

Mao, Haiou; Görg, Holger

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# Friends like this: The impact of the US–China trade war on global value chains

Haiou Mao<sup>1,2</sup> | Holger Görg<sup>2</sup> 

<sup>1</sup>Wuhan University, Wuhan, China

<sup>2</sup>Kiel Centre for Globalization, Kiel, Germany

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cumulative tariffs, indirect tariffs, trade war

## 1 | INTRODUCTION

The ongoing ‘trade war’ between the United States and China, where both countries hike up tariffs on clearly specified products, has been a subject of controversial public and political discussion even since before it started. The contention among US government officials is, of course, that this will benefit the United States, if not in the short then in the long run. This view of the world is, however, debated strongly by academic economists. Amiti, Redding, and Weinstein (2019) for example estimate that the changes in US trade policy have led to higher domestic prices for US consumers and an overall reduction in US welfare. Balistreri, Bohringer, and Rutherford (2018) reach a similar conclusion, as do Li, He, and Lin (2018) and Bellora and Fontagne (2019). These studies mirror a more general literature on the costs of protectionism, such as Ossa (2014), Costinot and Rodriguez-Clare (2014) and Felbermayr, Jund, and Larch (2015).

This short paper contributes to this literature by considering the indirect impact tariff increases between the United States and China can have on third countries through links in global supply chains. Consider Apple's iPhone, which relies heavily on imported inputs from China. If the US imports this product at higher tariffs, this increase will also feed into, say, exports of iPhones from the United States to Canada. We calculate the implications for third countries, say Canada, using the concept of cumulative and indirect tariffs in global value chains, as espoused in Rouzet and Miroudot (2013). The basic idea is that imposition of higher tariffs by the United States on Chinese imports, which are then

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used in the United States for production and subsequent further exporting to other countries, imposes an additional tariff cost for third countries. They, probably unintentionally, get hurt through this.

Ours is, to the best of our knowledge, the first attempt to apply these concepts of cumulative and indirect tariffs in the context of the US–China trade war. While other studies have also looked at the impact on third countries, they usually consider trade diversion which may benefit other trade partners (e.g., Balistreri et al., 2018; Bolt, Mavromatis, & van Wijnbergen, 2019). The idea that the tariff increase will feed through the global supply chain also into exports to third countries is largely unexplored.<sup>1</sup>

We combine data from input–output relationships, imports and tariffs, to calculate the impact of the tariff increases by both the United States and China on cumulative tariffs paid by third countries. We show that the tariff hikes increase cumulative tariffs for other countries and thus hurt trade partners further downstream in global supply chains. We also show that this is particularly important for tariff increases on Chinese imports in the United States. These are likely to be used as intermediates in the United States, which are then re-exported to third countries. Interestingly, the most heavily hit third countries are the closest trade partners, namely the EU, Canada and Mexico. We estimate the tariffs impose an additional burden of between 500 million to 1 billion US dollars on these countries. China's tariffs on US imports have less of an effect, as they are less likely to be re-exported.

Section 2 outlines our methodology. Section 3 describes the data sets. The results of our calculations are presented and discussed in Section 4, while Section 5 concludes.

## 2 | METHODOLOGY

A cumulative tariff is the total cost of all tariffs incurred in a production process along the global value chain. It provides evidence on the extent to which trade costs are magnified in international production networks (Rouzet & Miroudot, 2013). Based on the calculation of cumulative tariffs, the extra tariff burden on third countries caused by tariff adding between two trading partners can be estimated. This is referred to as the indirect tariff burden. In other words, the indirect tariff burden can show clearly how much a third country gets hurt by tariff hikes between two countries.

### 2.1 | Cumulative tariff

We use the method developed by Rouzet and Miroudot (2013) to calculate the cumulative tariff on imports. The cumulative tariff consists of two parts, namely a direct tariff and an indirect tariff. The calculation of a cumulative tariff can be described as follows, in which we first ignore the dimension of industries for the sake of simplicity:

- Stage 0: the direct tariff  $t_{i,j}$  is imposed by country  $j$  on country  $i$ .
- Stage 1: for country  $i$  producing per unit output, it imports  $a_{m,i}$  from country  $m$  as intermediate input,  $m \in (1, 2 \dots N)$ . Then the cumulative tariff of country  $j$ 's import from country  $i$  for stage 1 is

<sup>1</sup>There are, of course, important antecedents to this way of evaluating second order effects of tariff changes, in particular in the literature on effective rate of protection (ERP), see, for example, Greenaway and Milner (2003), Krueger et al. (1980) and Corden (1966). One of the important insights of this literature is that it is important to look at the entire tariff structure in order to evaluate their effects. This is also at the heart of our approach.

