The Day After Tomorrow: Evaluating the Burden of Trump's Trade War*

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Abstract

President Trump of the United States threatened to impose high import tariffs against China's exports during his presidential campaign. This paper evaluates the possible effects on the world economy if President Trump eventually pulls the trigger on a trade war against China. Based on the multi-sector and multi-country general equilibrium model of Eaton and Kortum (2002) with inter-sectional linkage, we examine the changes in exports, imports, output, and real wages in 62 major economies in response to the 45% tariffs imposed by America against the imports from China. By exploring different scenarios depending on whether China chooses to retaliate and trade achieves rebalance or not, our calibration results suggest that in all scenarios, a trade war triggered by the high U.S. import tariffs will be a catastrophe for bilateral trade. The USA will be one of the biggest losers in terms of social welfare, while China may lose or gain slightly depending on the effect of trade war on trade rebalance. Some small open economies may benefit slightly, while other countries may receive collateral damage.

Key words: Tariffs, Gains from Trade, Protectionism

JEL classification: F10, F11

1 Introduction

Will the U.S. President Donald Trump pull the trigger on a trade war against the country's main trade partners, such as China? Rather than being merely a propaganda in Trump's presidential campaign, protectionism has become a major threat to the world economy and the international trade system. The new president called for "America First" and for "Buy American, Hire American" in his inaugural speech and immediately began carrying out his campaign pledges after taking office to break the trade ties of the U.S. with its neighboring countries and main trade partners. For instance, President Trump formally withdrew the U.S. from the Trans-Pacific Partnership (TPP), an agreement among 12 countries across 3 continents that took nearly 10 years to negotiate under his predecessor, the former United States President Barack Obama. He also signed an executive order to build a wall along the Mexican border and threatened Mexico to pay for its construction by paying taxes on its exports to the U.S.. He ordered his team to initiate a renegotiation of the North American Free Trade Agreement (NAFTA) among the U.S., Mexico, and Canada. These actions, among many others, have dispelled any remaining doubt over the sincerity of President Trump's promises during the election campaign. In the recent meeting of G20 finance ministers and central bankers, the financial leaders of the world's biggest economies dropped a pledge to keep the global trade free and open, thereby acquiescing to an increasingly protectionist of the U.S..

China is among the main targets of President Trump during his campaign and administration. In his speech in Monessen, Pennsylvania on June 28, 2016, Mr. Trump condemned China's entry to the World Trade Organization as a catastrophe for U.S. manufacturing workers. He also proposed the idea of imposing 45% of import tariffs on China's exports to the U.S. during his meeting with the editorial board of The New York Times in January 2016. In his well-known tweet, President Trump also blamed China as the "grand champion in manipulating the currency" to boost its exports to the U.S.. Therefore, we need to think and evaluate the possible risk scenarios if President Trump does pull the trigger on a trade war against China or the rest of the world (ROW).

In this paper, we adopt a multi-country and multi-sector general equilibrium model of Eaton and Kortum (2002) with inter-sectoral linkages *a la* Caliendo and Parro (2015) to examine the changes in the exports, imports, output, and real wages of 62 major economies in response to a hypothetical 45% tariff on the U.S. imports from China. We consider three possible cases of such tariff hike on sectors including agriculture, mining, and manufacture. In the first case, the U.S. increases its import tariffs to 45% for the imports from China and after that all countries have balanced trade. The balanced trade is one of the goals of the trade war as the U.S. government has blamed on China for its large trade surplus for a long time.[1] In the second case, we assume China would retaliate by increasing their tariffs to the same level for their imports from the U.S. and after that all countries have balanced trade. In the third case, we consider both China and US imposes high tariffs to each other but all countries keep the unbalanced trade same as without China-US tariff war. For simplicity, we name those three cases above as "U.S. against China ($D_n = 0$)", "U.S. vs. China ($D_n = 0$)"and "U.S. vs. China ($D_n! = 0$)"respectively.

Our exercise shows that in all scenarios, the high U.S. import tariff will be a catastrophe for bilateral trade. In the case of "U.S. against China", China's exports to the U.S. will be cut by 83% on average, and half of the 18 tradable sectors of China will experience a more than 90% drop in their exports, including textile, metal products, computers, and electrical equipment. In the next two cases, the trade war between China and U.S. leads to a similar dramatic drop in the bilateral trade (about 83% on average). The bilateral trade between two countries in 9 sectors will be cut by more than 90%, including agriculture, mining, and petroleum products as well as computer and electrical equipment.

