impact can be seen in productions for electronic equipment, manufactures and textiles and apparel production in the U.S. This stems from the fact that U.S. has been dependent on Chinese products in these industries, and hence with the new restrictions in effect, domestic production of said goods increases. Electronic equipment industry faces a drop in production in China due to the tariff raise. Hence, domestic production in the U.S. increases to cover for the shortage of imports, from which the U.S. relied heavily on China. Similarly, in China, other transport equipment, chemicals, plastics and rubbers and machinery and equipment production increases. The U.S. production of these products decrease due to the decline in exports led by the increase in tariffs.

Figure 3. Estimated Impact on Production in the U.S. and China from Scenarios 2 and 3 Combined



Concluding Remarks

The worldwide negative economic impact from the raging trade war is non-negligible based on our CGE simulations. In the event that all scenarios occur, both U.S. and China's GDPs decrease. The U.S. is hit the hardest by the scenario of them imposing tariffs on motor vehicles and parts, whereas U.S.-China trade friction scenarios have a significantly negative effect on the Chinese economy.

There is minimal effect on the Japanese economy. Nevertheless, production levels among industries change and shift, and hence will require smooth and frictionless labor movement. Therefore, it is important to set up policies that will protect workers who will face unemployment, lower wages or decrease in the quality of their working environment.

In January 2019, official delegations from the U.S. and China began trade talks, agreeing to a 90-day truce, which ends on March 1, 2019. Moreover, Japan and the U.S. have agreed to enter into negotiations under the "trade agreement on goods (TAG)" framework. There are speculations that these agreements may include clauses for quota regulations. In such cases, further research is needed to include these potential policies.

Moreover, our assumption of full employment has the tendency to underestimate the negative impact the protectionist policies have on an economy. For example, by making labor markets endogenous, we will be able to make more viable estimations of the impact on the labor market in the short-run.

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