$$CT_{ij}^{(1)} = t_{ij} + \sum_{m=1}^N a_{m,i} t_{m,i}. \quad (1)$$

- Stage 2: for country  $m$  producing per unit output, it imports  $a_{l,m}$  from country  $l$  as intermediates input,  $l \in (1, 2 \dots N)$ . The cumulative tariff for stage 2 is

$$CT_{ij}^{(2)} = t_{ij} + \sum_{m=1}^N a_{m,i} t_{m,i} + \sum_{m=1}^N \sum_{l=1}^N a_{m,i} a_{l,m} t_{l,m}. \quad (2)$$

- Stage  $s$ : likewise, the cumulative tariff for stage  $s$  is

$$CT_{ij}^{(s)} = t_{ij} + \sum_{m=1}^N a_{m,i} t_{m,i} + \sum_{m=1}^N \sum_{l=1}^N a_{m,i} a_{l,m} t_{l,m} + \dots \\ + \sum_{m_1, m_2, \dots, m_s \in N} a_{m_1, i} a_{m_2, m_1} a_{m_3, m_2} \dots a_{m_s, m_{s-1}} t_{m_s, m_{s-1}}, \quad (3)$$

when  $s \rightarrow \infty$ ,  $CT_{ij}^{(s)}$  accounts for all the tariffs incurred along the value chain.<sup>2,3</sup>

The calculation of tariffs incurred along the value chains Equation (3) can be presented in a matrix form as shown in Equation (4), where we now include the dimension of industries for generalisation:

$$CT = T + \left( \left[ \sum_{n=0}^{\infty} \mathbf{e} \times \mathbf{C} \times \mathbf{A}^n \right] \times \mathbf{e} \right) \circ \mathbf{D} = T + \left( (\mathbf{e} \times (\mathbf{A} \circ \mathbf{T}) \times (\mathbf{I} - \mathbf{A})^{-1})' \times \mathbf{e} \right) \circ \mathbf{D} = T \\ + \left( (\mathbf{e} \times (\mathbf{A} \circ \mathbf{T}) \times \mathbf{B})' \times \mathbf{e} \right) \circ \mathbf{D} \quad (4)$$

where  $CT$  is the  $NH \times NH$  cumulative tariff matrix,  $N$  is the total number of countries,  $H$  is the total number of industries.  $T$  is the  $NH \times NH$  direct import tariff matrix.  $\mathbf{e}$  is a  $1 \times NH$  vector of ones.  $\mathbf{A} \circ \mathbf{T} (= \mathbf{C})$  is the result of element by element multiplication of  $\mathbf{A}$  and  $\mathbf{T}$ , where  $\mathbf{A}$  is the input–output coefficient matrix.  $\mathbf{I}$  is an identity matrix.  $\mathbf{D}$  is a matrix with all elements set to be 1, except for zeros for the elements for the industrial interactions within the same countries. This is to make sure that the import tariff for countries on themselves is 0.  $\mathbf{B}$  is the Leontief inverse matrix.

In Equation (4),  $((\mathbf{e} \times (\mathbf{A} \circ \mathbf{T}) \times \mathbf{B})' \times \mathbf{e}) \circ \mathbf{D}$  is the indirect tariff matrix.

<sup>2</sup>Note that our calculations throughout are based on nominal published tariffs rather than nominal applied tariffs.

<sup>3</sup>This calculation assumes that there is a 100% through of tariff changes. This implies that our cumulative tariffs are likely to be an upper bound estimate.

## 2.2 | Indirect tariff burden caused by tariff adding

Assuming the direct tariff matrix is altered from:  $T^1$  to  $T^2$ ,  $T^2 = T^1 + \Delta T$ , we have:

$$\Delta CT = \Delta T + ((e \times (A \circ \Delta T) \times B)' \times e) \circ D = \Delta T + \Delta IT \tag{5}$$

where  $\Delta T$  is the change in the direct tariff matrix and  $\Delta IT$  accounts for the change in the indirect tariff burden caused by  $\Delta T$  through the global production network.

To have a clearer idea about what we mean by the indirect tariff burden caused by tariff adding, we consider a simple scenario with a world consisting of three countries. A change happens on the import tariff of country 3 on country 2  $\Delta T_{23}$ , while the tariff matrix for other countries remains the same. Then, the change in the cumulative tariff is:

$$\begin{aligned} \Delta CT &= \Delta T + \left( e \times \left( \begin{bmatrix} A_{11} & A_{12} & A_{13} \\ A_{21} & A_{22} & A_{23} \\ A_{31} & A_{32} & A_{33} \end{bmatrix} \circ \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & \Delta T_{23} \\ 0 & 0 & 0 \end{bmatrix} \times \begin{bmatrix} B_{11} & B_{12} & B_{13} \\ B_{21} & B_{22} & B_{23} \\ B_{31} & B_{32} & B_{33} \end{bmatrix} \right)' \times e \circ D \right) \\ &= \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & \Delta T_{23} \\ 0 & 0 & 0 \end{bmatrix} + \begin{bmatrix} 0 & A_{23} \Delta T_{23} B_{31} & A_{23} \Delta T_{23} B_{31} \\ A_{23} \Delta T_{23} B_{32} & 0 & A_{23} \Delta T_{23} B_{32} \\ A_{23} \Delta T_{23} B_{33} & A_{23} \Delta T_{23} B_{33} & 0 \end{bmatrix} \end{aligned} \tag{6}$$