The trade war will not only crash bilateral trade but also lead to a slump in outputs and significant loss in social welfare. In the case of two country engage in trade war, that is "U.S. vs China ($D_n = 0$)," Chinese output in textile and computer products will drop

[1] For simplicity we assume all countries achieve trade balance after the trade war starts. We will also consider the case when trade imbalance remains.

by 6.29% and 14.26%, respectively. Meanwhile, the outputs in the agriculture and food industries in the U.S. will decline by 1.14% and 4.18% respectively. To measure social welfare loss, we use changes in real wages before and after the trade war, as it takes into account the rising price index. In the first two scenarios, we find that the U.S. will become one of the biggest losers and China will bear only a small welfare loss. Specifically, the U.S. will experience 0.66% and 0.75% welfare losses, respectively, compared with China's maximum loss of 0.04% in the case of "U.S. against China" with balanced trade. In the third case with unbalanced trade, China will be the largest loser (-0.37%) and the U.S. will be the second largest one (-0.32%). Some other countries in Asia may slightly gain from the trade diversion, while some advanced economies may receive collateral damage due to the spillover effect from the input-output linkage and the general equilibrium effect of the trade war between the largest two economies in the world.

Our study highlights the important role of trade imbalance in the consequence of the Sino-US trade war. The trade balance matters because one country can finance their consumption through trade deficit if their income from labor and tariff revenue is insufficient for their total consumption. Thus, a country with trade deficit indicates that it receives a net income transfer from other countries, and this transfer won't be available if the economy restores trade balance. It is less clear how the trade war would affect the trade imbalance, as the trade imbalance is usually determined by the dynamic consideration of saving and investment, which is absent in our static model. For simplicity, we consider two possibilities: the trade war restores trade balance or maintains the current trade imbalance. The reality would be in between but these two possible scenarios explain why the U.S. is put in a disadvantage due to the current large trade deficits, and China may slightly gain from the trade war if trade achieve rebalance.

Given the current trade imbalance for the U.S. and China, the presumption of whether trade war leads to trade balance or not has very different implications for two countries. If the trade war leads to a trade balance, the U.S. must export more and import less in order to switch from trade deficit to balanced trade, while China needs to reduce exports more than the decline in imports in order to achieve the balance. In other words, the U.S. won't receive the net income transfer, which acts a negative income shock, in addition to the possible tariff hike imposed by China, while China will not need to pay for the net income transfer which may alleviate the negative effect of trade war on its economy. Thus, in this case the social welfare loss will be even larger for the U.S., and China may gain slightly if the positive income effects dominates, as shown in the "U.S. vs. China ($D_n = 0$)". By contrast, if the trade war does not change the current trade imbalance, China won't benefit from the extra income transfer while the U.S. can still maintain the external borrowing even the trade war reduces overall trade overall. Thus, China may be hurt more than US by the trade war, as shown in the case of "U.S. vs. China ($D_n! = 0$)". Our analysis implies that trade balance might not be a desirable target for US if it aims to launch the trade war against China.

Admittedly, the quantitative effects of Trump's trade war on output and social welfare are less striking as those on bilateral trade. However, our calculation of welfare loss is rather conservative and likely to underestimate the effect of the possible trade war on output and social welfare. One key assumption in our model is that all economies function well without any other frictions, except for trade costs. Given that labor is freely mobile across all sectors within country, the sectoral reallocation between tradable and non-tradable sectors, together with the import substitution among different source countries, can offset the unilateral import tariff hikes imposed by the other country. Moreover, the input-output linkage also makes these unilateral tariff hikes less effective. However, in reality these adjustments may not be smooth and the impact of trade war on the world economy will be magnified. Nevertheless, the trade war is likely to trigger a tsunami in the global financial market, which has not been taken into account in our framework.

