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The 2018 trade war: data and nascent general equilibrium analysis

By Minghao Li,[a] Edward J. Balistreri[b] and Wendong Zhang[c]

This study introduces a database of 2018 tariff increases resulting from the recent trade war and quantifies the impacts using the canonical GTAPinGAMS model calibrated to GTAP version 9 accounts. We report relatively modest economy-wide welfare impacts in this perfect-competition Armington model, with substantial impacts on the pattern of trade and output in important sectors.

JEL codes: F11, F12, F17

1. Introduction

The year 2018 witnessed the largest trade war in decades. In March, the United States increased tariffs on aluminum and steel by 10% and 15% respectively. Canada, China, the European Union (EU), India, Mexico, and Turkey each retaliated with proportional tariff increases on U.S. goods. In the meantime, the trade disputes between the United States and China quickly escalated to a scale without precedent. In June and August, the United States imposed 25% additional duty on $50 billion worth of Chinese imports related to China's "China 2025" industry policy. China responded with 25% additional tariffs on the same amount of U.S. products. In September, the United Stated raised tariffs by 10% on $200 billion worth of products from China and China retaliated with 5% to 10% tariffs on $60 billion worth of products from the United States. The 10% tariffs applied by the United States on $200 billion Chinese goods increase to 25% in early 2019, and China has a planned response.[1] This study is one of the first general-equilibrium analyses of these recent trade disputes. By compiling comprehensive data on tariff increases and evaluating them using a widely used transparent structure our

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[1] The final proposed tariff escalation was scheduled to go into effect as of January 2019, but this has now been delayed to March.

analysis provides the foundation and reference point for future studies that might logically consider alternative trade structures and validation exercises.

This paper, first, introduces a harmonized database of all tariff increases in the recent trade disputes (which is made available for free download); and, second, analyzes the impacts of these tariffs on welfare, sectoral output, commodity prices, and trade patterns. We investigate the tariff changes within the established canonical Lanz and Rutherford (2016) GTAPinGAMS model calibrated to the Global Trade Analysis Project (GTAP) version 9 accounts. We find that, with the accumulated tariffs implemented as of September 2018, China's welfare falls by 1.3% while U.S. welfare falls by 0.14%. The tariffs have substantial effects on the output of targeted sectors. Bilateral trade between the U.S. and China falls by between 33% and 43% under the accumulated tariffs as of September 2018. There is significant trade diversion as China increases its penetration into the markets in the EU, Canada, and Mexico. There are significant limitations of the off-the-shelf GTAPinGAMS model. We discuss some of these and indicate avenues for future research in the conclusion.

2. Method

2.1 The canonical GTAPinGAMS model

The GTAPinGAMS model (Lanz and Rutherford, 2016) is a Computable General Equilibrium (CGE) model calibrated to the Global Trade Analysis Project (GTAP) 9 database as documented by Angel Aguiar and McDougall (2016). This model adopts a particular trade structure consistent with the Armington (1969) assumption. Goods under a given commodity classification from different countries are treated as imperfect substitutes. The Armington elasticities of substitution are the most crucial parameters for assessing trade responses (McDaniel and Balistreri, 2003). Besides the main results, we conduct sensitivity analyses using one and two standard deviations around the original estimates adopted in GTAP, which come from Hertel et al. (2007).

We maintain the 47 commodities in the GTAP 9 database but aggregate the 140 GTAP countries and regions to 22. In particular, countries in the EU are aggregated into one region. The United States and countries that are among the top 20 steel and aluminum exporters to the United States (if not in the EU) are maintained as individual countries. Other countries are aggregated to a rest-of-world (ROW) region. We solve the global multi-regional version of the GTAPinGAMS model as otherwise parameterized in Lanz and Rutherford (2016).

2.2 Tariff data and scenarios

Tariff increases are collected from original government announcements. These tariff increases are mostly at the eight-digit Harmonized Commodity Description and Coding System (HS code) level, which are crossed-walked and aggregated to

GTAP sectors using the method described in the documentation for the database (Li, 2018). All data and code for data processing can be downloaded for free.