From Equation (6), we can see why and by how much the indirect tariff is changed. Take country 1 as an example. The indirect import tariff change of country 2 and country 3 on country 1 is  $A_{23} \Delta T_{23} B_{31}$ , among which  $B_{31}$  is the total requirement of inputs from country 3 for producing 1 unit of a good in country 1,  $A_{23}$  is the direct inputs from country 2 for producing 1 unit product in country 3. Thus,  $A_{23} \Delta T_{23} B_{31}$  means the indirect tariff change transferred through the production network from country 3 to country 1.

The cumulative tariff can thus be calculated at the industry level. To get a more aggregate picture, we can also calculate cumulative tariffs or indirect tariff changes at the country pair level rather than country-industry: In this case, we use the import ratio as the weight to sum up the tariff from industry level to country level.

## 3 | DATA

The data used in this paper include input–output data, tariff data and import data. A description of the data and the source is given in Table 1. We calculate the input–output coefficient matrix  $A$  using the World Input-output Table from the WIOD database. These data relate to the latest year for which the data are available, 2014. The country–industry–country level import tariffs are from UNCTAD TRAINS database at HS 4 product level. The latest year is also 2014.<sup>4</sup> Considering that the industry categories HS 4 and WIOD (ISIC 4.0) are different, we use the industry product concordance provided by World Integrated Trade Solutions (WITS). We then add up tariffs to the ISIC 4.0 level using import weights. Import data at HS 4 level are also from UNCTAD TRAINS database. After calculating the cumulative tariff matrix, we need to use the import ratios for WIOD industries as weights to sum industry level tariff to country level data. Import data for WIOD industry categories are from the UNCTAD STAN database.

<sup>4</sup>For countries, including Indonesia, India, Mexico, Turkey, tariff and import data for 2014 are missing, thus we use 2013 data as replacement.

**TABLE 1** Data sources

Data Description	Data Source
World Input-output Table	WIOD Database (Latest to 2014)
Import tariff for HS 4 industry of country pair	UNCTAD-TRANIS Database (Latest to 2014)
Tariff amount and commodity list of US import tariff adding on China (To June 10th, 2019)	Office of the United States Trade Representatives
Tariff amount and commodity list of China import tariff adding on US (To June 10th, 2019)	Ministry of Finance of the People's Republic of China
The import for HS 4 industry of country pair	UNCTAD-TRANIS (Latest to 2014)
The import for HS 6 industry between US and China	UN COMTRADE
The import of ISIC 4.0 industry for country pairs	UNCTAD Stan
The concordance of HS 4 industry and ISIC 4.0 industry	From World Integrated Trade Solutions

*Notes:* The commodity list of US import tariff adding on China is from <https://ustr.gov/about-us/policy-offices/press-office/press-releases/2018/september/ustr-finalizes-tariffs-200>.

The notice of increase tariff from 10% to 25% of United States on China: <https://ustr.gov/about-us/policy-offices/press-office/press-releases/2019/may/notice-regarding-application-section>.

Tariff amount and commodity list of China import tariff adding on United States is from [http://gss.mof.gov.cn/zhengwuxinxi/zhengcefabu/201808/t20180803\\_2980950.html](http://gss.mof.gov.cn/zhengwuxinxi/zhengcefabu/201808/t20180803_2980950.html).

To investigate the indirect tariff burden of the ‘US-China Trade War’ on third countries, we collect the tariff-adding amounts and commodity lists from the government websites of the United States and China. The tariff-adding information of United States on China is from the Office of the United States Trade Representatives, and the tariff-adding information of China on United States is from Ministry of Finance of the People's Republic of China.<sup>5</sup>

## 4 | RESULTS

### 4.1 | Cumulative tariffs and indirect tariffs

To start off, we present the cumulative tariff rates, calculated as in Equation (4), which are presented for the 12 countries in our data base. Table 2 shows the results with the tariff-imposing destination country in columns and the trade partner country in rows.<sup>6</sup> This shows, for example, in the first row that the average cumulative tariff imposed by China on total imports is 3.79%. Table 3 then shows the ratio of indirect to cumulative tariffs, that is, the share of cumulative tariffs that are incurred before the good crosses the last border. For China, this shows that of the 3.79% cumulative tariff, only 5.65% are indirect tariffs, the remaining 94.35% are direct tariffs imposed at the Chinese border.

