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Exploring the impacts of Sino–US trade disruptions with a multi-regional CGE model

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ABSTRACT

With the aim to explore the boundary effects of the Sino–US trade war, this study considers a multi-region CGE model to set up six trade disruption scenarios based on the severity of trade friction, and empirically examines the gains and losses for China and the US, as well as potential impacts on other countries. The results show that: (1) Sino–US trade disruptions will likely result in a lose-lose situation; (2) compared to agriculture, China’s restriction on manufacturing imports may generate a greater negative impact on the US; (3) a trade diversion pattern is observed, indicating shrinking of bilateral trades between the two countries and increasing exports toward third trading partners; (4) although the US trade sanctions will substantially reduce the trade deficit with China, the trade deficits with other countries will likely increase. By empirically quantifying the boundary effects of Sino–US trade disruptions, this study sheds light on the negative effects of a trade war for both countries, as compared to proper negotiations.

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1. Introduction

Over the past two decades, as globalisation became more pervasive, the global political and economic patterns have undergone drastic changes (Munir & Ameer, 2018; Panigrahi, Bahinipati, & Jain, 2019). China, as the main beneficiary of the latest round of trade liberalisation, has maintained an average annual GDP growth rate of over 9% since 2000. China is now the second largest economy, and the economic gap between China and the United States (US) is shrinking rapidly. However, China’s economic miracle is facing the challenge of Sino-US relations, especially after President Trump came to power. In particular, the 2018 US National Security

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Strategy and US National Defense Strategy called China a strategic competitor and a revisionist power that challenges US interests (Guo, Lu, Sheng, & Yu, 2018; Wang, 2018). Unwilling to show weakness, China has reacted with countermeasures. As a consequence, Sino-US relations are now suffering unprecedented difficulties.

At the outset of his campaign, Trump regarded China in the trading field as a currency manipulator and threatened to impose punitive tariffs on Chinese goods (Li, 2017). In June 2018, the US government announced a 25% tariff on \$50 billion of imports from China, citing unfair trade practices related to intellectual property rights and technology (Li, He, & Lin, 2018). After China retaliated on the same amount of US goods, the Trump administration announced 10% tariffs on additional \$200 billion of Chinese products (Sheng, Zhao, & Zhao, 2019). China again responded with tariffs on about \$60 billion of US goods. Although this tense confrontation seems to have eased through several rounds of negotiations, the two sides have not agreed on many issues including trade imbalance, intellectual property rights, and subsidies for state-owned enterprises (Lukin, 2019; Wang, 2018). Even if this trade war comes to an end soon, it seems likely that the Sino-US economic rivalry will intensify over time (Kim, 2019; Li et al., 2018).

Sino-US trade frictions are not a new problem. China and the US are both large global trading nations, and trade frictions have always accompanied the development of bilateral relations. Most scholars focus on the causes of trade friction looking at two aspects: economy and politics. Economically, some studies suggest that trade imbalances, exchange rates, and market system differences are the main causes of the Sino-US trade conflicts (Friedberg, 2005; Hughes, 2005; Lin & Wang, 2018; Yang, 2012). Trade protectionism caused by economic recessions provides an important background for trade friction (Irwin, 2017; Kim, 2014; Stiglitz, 2018), while over-dependence on the US by China's export market exacerbates the likelihood of trade frictions (Glaser & Viers, 2016; Woo, 2008). In politics, some scholars believe that political elections in the US (Jervis, 2016; Woo, 2008) and the strategic containment strategy of the US towards China's rise will stimulate the US to manipulate trade frictions against China (He, 2017; Kim, 2019). In short, the reasons for the trade frictions between China and the US are complex. However, they reflect the strategic anxiety of the US towards China's rise. Both countries benefit from the complementary bilateral relationship while also suffering from the competition. Economic cooperation and political containment characterise the relationship between the two countries, leading to frequent trade frictions.

In view of the obvious negative impact of the Sino-US trade frictions, some scholars have discussed how to rebalance trade between China and the US. From the perspective of China, Zhang (2012) suggests that the exchange rate issue is not the main cause of the Sino-US trade imbalance, and that the appreciation of the CNY could not effectively solve the US's trade deficit. Kim (2014) examines the impact of Sino-US trades on the trade imbalance and found no significant relationship between China's exports to the US and the corresponding trade deficit. Guo et al. (2018) suggest an increase in China's imports from the US to reduce the trade imbalance, while Lin and Wang (2018) believe that the Sino-US trade imbalance is mainly related to the industrial transfers of Japan, South Korea, and other countries. From the viewpoint of the US, Lin (2013) argues that the main reason for the US trade imbalance

is overconsumption by US families, which is related to the increase in the value of assets brought under financial control and its expansionary monetary policy. Lawrence (2018) suggests that instead of breaking free trade rules with tariff penalties against China, the US could rebalance trade more effectively by cooperating with other countries, while taking actions that are consistent with maintaining the rules-based system.

A Sino-US trade war is not only a current threat, but also a potential future one (Li et al., 2018). Exploring its impacts is thus particularly valuable and interesting from a policy perspective. However, to the best of our knowledge, the literature on this topic is scarce. Dong and Whalley (2012) adopt two closely related numerical general equilibrium models of world trade to study the consequences of Sino-US trade conflicts, and find that bilateral retaliation can be welfare improving for the US but not for China. Li et al. (2018) build a 29-region CGE model to evaluate the potential impacts of a Sino-US trade war. Their results show that a trade war would harm most countries especially in terms of GDP and manufacturing employment, but would be beneficial in terms of welfare and trade. Differently, Rosyadi and Widodo (2018) and Shagdar and Nakajima (2018) consider the Global Trade Analysis Project (GTAP) to explore the possible impact on the global economy of Trump's proposed tariff increase against China. These studies find that a trade war may generate a negative impact on both China and the US' GDP, whereas other countries' GDP would increase.

The above studies adopt different CGE models to explore the economic consequences of Sino-US trade conflicts by assuming that the tariffs between these two countries simply increase by a certain percentage (e.g. 15%, 30%, 45%, and 60%). Only few studies focus on the impacts of a partial or even complete Sino-US trade disruption. However, this is not an unrealistic scenario. For example, some scholars have already suggested China to stop importing US soybeans or aircrafts in response to Trump's actions (He et al., 2019; Yao, 2018).