We construct three scenarios with different tariff increases:

Scenario 1: Steel-aluminum Tariff increases due to the U.S. steel and aluminum tariffs and retaliatory tariffs from Canada, China, the EU, India, Mexico, and Turkey.

Scenario 2: September 2018 Tariff increases in scenario 1 and additional tariff increases between the United States and China, including the $50 billion round and the $200 billion/$60 billion round of tariff increases. The scenario reflects the current tariffs (as of December 2018).

Scenario 3: Full tariffs Tariff increases in scenario 1 and 2, and additional tariff increases that are scheduled to happen early in 2019 (currently March, 2019), i.e., the U.S. tariffs on $200 billion Chinese products will increase by another 15%, and China's retaliatory tariffs will increase by 0 15%.

3. Results

3.1 Welfare

We first report percentage changes in overall welfare across countries (Figure 1), for the three scenarios. Welfare calculations are based on equivalent variation. Overall, the steel and aluminum tariffs have minor effects on welfare compared to the trade disputes between the United States and China. With the accumulated tariffs as of September 2018 (scenario 2), welfare in the United States decreases by over 0.1% and welfare in China decreases by 1.3%. Most other countries and regions, especially major exporters of manufactured goods to the United States such as Mexico, gain from the trade disputes between the United States and China. Given the scale of the trade distortion, the estimated welfare impacts are surprisingly small. One reason is that the sizable tariffs are limited to US-China trade. Trade diversion to and from other countries substantially offsets the impacts. The results are also consistent with high optimal tariffs—a well known suspicious feature of Armington models.[2] The tariff increases generate beneficial terms-of-trade impacts that help to offset the adverse welfare impacts. Error bars are included in the graph to illustrate the range of results when we increase and decrease the trade elasticities by two standard deviations (as reported in their original estimation (Hertel et al., 2007)). Deviations from the central trade elasticities has little

[2] See Brown (1987), Balistreri and Markusen (2009), and Balistreri and Rutherford (2013) for a critiques of the Armington structure and implied optimal tariffs. In fact, for China Balistreri and Rutherford (2013) show that the qualitative welfare impact of a marginal move away from observed tariffs is sensitive to the particular trade structure: Armington (1969) versus Melitz (2003).

impact on the welfare impacts, but does play a role in the sectoral responses reported below.