<sup>5</sup>However, the commodity list of tariff-adding is at the HS8 code, which makes classifying it into WIOD industry category difficult. The main problem is that there is a lack of bilateral trade data for HS8 products between United States and China which are necessary as weights. By checking the subgroup of HS6 products, we found that only 38.1% HS6 products have subgroup in HS8, the remaining 61.9% HS6 products do not have subgroups. (The information of subgroups of HS6 products is from <https://www.usitc.gov/tata/hts/bychapter/index.htm>.) It means that taking the tariff adding on HS8 products as the tariff adding on HS6 products should not overestimate the indirect tariff by too much. The bilateral trade data of HS6 products between United States and China are from UN COMTRADE database.

<sup>6</sup>Overall, these results are roughly comparable to Rouzet and Miroudot (2013), who use 2009 data for their calculations.

**TABLE 2** The cumulative import tariff (2014) (%)

	AUS	BRA	CAN	CHN	IDN	IND	JPN	KOR	MEX	RUS	USA	EU
TOT	2.09	7.69	1.66	3.79	2.28	4.05	2.34	3.71	5.23	5.46	1.54	0.92
AUS		3.22	3.05	1.26	4.61	4.34	3.24	5.19	2.96	5.61	1.80	3.59
BRA	3.56		2.40	3.08	5.98	10.49	2.37	66.81	8.54	14.76	2.13	7.63
CAN	2.02	5.83		4.40	1.87	15.14	11.14	6.07	7.79	11.02	0.30	1.82
CHN	4.00	14.86	3.46		1.45	6.73	3.49	6.24	3.55	6.64	3.33	4.26
IDN	0.57	19.31	5.68	1.03		23.53	0.73	0.90	10.31	4.58	5.89	5.59
IND	3.76	7.29	4.48	4.30	4.05		1.55	4.95	10.28	7.79	3.36	5.69
JPN	3.64	14.38	2.25	8.31	7.41	7.92		4.77	4.89	3.71	1.35	3.57
KOR	3.05	12.90	3.53	7.37	2.00	7.63	2.64		4.00	6.10	1.20	1.13
MEX	4.07	4.14	1.66	8.38	4.68	4.37	5.85	5.21		5.62	1.39	1.28
RUS	0.37	2.57	1.15	1.07	1.09	7.22	0.55	5.17	5.05		1.57	0.75
USA	0.22	7.39	1.10	6.90	4.53	7.76	6.22	7.56	6.53	8.01		2.37
EU	3.41	11.57	2.75	9.28	6.23	8.84	3.85	2.25	5.44	6.52	1.61	

This looks quite different for countries generally higher up the value chain, such as the United States. Here, Table 2 shows that the cumulative tariff adds up to 1.54%, 26.6% of which are indirect tariffs incurred before the goods cross the US border (Table 3).

The importance of the concept of cumulative tariffs as summing up tariffs along the value chain can be illustrated well by looking at the US–Mexican relationship. While both countries are in NAFTA with low to zero tariffs for goods, Tables 2 and 3 show that the cumulative tariff imposed by the United States on imports from Mexico adds up to 1.39%. 98.81% of which are indirect tariffs, that is, tariffs imposed on intermediate goods before crossing from Mexico into the United States.

While these cumulative tariffs are aggregated at the country level, we can use the information on the input–output structure to zoom in at the industry level. This is what is done in Tables 4 and 5. We use Equation (5) and calculate the expected increase in cumulative tariffs for a hypothetical tariff increase by the United States and China, respectively.

Table 4 considers an increase in US tariffs on Chinese imports by 100%. We can see that industries are affected differently and that the cumulative tariff increase also differs across countries. Quite interestingly, the countries hit hardest by a tariff increase vis-à-vis China are the US main trading partners Canada and Mexico—and here in particular the chemical, electrical/electronics and vehicle manufacturing industries. These are all industries that rely heavily on imported intermediates, and increasing tariffs on such from China leads to a significant increase in cumulative tariffs.

Table 5 presents results for the opposite scenario, namely, an increase on import tariffs by China on US imports by 100%. These results show the impact on cumulative tariffs is much smaller than for the scenario of a US tariff increase. Other countries are hit far less by Chinese tariffs on US goods than by US tariffs on Chinese goods. This reflects the fact that the latter are more likely to be intermediates in the production process.