The purpose of this study is to investigate the boundary effects of Sino-US trade frictions. By adopting the GTAP model, this study sets out six trade disruption scenarios to simulate possible impacts worldwide. Our study makes a novel contribution to the literature since, to the best of our knowledge, it is the first attempt to approximate the maximum influence of trade frictions on China and the US. Moreover, given their potential effects on global economy, the study also sheds light on the boundary effects of these frictions on other countries.

2. The Sino-US trade relations

2.1. Comparison of aggregate statistics between China and the US

Table 1 compares the aggregate indexes of China and the US in 2016. According to World Bank figures, China and the US had a total population of 1.70 billion, accounting for about 22.60% of the world's level. Total GDP of the two countries was up to USD 29.82 trillion (39.32% of the world GDP). Both countries are major global trading nations, and exports are important drivers of economic growth. In 2016, the accumulated exports of the two countries were USD 3.55 trillion, with a share of 22.79%. Of this, China's exports were USD 2.10 trillion, accounting for 18.73% of its

Table 1. Comparison of economic aggregate indexes between China and the US in 2016.

	Population (Billion)	GDP (USD Trillion)	Per capita GDP (US dollar)	Import (USD Trillion)	Export (USD Trillion)	Trade balance (USD Billion)
China	1.38	11.20	8,123.20	1.59	2.10	509.72
The US	0.32	18.62	57,638.20	2.25	1.45	-797.75
World	7.44	75.85	10,189.60	15.57	15.57	0.00

Note: Data from World Bank (2018).

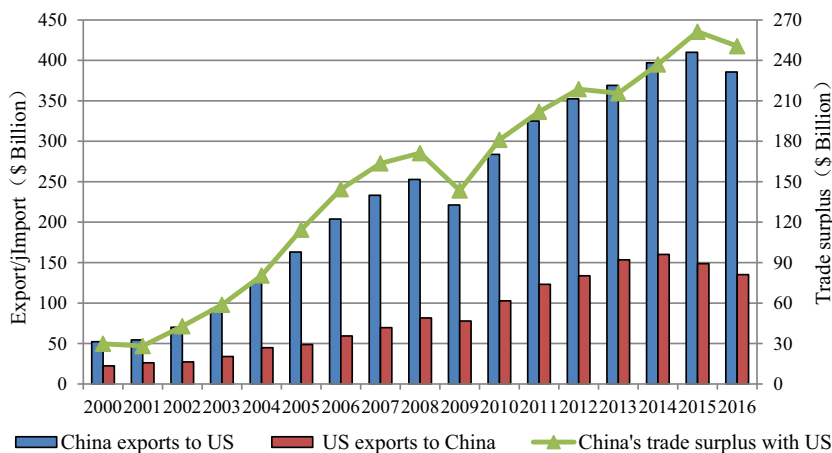


Figure 1. Trade contacts between China and the US. Data source: United Nations Statistics Division (2018).

GDP. The US exports were USD 1.45 trillion, accounting for 7.79% of its GDP. In terms of trade balance, China maintained a favourable trade surplus of about USD 509.72 billion while the US suffered a trade deficit of USD 797.75 billion. With such huge economic figures and trade volumes, a trade war between China and the US would inevitably and significantly impact the existing trade system and the world economy.

2.2. Trade relations between China and the US

Figure 1 presents the trade exchanges between China and the US since 2000, and shows that the two countries are important trading partners. Bilateral trade has developed rapidly. China's exports to the US increased from USD 52.16 billion in 2000 to USD 385.69 billion in 2016, with an average annual growth rate of 12.49%. Meanwhile, US exports to China increased from USD 22.38 billion to USD 135.12 billion, with an average annual growth rate of 11.16%. China maintains a trade surplus with the US, with an amount increased from USD 29.78 billion to its peak value of USD 261.29 billion in 2015, before declining slightly to USD 250.56 billion in 2016. Figure 1 also shows that, although China's trade surplus with the US increased, its growth rate has been declining. For example, between 2000 and 2008, the average annual growth rate of China's trade surplus with the US was 24.44%, much higher than the rate of 8.28% between 2009 and 2016.

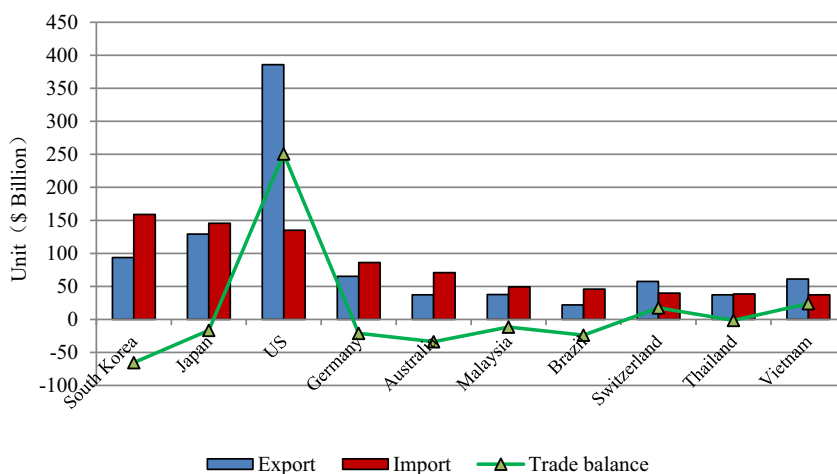


Figure 2. China's trade surplus with major trading partners in 2016. Data source: United Nations Statistics Division (2018).

2.3. Comparison of main trading partners of China and the US

Although China maintains a trade surplus with the US, it suffers trade deficits with most other countries. Figure 2 lists the trade contacts between China and the top ten import partners in 2016. It can be seen that China had trade deficits with Korea, Japan, Germany, Australia, and Brazil. The largest trade deficit was with South Korea (USD 65.27 billion). As a world factory, China imports raw materials and intermediate inputs from these countries, and then exports final products to the US, which has led to a transition in the trade surpluses of these countries with the US to China's surplus with the US. This indicates that US trade restrictive measures will not only reduce the level of China's exports, but also break the industrial division of labour between China and its trading partners, and weaken the importance of China in the international trade.