3.2 Sectoral Impacts in the United States and China

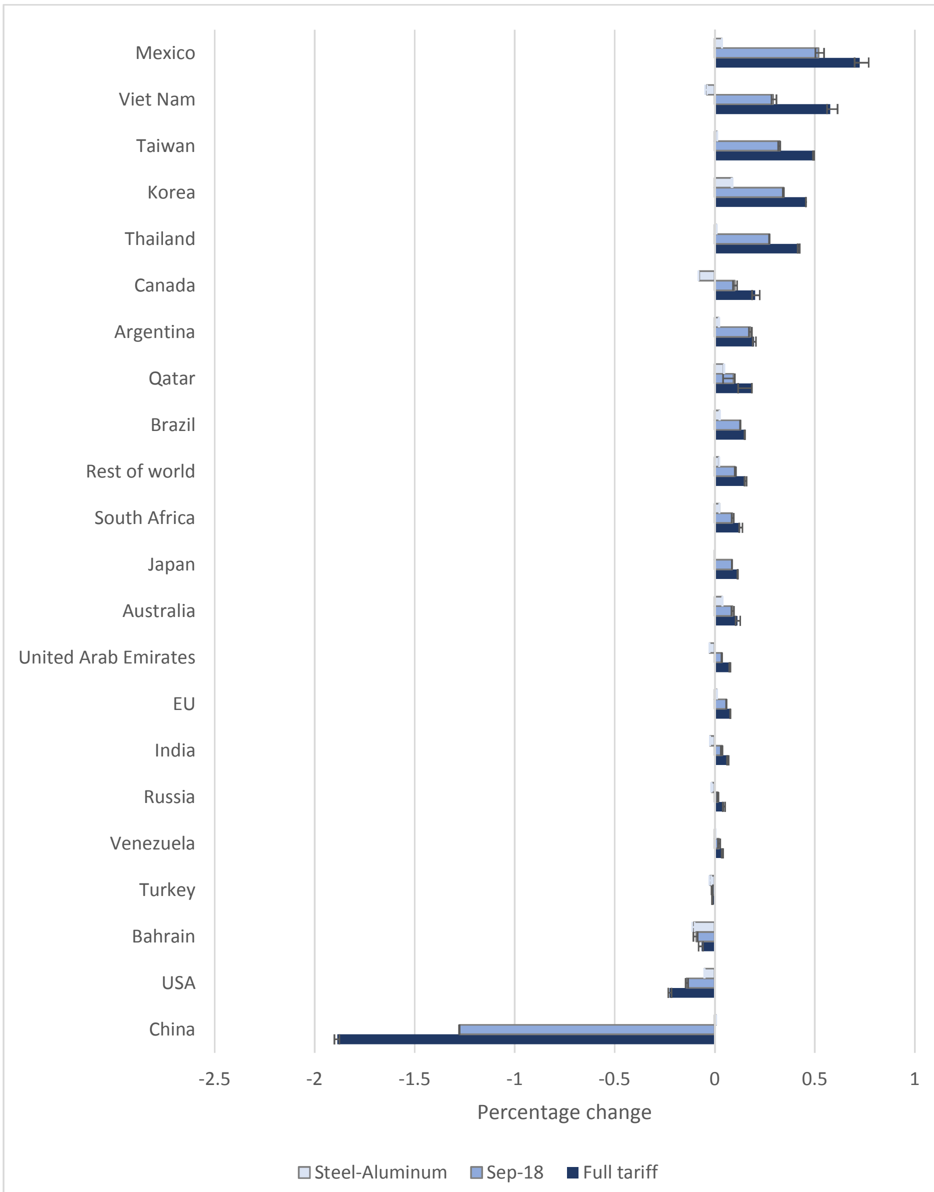
While welfare change is essential for aggregate policy decisions, there are important distributional impacts that cleave with import-competing and exporting sectors. In this section, we present changes in revenue by sector. Figures 2 and 3 present the major sectoral impacts for the US and China. The first-order effect of a tariff increase is to depress revenue in exporting sectors and increase revenue in import-competing sectors that are targeted. These impacts explain the revenue growth of the U.S. iron and steel sector under scenario 1 (Figure 2). It can also explain the decline in the U.S. oilseed production (largely soybeans). In scenarios 2 and 3 sizeable tariffs on Chinese manufactured goods support the U.S. electronic equipment and other machinery sectors. For China, the electronic equipment and other machinery sectors suffer significantly under these barriers. We present the results in both percentage and absolute change ($B) to reveal the importance of the trade dispute to the individual sector and the economy as a whole. For example, in scenario 2, the revenue of the U.S. oilseed sector declines by over 15% or $6B, and the revenue of the Chinese electronic equipment sector declines by nearly 4%, which is a loss of more than $35B.

We also highlight second-order effects that operate through upstream and downstream sectors. For example, in the US the transport equipment (other than cars and truck) sector suffers a loss from the steel and aluminum tariffs due to higher input costs, and the service sectors like the trade sector (retail and wholesale trade) in the United States and China suffer significant revenue reductions.

The shifts in sectoral output are driven by price changes. In Table 1 we report a set of price changes for the US economy. These are the prices faced by US agents after the general equilibrium adjustments. The prices are reported relative to the numeraire, which is the true-cost-of-living index for US consumers. In the first column we report the domestic price impacts. The second column reports the composite price of imports. This includes goods from regions with tariff changes and goods from regions that do not have tariff increases.[3] In the third column we report the prices of Chinese goods imported into the US. One surprising result is the relatively small impact on the domestic price of oil seeds (which includes soybeans). The roughly 3% domestic price reduction is substantially less than what has been observed in the commodity markets. We caution, again, that our results are illustrative of what one might expect from an off-the-shelf static perfect competition model. Under perfect competition the implied supply curve is very elastic

3 Imports are aggregated in a constant-elasticity-of-substitution nest. Then the import composite substitutes for domestic goods. This allows us to report a price on the import composite, as well as imports from specific trade partners.