Rather than using a hypothetical increase in tariffs by 100%, we can use the actual values imposed by the United States and China in the current trade war. Table 6 shows the rates, based on official announcements

**TABLE 3** The ratio of indirect import tariff to cumulative import tariff, measurement: %

	AUS	BRA	CAN	CHN	IDN	IND	JPN	KOR	MEX	RUS	USA	EU
TOT	11.27	3.37	17.67	<b>5.65</b>	9.29	4.00	10.00	4.99	5.14	4.76	26.60	26.06
AUS		5.71	8.70	10.97	3.91	3.56	4.18	2.76	7.84	4.64	15.32	5.82
BRA	25.61		29.88	14.53	9.26	3.96	18.86	0.69	14.22	3.41	33.59	7.52
CAN	11.34	3.76		4.99	13.56	1.24	2.04	2.45	3.81	2.54	69.46	8.86
CHN	10.49	2.89	12.51		27.05	6.47	12.56	6.83	14.85	6.45	13.67	10.05
IDN	73.36	2.22	7.45	23.82		0.84	35.64	22.22	5.23	8.21	7.24	7.08
IND	18.38	7.39	15.99	12.26	17.50		35.35	11.06	8.62	9.99	19.48	11.73
JPN	3.44	1.02	6.13	1.93	2.07	1.92		3.69	2.71	3.78	10.48	4.10
KOR	17.36	5.86	21.31	10.31	29.76	8.18	33.49		18.85	12.98	61.64	62.86
MEX	33.10	38.39	91.92	14.57	23.23	8.96	20.07	15.49		26.29	98.81	76.83
RUS	57.53	22.22	46.13	23.35	34.17	5.36	40.44	4.58	9.90		19.99	32.55
USA	79.35	1.97	15.81	2.21	3.21	1.88	2.29	1.91	2.58	2.29		6.50
EU	5.83	1.80	7.40	2.34	3.29	2.13	5.67	9.10	3.84	3.23	12.66	



**TABLE 4** The indirect tariff burden on third country of US adding 100% tariff on import from china for each industry (%)

Industry	TOT	AUS	BRA	CAN	CHN	IDN	IND	JPN	KOR	MEX	RUS	USA	EU
Crop and animal production, hunting and related service activities	0.03	0.04	0.03	0.18	0.04	0.06	0.02	0.08	0.06	0.17	0.01	0.01	0.02
Forestry and logging	0.01	0.01	0.01	0.04	0.01	0.02	0.00	0.02	0.01	0.04	0.00	0.00	0.00
Fishing and aquaculture	0.01	0.01	0.01	0.03	0.01	0.01	0.00	0.01	0.01	0.03	0.00	0.00	0.00
Manufacture of food products, beverages and tobacco products	0.08	0.11	0.18	0.45	0.07	0.05	0.06	0.09	0.09	0.44	0.06	0.05	0.06
Manufacture of food products, beverages and tobacco products	0.07	0.09	0.10	0.40	0.07	0.10	0.04	0.13	0.11	0.36	0.04	0.03	0.05
Manufacture of textiles, wearing apparel and leather products	0.35	0.51	0.41	2.29	0.30	0.19	0.17	0.34	0.28	2.21	0.24	0.26	0.24
Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	0.17	0.23	0.19	0.97	0.17	0.10	0.09	0.19	0.14	0.73	0.10	0.10	0.12
Manufacture of paper and paper products	0.31	0.33	0.36	1.65	0.26	0.25	0.17	0.34	0.29	1.45	0.17	0.19	0.18
Printing and reproduction of recorded media	0.01	0.01	0.01	0.04	0.01	0.00	0.00	0.01	0.01	0.04	0.01	0.00	0.01
Manufacture of coke and refined petroleum products	0.25	0.23	0.46	0.91	0.18	0.15	0.13	0.24	0.21	0.88	0.13	0.12	0.17
Manufacture of chemicals and chemical products	3.25	3.47	7.03	13.71	2.62	2.06	1.92	3.47	3.01	13.08	1.95	1.69	2.57
Manufacture of basic pharmaceutical products and pharmaceutical preparations	0.24	0.28	0.55	1.10	0.21	0.16	0.15	0.28	0.24	1.05	0.16	0.14	0.22
Manufacture of rubber and plastic products	0.83	0.96	0.90	4.36	0.60	0.38	0.35	0.72	0.69	3.48	0.51	0.46	0.44
Manufacture of other non-metallic mineral products	0.37	0.42	0.44	2.21	0.31	0.17	0.21	0.34	0.36	1.74	0.23	0.23	0.23
Manufacture of basic metals	1.09	1.33	1.08	5.77	0.89	0.44	0.70	0.88	1.03	4.99	0.78	0.69	0.72
Manufacture of fabricated metal products, except machinery and equipment	1.47	1.83	1.57	7.54	1.17	0.67	0.72	1.29	1.43	6.01	1.11	0.85	0.86

(Continues)

TABLE 4 (Continued)