Figure 3 shows the trade contacts between the US and its top ten import source countries in 2016. The figure illustrates that the US had trade deficits with most countries. The largest was with China at USD 250.56 billion, accounting for 31.41% of the total deficit in 2016. Mexico, Japan, and Germany were also main trade deficit countries for the US and the trade surpluses between the three countries and the US were over USD 60 billion. This means that if the US adopts unilateral trade sanctions against China, exports of other countries to the US would increase and may further aggravate the trade imbalance between the US and these countries.

2.4. Comparison of export structures in China and the US

The Sino-US trade exhibits strong complementarities. Figure 4 shows the difference in the export structures between China and the US, indicating that China's exports to the US have been mainly concentrated in labour-intensive goods, represented by textiles and leather and machinery and equipment, where the final assembly stage was performed in China. In 2016, machinery and equipment manufacturing, textiles and

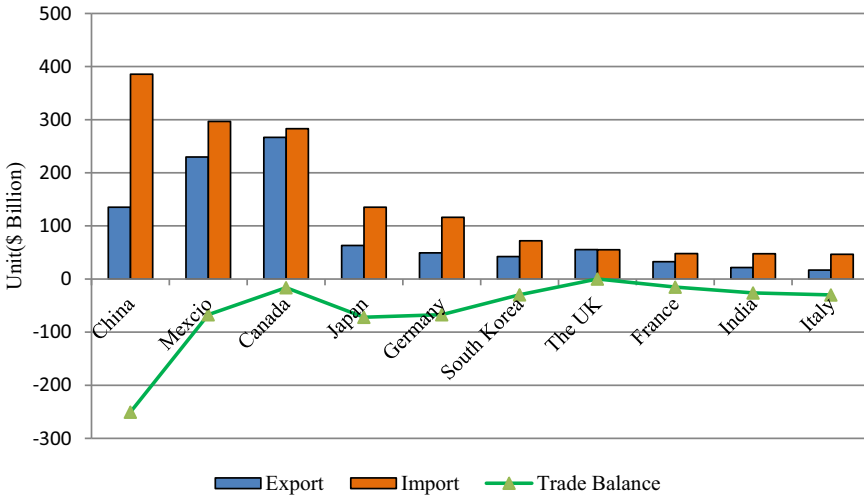


Figure 3. Trade balance between the US and its major trading partners. Data source: United Nations Statistics Division (2018).

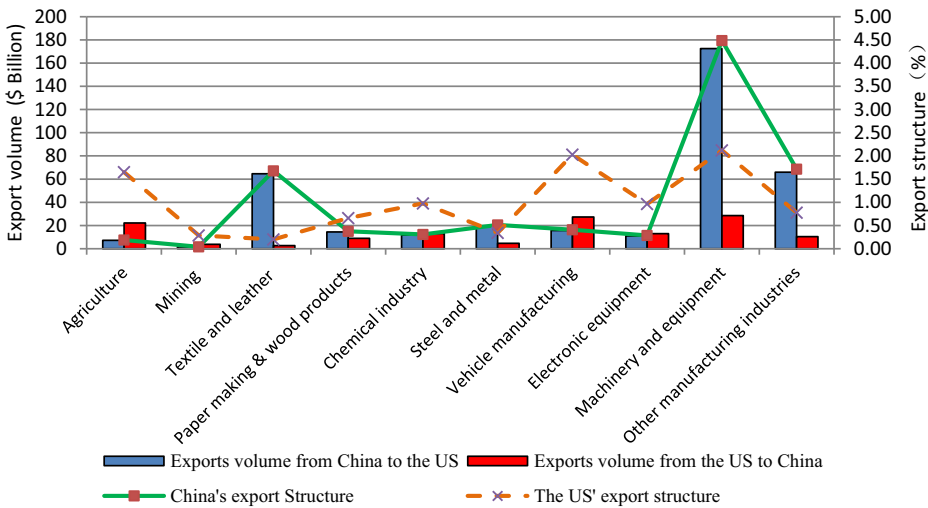


Figure 4. Comparison between trade structures of China and the US in 2016. Data source: United Nations Statistics Division (2018).

leather, and other manufacturing industries accounted for 44.86%, 16.79%, and 17.16%, respectively, of the US's total imports from China. Exports of the US to China were mainly concentrated in the machinery manufacturing and transportation equipment industries, which had high technology content and value added. The two industries accounted for 21.20% and 20.27%, respectively, of total exports to China. Figure 4 also shows that agriculture was an important export component for the US. In 2016, China imported USD 22.22 billion in agricultural products from the US, accounting for 16.49% of the total imports.

3. Method and data processing

3.1. The GTAP model

The empirical analysis is based on the GTAP model, which is also a global multi-region comparative statics CGE model. Compared to econometric models, the CGE model is particularly useful to evaluate the impacts of economic sanctions on the global economy (Dong & Li, 2018; Guo et al., 2018). It is deemed to be superior to a partial equilibrium approach in its ability to provide economy-wide evaluation instead of an isolated analysis of a particular market or sector (Rosyadi & Widodo, 2018). As both China and the US are large economies dominating global trade, a shift in their trade policy could affect other countries. A CGE model can capture these linkages through price mechanisms (Dong & Whalley, 2012; Rosyadi & Widodo, 2018) and thus was specifically chosen for this study.

Figure 5 displays the main structure of the GTAP model. As shown, it assumes that every country has a regional household account that collects all sources of income in the region, including labour and capital factor remuneration, as well as tariff income. Total expenditure includes government consumption, private consumption, and savings, satisfying the Cobb–Douglas functional form (Song & Cui, 2016). To make use of price elasticity for calibrating the model, private consumption is characterised by non-homothetic constant difference of elasticity (CDE), and government consumption is assumed to follow a Cobb–Douglas function (Cui & Song, 2019).