Figure 1. Welfare impacts across regions (% change)



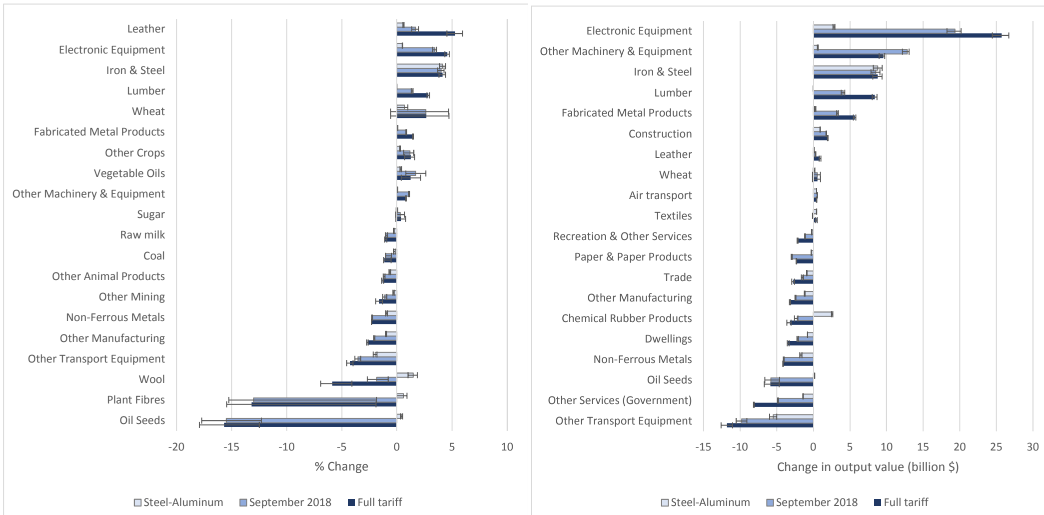


Figure 2. US revenue changes (% and $B) by sector (top 10 winners and losers)

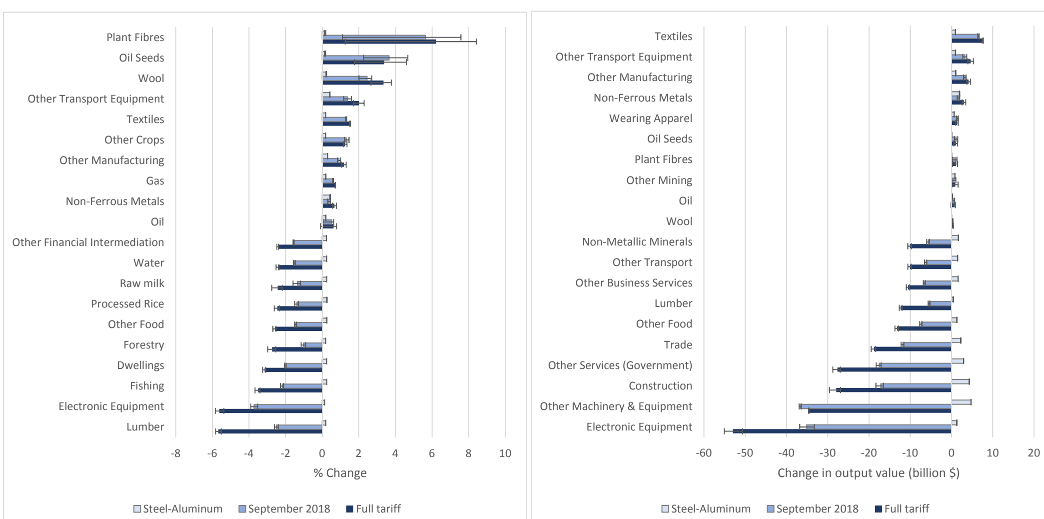


Figure 3. China revenue changes (% and $B) by sector (top 10 winners and losers)

(constant returns to scale) so substantial quantity reductions dominate (revenue is down by over 15%). Model extensions would more carefully consider appropriate supply responses as they relate to immobile factors in agriculture (land).