Industry	TOT	AUS	BRA	CAN	CHN	IDN	IND	JPN	KOR	MEX	RUS	USA	EU
Manufacture of computer, electronic and optical products	5.72	6.94	6.17	22.14	5.96	2.23	3.27	6.14	6.35	17.36	5.06	3.32	4.60
Manufacture of electrical equipment	2.05	2.72	2.19	9.52	1.69	0.92	1.03	1.87	2.28	8.56	1.61	1.13	1.29
Manufacture of machinery and equipment <i>n.e.c.</i>	2.60	3.35	3.21	13.62	2.01	1.27	1.30	2.24	2.81	10.53	1.97	1.42	1.50
Manufacture of motor vehicles, trailers and semi-trailers	2.28	2.23	1.35	15.49	1.43	0.44	0.49	0.94	1.17	9.48	1.24	1.50	0.77
Manufacture of other transport equipment	0.38	0.28	0.26	0.74	0.26	0.11	0.20	0.29	0.19	0.37	0.39	0.09	0.50
Manufacture of furniture; other manufacturing	0.18	0.32	0.23	0.91	0.14	0.08	0.11	0.23	0.18	0.72	0.13	0.09	0.15

**TABLE 5** The transfer tariff burden of China adding 100% tariff on import from United States for each industry (%)

Industry	TOT	AUS	BRA	CAN	CHN	IDN	IND	JPN	KOR	MEX	RUS	USA	EU
Crop and animal production, hunting and related service activities	1.06	2.09	1.51	1.16	0.25	1.97	1.01	2.62	1.59	0.99	1.82	1.85	0.88
Forestry and logging	0.03	0.10	0.06	0.06	0.01	0.07	0.05	0.09	0.07	0.05	0.07	0.09	0.03
Fishing and aquaculture	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Manufacture of food products, beverages and tobacco products	0.35	0.62	0.53	0.34	0.14	0.70	0.50	0.57	0.61	0.44	0.54	0.51	0.24
Manufacture of food products, beverages and tobacco products	0.33	0.56	0.48	0.32	0.10	0.61	0.39	0.66	0.51	0.37	0.52	0.51	0.24
Manufacture of textiles, wearing apparel and leather products	0.10	0.16	0.10	0.09	0.01	0.11	0.05	0.18	0.09	0.06	0.13	0.15	0.07
Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	0.15	0.27	0.14	0.17	0.03	0.16	0.12	0.23	0.16	0.13	0.18	0.28	0.10
Manufacture of paper and paper products	0.30	0.59	0.40	0.33	0.11	0.47	0.37	0.55	0.45	0.39	0.47	0.54	0.23
Printing and reproduction of recorded media	0.02	0.03	0.02	0.02	0.01	0.03	0.02	0.03	0.03	0.02	0.03	0.03	0.01
Manufacture of coke and refined petroleum products	0.28	0.45	0.41	0.25	0.10	0.49	0.36	0.44	0.42	0.32	0.40	0.40	0.18
Manufacture of chemicals and chemical products	1.85	3.40	3.15	1.94	0.69	3.53	2.66	3.40	3.04	2.44	2.99	3.12	1.39
Manufacture of basic pharmaceutical products and pharmaceutical preparations	0.03	0.05	0.05	0.03	0.01	0.05	0.05	0.06	0.05	0.05	0.05	0.06	0.02
Manufacture of rubber and plastic products	0.18	0.30	0.24	0.18	0.06	0.26	0.21	0.30	0.25	0.25	0.28	0.30	0.13
Manufacture of other non-metallic mineral products	0.04	0.07	0.06	0.05	0.02	0.07	0.06	0.07	0.07	0.06	0.07	0.07	0.03
Manufacture of basic metals	0.19	0.34	0.28	0.22	0.07	0.37	0.26	0.33	0.34	0.30	0.36	0.33	0.15
Manufacture of fabricated metal products, except machinery and equipment	0.13	0.21	0.17	0.13	0.04	0.21	0.16	0.21	0.19	0.18	0.22	0.21	0.09

(Continues)

TABLE 5 (Continued)

Industry	TOT	AUS	BRA	CAN	CHN	IDN	IND	JPN	KOR	MEX	RUS	USA	EU
Manufacture of computer, electronic and optical products	1.59	2.10	1.77	1.40	0.70	1.63	2.03	2.52	2.34	2.58	2.04	2.65	1.16
Manufacture of electrical equipment	0.24	0.35	0.30	0.22	0.09	0.32	0.29	0.37	0.33	0.36	0.35	0.38	0.17
Manufacture of machinery and equipment n.e.c.	0.69	1.09	0.95	0.68	0.22	1.26	0.88	1.08	0.97	0.91	1.32	1.04	0.47
Manufacture of motor vehicles, trailers and semi-trailers	0.11	0.15	0.14	0.12	0.03	0.14	0.11	0.17	0.15	0.17	0.20	0.17	0.07
Manufacture of other transport equipment	0.11	0.17	0.14	0.11	0.04	0.21	0.16	0.16	0.15	0.13	0.18	0.16	0.09
Manufacture of furniture; other manufacturing	0.20	0.31	0.23	0.19	0.06	0.30	0.21	0.29	0.29	0.23	0.29	0.30	0.13