The GTAP model is a powerful tool for international trade analysis, and the dimensionally large input–output tables, the detailed trade and investment database and its flexibility in regional disaggregation make it possible to focus on any regional setting or aggregation level (Ha, Kompas, Nguyen, & Long, 2017). For imports, the

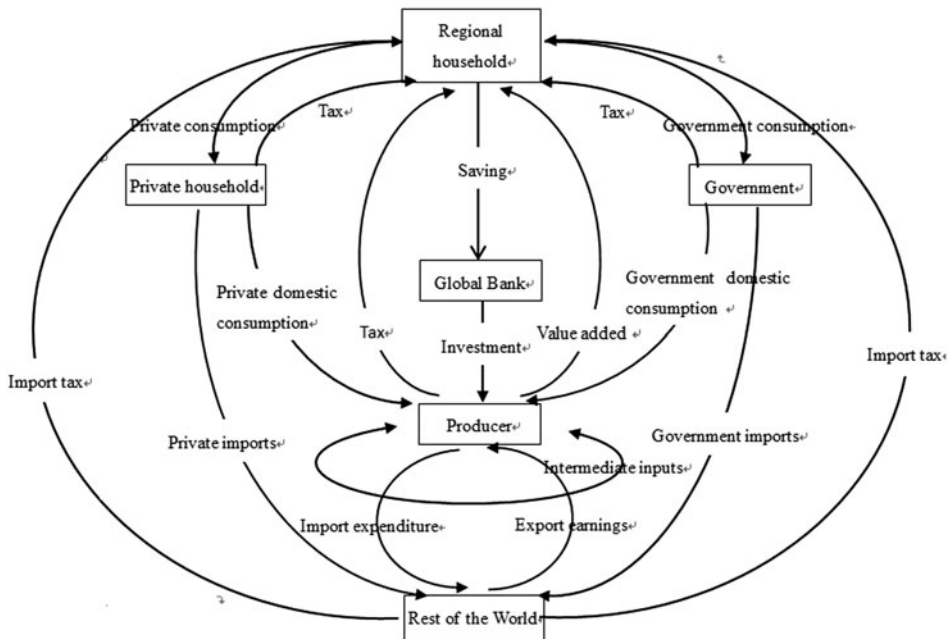


Figure 5. Structure of the GTAP model. Source: Hertel, Tyner, and Birur (2010).

GTAP model assumes that they are different from domestic products, and can be imperfectly substituted. Likewise, products from different countries are imperfectly substituted. They all satisfy the Armington assumption (Cui, Song, & Zhu, 2019). Regarding import tariffs, the model includes two types of tariff variables: import tariffs on all trading partners, denoted tm , and import tariffs on a specify country, denoted tms . As Sino–US trade frictions mainly involve tariff adjustments between China and the US, the simulation was carried out based on the variable tms . As this study aims to clarify the impact of the suspension of some or all trades between China and the US, we swap tms with import volumes (qxs). In other words, the exogenous variable tms is assumed to be endogenous, while the endogenous variable qxs is assumed to be exogenous.

3.2. Database and policy scenarios

The empirical analysis is based on the latest GTAP 9.0 database, with 2011 as the base year. Despite its obsolescence, the database is still being used in the latest research because of delays in updating input-output tables worldwide (Guo et al., 2018; Rosyadi & Widodo, 2018). The GTAP 9.0 database divides the world into 140 regions, with each containing 57 sectors. To ease research, most previous studies have conducted regional and sector aggregation based on the original database. For example, Itakura (2014) uses the GTAP 7.1 database (base period 2004) to construct a 22-region 23-sector CGE model to analyse the economic impact of the trade liberalisation of goods and services in the ASEAN region. Cui et al. (2019) use the GTAP 9.0 database (base period 2011) to construct a 4-region 13-sector CGE model to assess the economic and environmental impacts of China–Japan–South Korea free trade zone.

To highlight specific impacts of Sino–US trade frictions on major countries, the 140 regions were divided into 11 categories: China, the US, India, Japan, South Korea, Russia, the United Kingdom (UK), other Eastern European countries (OEE), the Association of Southeast Asian Nations (ASEAN), European Union (EU), and the rest of the world (ROW). OEEs include Belarus, Bosnia and Herzegovina, Bulgaria, Kosovo, Macedonia, Moldova, Montenegro, Serbia, and Ukraine. For industrial aggregation, with reference to other studies (Cui, Peng, & Zhu, 2015; Yoon, Gong, & Yeo, 2009) and considering the fact that US trade sanctions against China were mainly on the manufacturing sector, the 57 industrial sectors were classified into 17 categories: agriculture; mining; textile, garment and leather; paper-making and wood products; oil and coal production; chemical; non-metallic mineral products, iron and steel; non-ferrous metal; metal products; automobiles and parts; other transportation equipment; motor and electronic products; machinery and equipment manufacturing; other manufacturing; electricity, gas and water production and transportation; and other services.

Table 2 lists six policy scenarios based on the severity of the trade war, covering the US unilateral measures, China's countermeasures against the US, and end of trade between the two. According to the United Nations Commodity Trade Statistics Database, China exported USD 384.6 billion to the US in 2016, USD 377.3 billion of which were

Table 2. Scenario settings.

Code	Scenario description
S1	Exports of China's manufacturing industry to the US decrease by USD 50 billion
S2	Exports of China's manufacturing industry to the US decrease by USD 150 billion
S3	Exports of China's manufacturing industry to the US decrease by USD 50 billion and exports of agriculture of the US to China are completely halted
S4	Exports of China's manufacturing industry to the US decrease by USD 50 billion and exports of commodities from the US to China also decrease by USD 50 billion
S5	Exports of China's manufacturing industry to the US decrease by USD 150 billion and exports from the US to China are ceased completely
S6	Trade between China and the US is completely halted

Source: The Authors.

Table 3. Impacts of Sino–US trade frictions on real GDP of different regions (%).