Table 1. US Price Changes (%)

		Domestic	Duty-paid import composite	Duty-paid imports from China
ele	Electronic Equipment	1.0	4.9	13.1
i_s	Iron and Steel	0.7	15.5	22.9
nfm	Non-Ferrous Metals	0.6	2.8	13.7
fmp	Fabricated Metal Products	0.6	4.7	17
mvh	Motor Motor vehicles and parts	0.5	1.2	22.3
lea	Leather	0.4	3.9	5.5
lum	Lumber	0.4	6.5	20.1
ome	Other Machinery and Equipment	0.3	3.5	27.6
otn	Other Transport Equipment	0.3	1.1	20.3
omf	Other Manufacturing	0.2	-0.3	-1.1
gas	Gas	0.1	0.2	0.2
cns	Construction	0.1	0.1	-1.6
tex	Textiles	0.1	1.2	2.9
p_c	Petroleum and Coke	0.1	0.5	43.9
wap	Wearing Apparel	0.1	0.3	0.4
crp	Chemical Rubber Products	0.1	1.3	12.2
oil	Oil	0.0	0.1	24.8
fsh	Fishing	0.0	0.8	19.3
frs	Forestry	0.0	1.8	12.8
atp	Air transport	0.0	0.2	-1.2
nmm	Non-Metallic Minerals	0.0	3.8	13.5
ppp	Paper and Paper Products	0.0	2.1	13.3
pcr	Processed Rice	0.0	0.7	22.4
b_t	Beverages and Tobacco products	0.0	0.5	6.7
wtp	Water transport	-0.1	0.1	-1.5
otp	Other Transport	-0.1	0.2	-1.6
wtr	Water	-0.1	0.1	-1.9
cmn	Communications	-0.1	0.2	-1.9
obs	Other Business Services	-0.1	0.2	-1.8
gdt	Gas Distribution	-0.1	0.6	24.3

ros	Recreation and Other Services	-0.1	0.3	-1.9
trd	Trade	-0.1	0.3	-1.9
osg	Other Services (Government)	-0.1	0.2	-2.0
ofd	Other Food	-0.2	2.3	19.5
isr	Insurance	-0.2	0.3	-1.9
ofi	Other Financial Intermediation	-0.2	0.3	-2.1
ely	Electricity	-0.2	0.7	23.5
sgr	Sugar	-0.2	0.9	13.4
dwe	Dwellings	-0.2	0.3	-2.1
omt	Other Meat	-0.4	0.9	22.6
mil	Milk	-0.4	0.3	-0.3
cmt	Cattle Meat	-0.4	0.4	22.7
omn	Other Mining	-0.4	1.5	23.7
oap	Other Animal Products	-0.6	4.0	19.8
wht	Wheat	-0.7	0.3	22.6
coa	Coal	-0.7	0.1	24.1
rmk	Raw milk	-0.9	0.3	-1.6
ctl	Cattle	-0.9	0.7	18.0
gro	Other Grains	-0.9	0.5	23.2
pdr	Paddy Rice	-1.0	0.6	22.7
v_f	Vegetable and Fruit	-1.1	0.9	22.7
wol	Wool	-1.1	0.2	23.6
ocr	Other Crops	-1.1	0.6	10.7
vol	Vegetable Oils	-1.3	0.4	17.2
c_b	Cane and Beet	-1.4	0.6	22.9
pfb	Plant Fibres	-2.2	0.7	24.2
osd	Oil Seeds	-2.8	1.0	24.1