**TABLE 6** The tariff added between China and US during ‘Trade War’ (%)

Industry	United States on China		China on United States	
	Tariff added	Import ratio	Tariff added	Import ratio
Crop and animal production, hunting and related service activities	16.84	0.21%	0.44	12.08%
Forestry and logging	25.00	0.00%	20.95	0.90%
Fishing and aquaculture	19.16	0.01%	0.45	0.20%
Manufacture of food products, beverages and tobacco products	11.45	0.08%	16.34	4.15%
Manufacture of food products, beverages and tobacco products	20.61	1.21%	8.73	3.94%
Manufacture of textiles, wearing apparel and leather products	4.70	12.82%	15.64	0.67%
Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	20.39	0.90%	23.47	1.18%
Manufacture of paper and paper products	22.73	0.72%	3.36	1.72%
Printing and reproduction of recorded media	0.00	0.06%	13.01	0.17%
Manufacture of coke and refined petroleum products	20.12	0.13%	2.34	1.87%
Manufacture of chemicals and chemical products	18.96	2.82%	11.33	11.29%
Manufacture of basic pharmaceutical products and pharmaceutical preparations	0.40	0.54%	1.41	2.54%
Manufacture of rubber and plastic products	16.16	3.92%	13.94	1.98%
Manufacture of other non-metallic mineral products	17.37	1.61%	12.92	0.90%
Manufacture of basic metals	8.02	0.92%	17.38	4.45%
Manufacture of fabricated metal products, except machinery and equipment	17.27	4.05%	14.44	1.17%
Manufacture of computer, electronic and optical products	5.13	37.09%	8.09	15.16%
Manufacture of electrical equipment	16.91	10.06%	19.93	2.89%
Manufacture of machinery and equipment n.e.c.	10.26	7.34%	11.93	7.88%
Manufacture of motor vehicles, trailers and semi-trailers	21.35	3.02%	0.29	10.66%
Manufacture of other transport equipment	8.13	0.76%	0.16	11.92%
Manufacture of furniture; other manufacturing	8.61	11.75%	19.81	2.26%
Total	9.57	100%	7.66	100%

of tariff added on listed goods and averaged by import weight to WIOD industry level.<sup>7</sup> We also show the corresponding import ratio,<sup>8</sup> that is, imports into the tariff imposing country from the partner country. In the first two columns, which shows US tariff increases and corresponding import ratios, we can see that

<sup>7</sup>The commodity list of US import tariff adding on China is from <https://ustr.gov/about-us/policy-offices/press-office/press-releases/2018/september/ustr-finalizes-tariffs-200>.

The notice of increase tariff from 10% to 25% of United States on China: <https://ustr.gov/about-us/policy-offices/press-office/press-releases/2019/may/notice-regarding-application-section>.

Tariff amount and commodity list of China import tariff adding on United States is from [http://gss.mof.gov.cn/zhengwuxinxi/zhengcefabu/201808/t20180803\\_2980950.html](http://gss.mof.gov.cn/zhengwuxinxi/zhengcefabu/201808/t20180803_2980950.html).

<sup>8</sup>We report the import ratio for each country in year 2017. The bilateral import data between United States and China are from UN COMTRADE, summed from HS4 products level to WIOD industry level.

**TABLE 7** The indirect tariff caused by US adding tariff on china during 'Trade War'

Countries	Indirect tariff rate added (%)			Indirect tariff growth rate			Indirect tariff burden (million \$)		
	For imports from United States	For imports from the world	For imports from United States (%)	For imports from United States (%)	For imports from world (%)	For imports from United States	For imports from the world	For imports from the world	
AUS	0.26	0.03	148.70	13.70	13.70	64.19	75.98	75.98	
BRA	0.18	0.04	125.70	13.70	13.70	53.58	64.17	64.17	
CAN	0.27	0.14	154.00	48.00	48.00	631.78	648.00	648.00	
CHN	0.22	0.02	143.80	10.40	10.40	338.38	412.93	412.93	
IDN	0.18	0.01	124.10	6.20	6.20	18.41	24.63	24.63	
IND	0.19	0.01	133.40	8.40	8.40	75.59	83.84	83.84	
JPN	0.19	0.02	137.10	10.60	10.60	162.88	184.76	184.76	
KOR	0.21	0.03	145.90	13.80	13.80	124.50	136.57	136.57	
MEX	0.24	0.11	139.70	41.90	41.90	508.69	522.16	522.16	
RUS	0.27	0.02	145.70	7.30	7.30	33.92	45.80	45.80	
USA	-	0.02	-	3.90	3.90	-	415.43	415.43	
EU	0.22	0.02	144.10	7.20	7.20	766.64	1,043.12	1,043.12	

Notes: The column of country names are who imports; By dividing Indirect tariff rate adding caused by 'trade war' with the total indirect tariff rate in 2014, we get the growth rate of indirect tariff. Indirect tariff burden caused by 'trade war' equals the indirect tariff rates multiplying import from United States or the world of 2018, while China's import data is 2017 for 2018 is not available. The same for Table 8.