	S1	S2	S3	S4	S5	S6
China	-0.062	-0.192	-0.079	-0.089	-0.264	-0.559
US	-0.007	-0.025	-0.008	-0.013	-0.038	-0.073
India	0.008	0.023	0.005	0.006	0.020	0.057
Japan	0.001	0.002	0.002	0.004	0.011	0.013
South Korea	0.003	0.009	0.017	0.026	0.071	0.077
Russia	0.004	0.011	0.002	0.005	0.014	0.035
UK	0.003	0.010	0.003	0.004	0.013	0.027
OEE	0.003	0.008	0.004	0.003	0.010	0.026
ASEAN	0.007	0.023	0.008	0.008	0.025	0.062
EU	0.003	0.009	0.003	0.003	0.010	0.023
ROW	0.007	0.022	0.006	0.006	0.019	0.059
World	-0.005	-0.016	-0.007	-0.009	-0.025	-0.048

Source: GTAP model simulation.

manufacturing products. Exports from the US to China were about USD 134.8 billion, including USD 22.2 billion in agriculture and USD 112.6 billion in manufacturing. Scenarios were set based on the above figures. More specially, S1 denotes the US adopting unilateral trade sanctions against China's manufacturing industry, resulting in reducing the exports from China to the US by USD 50 billion, with a decrease ratio of about 13%. S2 assumes that the US adopt further trade restrictive measures, reducing the export of China's manufacturing industry to the US by USD 150, with a decrease ratio of 40%. As a countermeasure to S1, S3 assumes that China stops importing agricultural products from the US. S4 denotes China choosing manufacturing industry as the countermeasure target, which assumes that exports from the US to China are decreased by USD 50 billion, equivalent to a decrease rate of 37%. S5 represents a countermeasure to S2, and assumes that China stops importing manufacturing products from the US, while S6 denotes Sino-US trade ceased completely.

4. Results

The empirical study was conducted in terms of real GDP, inflation, social welfare, terms of trade, imports and exports, trade balance, and trade diversion effects.

4.1. Impacts on real GDP

Table 3 shows the changes in real GDP in different regions under different scenarios. It can be seen that the Sino–US trade disruption generates negative impacts on the

global economy, with global GDP dropping in the six scenarios by a maximum of 0.048%. US' unilateral trade sanctions against China are not advantageous for either country, but China suffers more. For example, in S1, China's real GDP decreases by 0.062%, more than the decline of 0.007% for the US. China's trade retaliatory measures against the US negatively impact the economic growth for the latter, but different counteractions have different effects. In particular, if China takes retaliatory trade measures against US agricultural products (S3), the real GDP in the US would decline by 0.008%; if S4 is undertaken for the US manufacturing industry, its real GDP would fall by 0.013%. This shows that compared to agriculture, China's import restrictions related to the manufacturing industry generate a greater negative impact on the US economy.

If the trade friction is escalated to USD 150 billion, the decline in China's real GDP rises to 0.192%, greater than that for the US (0.025%). At this point, if China stops importing from the US (S5), the decline of the US real GDP would increase to 0.038%. In the extreme case of Sino-US trade disruption (S6), both countries would suffer major losses: China's real GDP decreases by 0.559%, more than for the US (0.073%). [Table 3](#) indicates that the Sino-US trade war would be 'a quarrel that benefits only a third party'. Taking S6 as an example, OEE's GDP would increase by 0.026%, and EU's GDP would increase by 0.023%. In short, the Sino-US trade war generates a lose-lose situation: the GDPs of both countries would decline while other countries may benefit from the conflict.

4.2. Impacts on inflation

[Table 4](#) reports the impacts of the Sino-US trade frictions on regional inflation, indicating that the US' unilateral trade sanctions against China would increase the domestic production costs, leading to a certain inflationary phenomenon. For example, in S1 and S2, the US GDP deflator rises by 0.19% and 0.59%, respectively. In contrast, China's GDP deflator declines by 0.56% and 1.71%, respectively, implying a risk of deflation. This is because with the decline in export demand, China may face the risk of overproduction, domestic prices' decrease, and downward economic pressure increase. [Table 4](#) indicates that if trade between China and the US completely stops, the US's GDP parity index would be reduced by 0.58% while that of China would fall substantially by 4.13%. Therefore, deflation would occur in both China and the US, although especially in the former. On the contrary, OEE

Table 4. Impacts of Sino-US trade frictions on GDP price indexes in various regions (%).

	S1	S2	S3	S4	S5	S6
China	-0.56	-1.71	-0.33	-0.24	-0.87	-4.13
US	0.19	0.59	-0.09	-0.26	-0.63	-0.58
India	0.09	0.27	0.19	0.18	0.51	1.05
Japan	0.04	0.11	0.10	0.24	0.66	0.77
South Korea	0.04	0.11	0.08	0.22	0.61	0.74
Russia	0.04	0.12	0.12	0.16	0.46	0.70
UK	0.05	0.15	0.09	0.13	0.35	0.71
OEE	0.04	0.12	0.11	0.12	0.34	0.64
ASEAN	0.10	0.30	0.22	0.25	0.70	1.19
EU	0.04	0.12	0.09	0.13	0.38	0.60
ROW	0.09	0.28	0.17	0.19	0.55	1.05

Source: GTAP model simulation.

Table 5. Impacts of Sino–US trade frictions on regional terms of trade (%).

	S1	S2	S3	S4	S5	S6
China	-0.46	-1.41	-0.32	-0.27	-0.91	-3.59
US	0.18	0.54	-0.12	-0.30	-0.73	-0.38
India	0.07	0.21	0.11	0.07	0.21	0.63
Japan	0.06	0.19	0.08	0.17	0.47	0.74
South Korea	0.04	0.11	0.04	0.11	0.30	0.46
Russia	0.05	0.15	0.04	0.06	0.18	0.49
UK	0.03	0.08	0.03	0.04	0.12	0.34
OEE	0.02	0.06	0.03	0.02	0.05	0.20
ASEAN	0.07	0.22	0.11	0.10	0.30	0.67
EU	0.02	0.05	0.02	0.03	0.09	0.18
ROW	0.05	0.15	0.08	0.10	0.29	0.58

Source: GTAP model simulation.

and the EU will experience some inflation, and their GDP price indexes will increase by 0.64% and 0.60%, respectively.