Table 2. Change in the pattern of international trade (%)

Exporter	Scenario	Importer: U.S.	China	EU	Canada	Mexico	Others	Total Exports
U.S.	Steel-aluminum		-1.6	-2.2	-2.8	-0.9	0.6	-0.9
	September 2018		-43.0	-2.6	-2.4	-0.2	0.0	-4.1
	Full tariffs		-54.4	-3.0	-2.3	-0.2	-0.6	-5.3
China	Steel-aluminum	-0.4		0.6	1.8	0.3	0.2	0.2
	September 2018	-33.4		6.2	8.6	8.8	5.0	-3.0
	Full tariffs	-48.2		8.9	12.1	13.0	7.4	-4.3
EU	Steel-aluminum	-0.9	0.2	0.4	1.4	0.5	0.1	0.2
	September 2018	3.4	0.3	0.2	2.1	1.7	-0.3	0.3
	Full tariffs	5.3	-0.2	0.0	2.4	2.2	-0.6	0.3
Canada	Steel-aluminum	-1.9	0.8	1.0		1.4	0.7	-0.9
	September 2018	0.0	2.0	-0.5		-0.1	-1.0	-0.2
	Full tariffs	1.1	0.5	-1.5		-0.5	-2.0	0.2
Mexico	Steel-aluminum	-0.3	0.3	0.3	0.7		0.0	-0.2
	September 2018	3.1	-3.1	-4.2	-3.2		-4.6	1.1
	Full tariffs	4.6	-5.1	-6.2	-4.9		-6.7	1.6
Others	Steel-aluminum	-0.2	0.3	0.4	1.3	0.9	0.2	0.2
	September 2018	3.9	0.0	0.1	1.6	1.7	-0.3	0.5
	Full tariffs	6.2	-0.6	-0.1	1.8	2.1	-0.6	0.5
Total imports	Steel-aluminum	-0.6	0.2	0.2	-0.9	-0.2	0.2	
	September 2018	-2.7	-3.6	0.3	-0.2	1.2	0.4	
	Full tariffs	-3.4	-5.1	0.2	0.2	1.7	0.4	

3.3 The pattern of trade

In Table 2 we report the percent change in trade flows. Major shifts in trade patterns are mostly focused on the United States and China. With the September 2018 tariffs, exports from China to the United States fall by 33.4%, and exports from the United States to China fall by 43%. We show significant trade diversion as total Chinese exports fall by only 3%, with major penetration into the EU, Canadian, and Mexican markets. While the US intent is to promote exports the trade disruptions have the opposite effect, as suggested by economic theory. It is notable that US exports fall to each of the major trading partners (China, the EU, Canada, and Mexico).[4] Overall, US exports fall by 4.1% under the tariffs accumulated as of September 2018.

4. Conclusion

This paper introduces a data source for the tariff increases resulting from the recent trade disputes and documents the impacts of these tariffs using a standard off-the-shelf general-equilibrium simulation model. We find modest impacts on overall welfare, but large impacts on sectoral revenue and the pattern of international trade. Key limitations of the GTAPinGAMS model that we employ include parametric and structural uncertainty. In order to look at some preliminary parametric sensitivities we present results based on the econometric standard errors on the elasticities of substitution between regional varieties (the trade elasticities). We leave an exploration of structural sensitivity for future research. Significant progress has been made in the adoption of advanced trade structures in a computational setting. In fact, the recent work of Balistreri and Tarr (2018), Costinot and Rodríguez-Clare (2014), and Balistreri, Hillberry, and Rutherford (2011) suggests considerable differences across models that consider trade induced variety and productivity adjustments. Our intention is to encourage this analysis by establishing a transparent reference point for more elaborate empirical simulation environments. We are also hopeful that the compiled database for the 2018 tariff increases will facilitate these and other future applications.

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[4] Our analysis does not currently consider the unratified renegotiated NAFTA, although the general consensus is that the new NAFTA (which largely maintains tariff-free trade in most goods) will have little impact at the aggregate level.

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