TABLE 8 The indirect tariff caused by china adding tariff on US during 'Trade War'

Countries	Indirect tariff rate added (%)		Indirect tariff growth rate		Indirect tariff burden (million \$)	
	For imports from China	For imports from world	For imports from China, %	For imports from world, %	For imports from China	For imports from world
AUS	0.05	0.01	11.45	5.35	27.72	29.71
BRA	0.05	0.01	11.65	4.08	17.39	19.14
CAN	0.05	0.01	11.02	2.59	27.79	34.91
CHN	–	0.00	–	1.28	–	50.49
IDN	0.05	0.01	12.36	5.78	22.14	23.11
IND	0.05	0.01	11.61	5.95	45.68	59.61
JPN	0.05	0.01	10.60	5.50	80.66	96.24
KOR	0.05	0.01	11.26	6.20	51.12	61.48
MEX	0.05	0.01	9.30	3.77	40.98	47.07
RUS	0.05	0.01	11.20	4.54	25.04	28.32
USA	0.05	0.01	10.52	3.04	269.44	325.07
EU	0.05	0.01	10.68	2.26	213.76	294.57

the United States imposed tariffs in industries with relatively low levels of imports, such as forestry and logging; manufacture of food products; or motor vehicles. The same goes for Chinese import tariffs which are targeted at industries from which relatively little is imported from the United States.

Table 7 shows corresponding changes in indirect tariffs as a result of the tariff increases, including tariff adding, growth rate and tariff burden. This shows that, while all countries bear the added indirect tariff when importing from the United States, Canada and Mexico experience the highest increases in indirect tariffs, at 0.27 and 0.24%, respectively. In other words, trade partners of the United States are hit hardest by US tariff increases on Chinese goods, as they use imported intermediates which are now subject to the tariff hikes. The indirect tariff caused by the trade war is equivalent, for example, to 29% of Canada's direct tariff on US imports.<sup>9</sup> While the calculated changes in indirect tariffs do not appear large at first sight, they are economically significant. As comparison, consider that the average direct tariff imposed by the EU or the United States on the world are only 1.13% or 0.68%, respectively.

To further underline the economic significance of the tariff changes, we also report the growth rate of indirect tariffs on imports from the United States and the world. For imports from the United States, the growth rate achieved nearly 150% for every country, which is substantial. For imports from the world, Canada and Mexico experience the highest growth rates of indirect tariffs. In addition, we calculate the indirect tariff burden in US dollars caused by US adding tariffs on China, by multiplying the indirect tariff rates with the import value in 2018. The countries bearing the largest tariff burden are the EU as well as Canada and Mexico—the main trading partners of the United States. Their additional costs due to the indirect tariff burden sum to 1 billion, 648 million and 522 million respectively. Note, however, that the United States and China are also severely affected.

The opposite scenario for tariff increases by China is shown in Table 8. It is clear that the impact of China's trade protection is much less than the actions of the United States. This again indicates that US goods are less important as intermediates which are exported from China to other countries, while Chinese goods imported into the United States are much more likely to be exported after processing in the United States. Still, considerable additional indirect tariff burdens fall on the United States and the EU, due to the large scale of imports from China.

## 5 | CONCLUSION

This paper investigates the potential indirect effects of tariff hikes in the recent United States–China trade war on other trading partners. To do so, we calculate cumulative tariff rates, which take into account trade restrictions affecting goods along the global value chains. Since Chinese imports into the United States are likely to be used as intermediates in goods that are then exported again by the United States, an increase in the tariff on such goods also affects third countries, as they import the processed good from the United States. This is less of an issue with US goods imported by China.

Because of the close trading relationship with the United States, the EU, Canada and Mexico are hit hardest in absolute terms by increased US tariffs on Chinese imports. We estimate that the tariffs impose an additional burden of between 500 million to 1 billion US dollars on these countries. This shows that third countries are not unaffected by trade wars between two countries, and therefore have an economic incentive to help solving the difficulties causing the dispute.

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<sup>9</sup>The direct tariff of Canada on United States is 0.93% in 2014.





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## ORCID

Holger Görg  <https://orcid.org/0000-0002-0485-261X>

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