4.3. Impacts on the terms of trade

Table 5 lists the impacts of Sino–US trade frictions on regional terms of trade. First, the US' unilateral trade sanctions against China strike the latter's export, resulting in terms of trade deterioration, while that outside China would improve to varying degrees. In S1, China's terms of trade deteriorate by 0.46%, and if China does not adopt countermeasures, the US terms of trade improve by 0.18%. Second, if China adopts retaliatory trade measures, it would relieve the deterioration of China's terms of trade and lower the export trade of the US. For example, the US terms of trade deteriorate by 0.12% in S3. As shown in Table 5, since China's exports to the US are far greater than the corresponding imports, cessation of trade greatly deteriorates China's terms of trade by 3.59% and that of the US by 0.38%. Regarding the terms of trade, the Sino–US trade frictions would only benefit other countries while damaging both China and the US. For example, in S6, the terms of trade of OEE and the EU will improve by 0.20% and 0.18%, respectively.

4.4. Impacts on social welfare

Table 6 shows the impacts of Sino–US trade frictions on social welfare. In the GTAP model, social welfare is represented by the ratio of the Hicks equivalent variation (HEV) to the total income of the region. As shown, US trade sanctions deteriorate China's social welfare while that of the US slightly improves. For example, in S1, China's welfare deteriorates by 0.21% while that of the US improves by 0.04%. China's retaliatory measures worsen US welfare and ease the extent of its welfare loss. For example, on the basis of S1, if China restricts agricultural imports, welfare in the US deteriorates by 0.03% and that in China by 0.17%. If the target is manufacturing, US welfare deteriorates by 0.09% while the Chinese one may remain unchanged. This shows that compared to agriculture, China's restrictions on manufacturing imports generate a more negative impact on the US, which is consistent with the changes in GDP.

Table 6. Impacts of Sino–US trade frictions on regional social welfare (%).

	S1	S2	S3	S4	S5	S6
China	-0.21	-0.64	-0.17	-0.17	-0.53	-1.66
US	0.04	0.11	-0.03	-0.09	-0.22	-0.02
India	0.02	0.07	0.04	0.03	0.09	0.22
Japan	0.01	0.04	0.02	0.04	0.12	0.18
South Korea	0.02	0.06	0.04	0.10	0.28	0.34
Russia	0.01	0.04	0.01	0.03	0.08	0.16
UK	0.02	0.06	0.02	0.03	0.08	0.23
OEE	0.02	0.07	0.03	0.02	0.05	0.22
ASEAN	0.04	0.14	0.07	0.08	0.22	0.45
EU	0.01	0.04	0.02	0.03	0.08	0.15
ROW	0.02	0.07	0.04	0.05	0.14	0.26
World	-0.01	-0.02	-0.01	-0.01	-0.03	-0.07

Source: GTAP model simulation.

Table 7. Impacts of Sino–US trade frictions on trade balances (\$ Bil).

	S1	S2	S3	S4	S5	S6
China	1.24	3.82	4.97	4.81	13.38	22.27
US	6.60	20.30	15.50	19.26	54.24	83.85
India	-0.28	-0.85	-0.71	-0.76	-2.14	-3.69
Japan	-1.34	-4.13	-3.31	-4.78	-13.34	-19.29
South Korea	-0.22	-0.69	-0.48	-0.74	-2.08	-3.00
Russia	-0.24	-0.74	-0.75	-0.69	-1.96	-3.15
UK	-0.37	-1.14	-0.91	-1.04	-2.93	-5.50
OEE	-0.07	-0.22	-0.18	-0.15	-0.44	-0.96
ASEAN	-0.70	-2.17	-1.03	-1.42	-4.07	-7.33
EU	-2.11	-6.50	-6.22	-6.93	-19.42	-30.42
ROW	-2.50	-7.68	-6.88	-7.56	-21.24	-32.79

Source: GTAP model simulation.

In the case of Sino–US trade collapse, China's welfare would decrease by 1.66%, which is much higher than 0.02% for the US. Contrarily, other countries may benefit from the Sino–US trade conflicts. For example, the welfare of OEE and the EU will increase by 0.22% and 0.15%, respectively. In short, the Sino–US trade frictions generate some welfare deterioration for both countries. As the Chinese economy is more dependent on the US, the former experiences greater welfare losses.

4.5. Impacts on trade balance

Table 7 shows the impacts of Sino–US trade frictions on regional trade balances. As shown, US' trade sanctions against China improve its trade imbalance. The US trade surplus increases by USD 6.60 billion and USD 20.30 billion in S1 and S2, respectively. However, as the US trade deficit in 2016 was up to USD 797.75 billion (see Table 1), the status of the US trade deficit cannot be reversed. US trade restrictions imposed on China are not conducive to reducing the latter's trade surplus. For example, China's trade surplus increases by USD 1.24 billion and USD 3.82 billion in S1 and S2, respectively. This is because, as a major processing trading country, China is still at the middle to low end of the global production chain. China's exports are bound to affect its imports from Japan and South Korea; that is, China's imports may fall sharply. Moreover, driven by the trade diversion effect, Chinese products would be exported to the US through third countries; that is, China's exports to other

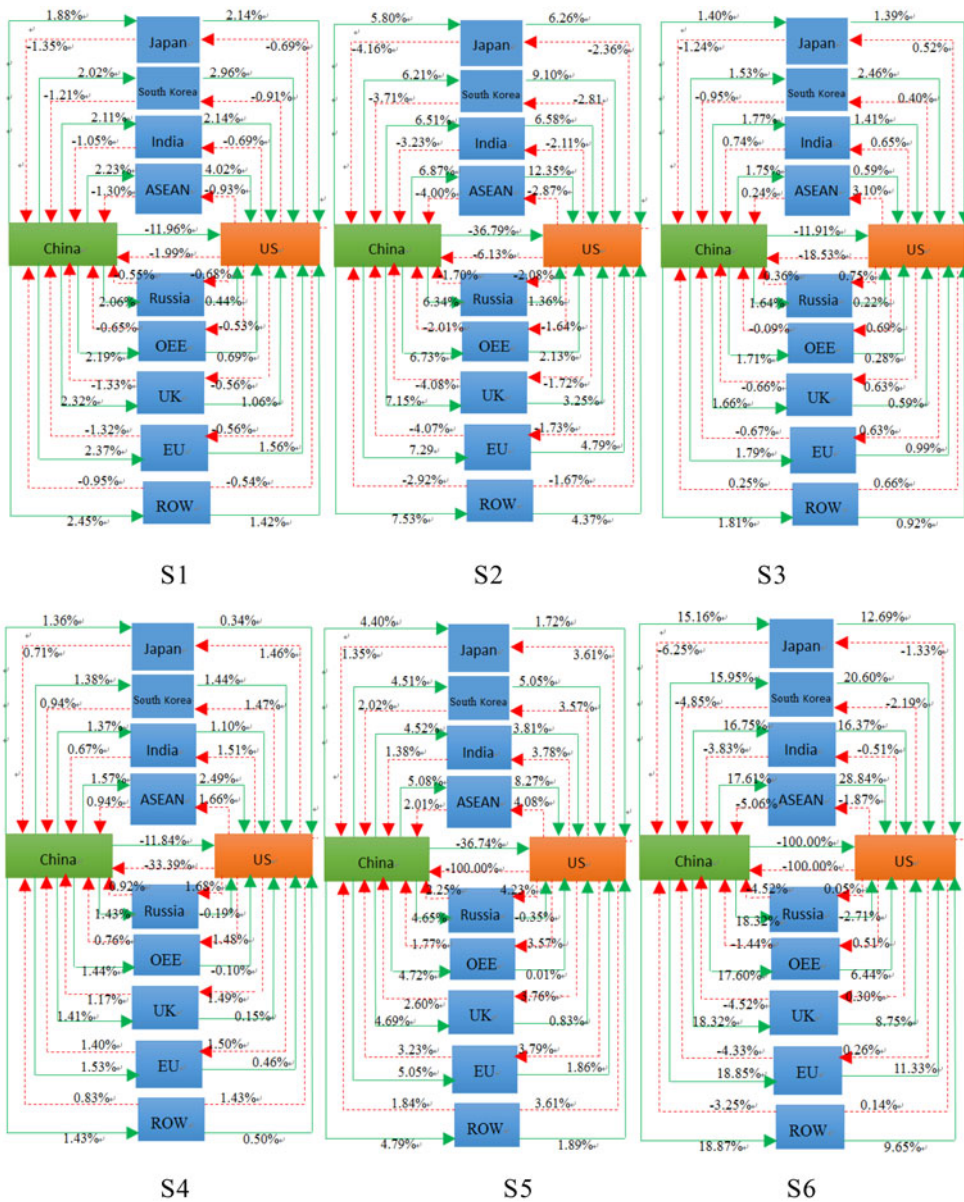


Figure 6. Trade diversion effects under different policy scenarios. Source: GTAP model simulation.

countries outside the US may increase (see Figure 6). As a result, although China’s trade surplus with the US falls sharply, its trade surplus with other countries improves, which ultimately increases China’s total trade surplus.

Second, China’s trade counteraction against the US further increases its trade surplus. For example, in S1, if China takes retaliatory trade measures against US agriculture (S3), China’s trade surplus is expected to increase by USD 4.97 billion. If the manufacturing industry is chosen as the target (S4), China’s trade surplus is expected to increase by 4.81 billion. As shown in Table 7, China’s trade surplus increases by

USD 22.27 billion in the extreme case, and the US trade imbalance reduces by USD 83.85 billion, less than 11% of the 2016 trade deficit. The result implies that independently of the extent of the trade friction, it cannot effectively solve the problem of the US trade imbalance. Though the US trade deficit with China can be greatly reduced, its deficits with other countries would increase.

4.6. Import and export changes

Table 8 shows the impacts of Sino–US trade frictions on regional exports. US' trade sanctions against China are unfavourable for both countries, but China's exports decrease more as Chinese commodities depend greatly on the US market. Taking S1 as an example, China's exports decrease by 0.87%, higher than the 0.70% decline in the US. The reason for the decline in US exports is that an increase in import tariffs increases the domestic production costs and weakens its international competitive advantages. At this time, if China restricts agriculture imports from the US, the latter's exports decrease by 0.87%. If China restricts import of manufacturing commodities, the decline reaches 1.25%.

As shown in Table 8, with further intensification of the Sino–US trade frictions, exports of both countries suffer more severely. For example, exports of China and the US fall to 2.69% and 2.15%, respectively, in S2. Compared to those in S1, China's decline increases by 1.82% while that of the US increases by about 1.45%. More extremely, if bilateral trade stops, China's exports would greatly decrease by 8.64% and those of the US by 7.80%. The decrease in China's exports is consistently larger than that of the US. Since a sharp drop in exports may stimulate the depreciation of the local currency, the RMB depreciation may be greater than that of the US dollar. As shown in Table 8, Sino–US trade frictions may cause an increase of exports for other regions. For example, in S6, the exports of OEE and the EU will increase by 0.03% and 0.26%, respectively.

Table 8 also presents the impacts of Sino–US trade frictions on regional imports, showing that the decline in China's imports is more notable than in its exports, which is related to China's large amount of processing trade. Specifically, China's imports decreases by 1.09% under S1, and by 11.32% under the extreme scenario (S6). Unlike China and the US, other regions' imports expand to varying degrees,

Table 8. Impacts of Sino–US trade frictions on regional exports and imports (%).

	Export						Import					
	S1	S2	S3	S4	S5	S6	S1	S2	S3	S4	S5	S6
China	-0.87	-2.69	-1.28	-1.41	-4.13	-8.64	-1.09	-3.35	-1.76	-1.91	-11.70	-11.32
US	-0.70	-2.15	-0.87	-1.25	-3.62	-7.80	-0.74	-2.27	-1.19	-1.60	-9.63	-8.61
India	0.11	0.35	0.09	0.12	0.37	1.00	0.13	0.41	0.20	0.23	0.88	1.40
Japan	-0.02	-0.07	-0.16	-0.10	-0.26	-0.34	0.12	0.36	0.19	0.41	2.08	1.68
South Korea	0.03	0.11	0.03	0.19	0.52	0.64	0.07	0.23	0.11	0.32	1.48	1.17
Russia	0.01	0.05	0.02	0.06	0.18	0.30	0.09	0.28	0.24	0.29	1.22	1.33
UK	0.04	0.12	0.03	0.08	0.24	0.45	0.07	0.23	0.13	0.19	0.66	1.01
OEE	-0.01	-0.03	-0.02	0.06	0.16	0.03	0.04	0.13	0.11	0.15	0.31	0.69
ASEAN	0.10	0.31	0.13	0.21	0.60	1.00	0.17	0.51	0.22	0.34	1.53	1.69
EU	0.02	0.06	0.01	0.06	0.18	0.26	0.05	0.17	0.11	0.17	0.47	0.75
ROW	0.10	0.30	0.11	0.14	0.42	0.93	0.16	0.49	0.26	0.32	1.54	1.72

Source: GTAP model simulation.

which is mainly related to the trade diversion effect. Sino–US trade frictions inhibit direct trade between the two countries, but both Chinese and American products are likely to be exported to each other's markets indirectly through a third country, causing an increase in imports for other countries. Taking S6 as an example, the imports of OEE and the EU will increase by 0.69% and 0.75%, respectively.

4.7. Trade diversion effect

As the two largest economies in the world, both China and the US play decisive roles in the international trade. Sino–US trade frictions would not only change the bilateral trade, but also impact the global production chain and generate non-negligible indirect impacts on other countries. Although the trade frictions reduce direct trade between China and the US, the two countries can export to each other through third countries; that is, there is a certain trade diversion effect. As shown in [Figure 6](#), first, if the US takes trade restrictive measures against China, China's exports to the US fall sharply by 11.96% in S1 and 36.79% in S2. Chinese products in the US market will be replaced by those of other countries, resulting in an increase in imports by the US from other countries. For example, in S1, US imports from OEE and the EU may increase by 0.69% and 1.56%, respectively. This finding suggests that trade diversion plays a very important role in alleviating the negative impact of trade frictions on China.

Second, if China takes retaliatory trade measures, US exports to China would be significantly inhibited, but the US may also export to China through third countries, which weakens the effect of China's countermeasures. Taking S3 as an example, in contrast to S1, the US exports to countries other than China all increase to varying degrees while the decline in the exports of these countries to China also slows down to different degrees. In particular, US exports to ASEAN increase by 0.59%, while ASEAN exports to China increase by 0.24%. [Figure 6](#) shows that in the extreme case (S6), China's exports to countries other than the US increase at rates all above 15%, far higher than the amplification of imports. As to the US, to make up for the absence of Chinese products, the imports from ASEAN and South Korea increase significantly, but the US export expansion is mainly aimed at the EU, with an increase rate of less than 1%. In short, although direct trade between China and the US substantially shrinks, indirect trade between the two countries substantially increases. Trade diversion eases the negative impacts of trade frictions in China and the US.

5. Conclusions and policy recommendations

Sino–US trade conflicts may intensify over time, and bilateral trade may interrupt with the escalation of trade frictions. To explore the potential impacts of a Sino–US trade disruption, this study sets up six scenarios based on the severity of the trade frictions. In order to identify the potential boundary effects of a trade war on both sides, pressure tests are performed with respect to many variables, from real GDP, social welfare, and trade balances to various trade disruptions. Moreover, the study examines the spillover effects of the trade war on other countries.

The study yields some important findings: (1) both China and the US would be harmed by trade disruptions, especially in the case of bilateral trade collapse, as China and US real GDPs would fall by 0.559% and 0.073%, respectively; (2) compared to agriculture, China's restriction on manufacturing imports may generate a greater negative impact on the US economy, but the latter is more damaging to China's GDP; (3) Sino-US trade disruptions may result in 'a quarrel that only benefits others', as other countries may benefit from the trade conflicts to different extents in terms of economic growth and welfare improvement; (4) a trade diversion pattern is observed, indicating shrinking in the bilateral trade and exports increase toward their third trading partners; (5) trade sanctions cannot fundamentally solve the US trade imbalance, because although the US trade deficit with China would reduce substantially, trade deficits with other countries would increase.

Sino-US trade disruptions can generate significant trade diversion effects, with both countries increasing their exports toward their third trading partners under the pressure of export obstruction. As such, a Sino-US trade war cannot hinder indirect trade between the two countries. This trade diversion has two policy effects. First, it weakens the impact of Chinese and US trade sanctions on each other, as well as the negative impact on the two countries from the trade disruptions. Second, it reshapes the world trade pattern, turning direct trade between China and the US into indirect trade that needs to be passed on by third trading partners, thus essentially increasing bilateral trade costs.

The simulation results show that both China and the US would be harmed, but the former more than the latter. Because of this, although the US could be willing to initiate a trade war with China to negotiate possible concessions, China may not want to be involved. This finding is consistent with the reality of Sino-US negotiations. However, the study also reveals that the negative impacts of the US trade sanctions on China are affordable. For example, in the case of a bilateral trade collapse, China's real GDP would decrease by 0.559%, far below the national economic growth rate of 6.6% in 2018. The trade war would also force China to reduce its dependence on exports. Therefore, should any trade dispute arise, the economy would be more resilient. As a result, it seems unlikely that Trump government's extreme pressure can force China to abandon its core interests.

This study has some drawbacks. Most of them are related to the limitations of standard GTAP models. This is a relatively static analysis that considers 2011 as the benchmark year for simulation, although the GTAP 9.0 database used is the latest version. As such, the model does not capture the potential long-term effects of Sino-US trade conflicts. Implementing a dynamic model framework would be an interesting extension of the study. Moreover, the trade war discussed here mainly focuses on merchandise, and trade barriers to services and investments are not considered due to data unavailability. Finally, for the sake of simplicity, the neoclassical closure rule, assuming labour market clearing without considering the impacts on employment, was adopted in the study. It would be interesting to modify the closing rule in order to simulate the unemployment effects of Sino-US trade conflicts.

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Declarations of interest

No potential conflict of interest was reported by the authors.

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