One of the most famous alternative approaches for evaluating the possible consequence of a trade war is the traditional Computational General Equilibrium (CGE) model, which fully specifies a parametric model of preferences, technology,and trade cost with ad-hoc parameters. Our approach differs from this model by following the recent development in quantitative trade models, which is largely triggered by the seminal work of Eaton and Kortum (2002). The extension of the Eaton and Kortum (EK) model into a multiple-sector with input-output linkage and other features has become the workhorse model for counter-factual analysis. This approach is suitable for analyzing trade policy changes and offers at least three significant advantages over the traditional CGE models or the recently developed CGE model with Melitz (2003)-type firm heterogeneity (Petri et al., 2012) for following reasons.

First, the EK model offers more parsimony by including a limited number of parameters. The latest version of the GTAP model has about 13000 parameters that cannot be estimated, whereas those researchers who adopt new quantitative trade models generally use data to estimate the key parameters before conducting counter-factual analysis. Second, the new quantitative trade models have more appealing micro-theoretical foundations. For example, one does not need to assume that each country produces one distinct good—the so called "Armington" assumption—to do quantitative work in international trade. Third, although the CGE model combined with Melitz (2003)'s model can capture firm heterogeneity, it is not only difficult to generate the sectoral gravity equation with macro implication but also very intractable to identify a rich set of related fixed costs using the actual data. By contrast, the EK model can deliver a nationwide gravity equation that even incorporates a country's trade deficit/surplus.

Many recent studies have applied or extended the EK framework for various topics, including the evaluation of the possible gains from a trade agreement, technological changes, and infrastructure improvement. For example, Donaldson (2010) takes the EK model to empirical data and assesses the gains from railroad construction in colonial India. Caliendo and Parro (2015) extends EK framework to include input-output linkage and evaluates the gains from NAFTA.[2] Dekle et al. (2008) also shows that the EK framework can be used to analyze hypothetical cases, such as how much the U.S. GDP needs to adjust to eliminate its high current account deficits. The rapid development in this approach provides suitable tools for us to evaluate the possible outcomes of a trade war triggered by the largest economy in the world.

The remainder of this paper is organized as follows. Section 2 reviews the bilateral trade relationship between U.S. and China, the dynamics of the bilateral trade, and the current trade conflicts. Section 3 presents our model, data, and calibration method. Section 4 shows the calibration results, and Section 5 presents the concluding remarks with discussions on trade policies.

2 An overview of the trade relationship between the U.S. and China

2.1 The bilateral trade relationship

From the establishment of the People's Republic of China (PRC, or China) in 1949, the U.S. had retained its diplomatic recognition of Taipei instead of Beijing. The diplomatic and economic interactions between the U.S. and China was in their lowest level during the Cold War. Conflicts in ideology and national security interests greatly impeded the bilateral trade between these nations.

Following the China-Soviet border conflicts in the late 1960s and the end of the Vietnam War in 1968, both China and the U.S. began to realize the potential benefits of normalizing bilateral relationship. In June 1971, the U.S. President Nixon ended the legal barriers of trade with China, and his ice-breaking visit China in 1972 further resumed the

[2] Di Giovanni et al. (2014) adopts a similar framework to evaluate the gain from China's trade integration with the world market and its fast technological changes. A few recent studies have introduced labor migration into the EK framework and explored the impact of goods and labor market frictions on economic growth and gain from trade (Galle et al., 2015; Caliendo et al., 2015; Tombe and Zhu, 2015).

trade relation between two countries.

Following China's 1978 market-oriented economic reform, the U.S. granted China the "Most Favored Nation" (MFN) tariff in January 1980. The MFN is a status of treatment granted by one country to another so that the recipient of this status enjoys advantages of low tariff rates or high import quotas. This title also ended the Smoot-Hawley Act that stipulated high tariff rates on imports from China since 1930. The U.S. soon became the second largest importer for China and China's third largest partner in 1986. Despite China's MFN status, the Sino-U.S. trade relationship was impeded by other legal and political issues. In particular, the Jackson-Vanik Amendment of 1974 would deny preferential trade policies to some countries, especially communist countries. The application of this amendment was waived by U.S. presidents, but the amendment required an annual congressional renewal of China's MFN status.

Since 1986, China began to apply for membership to the General Agreements on Trade and Tariffs (GATT) and its successor, the World Trade Organization (WTO), while the U.S. was also interested in China's further trade and FDI liberalization. Thus, the annual waiver of the Jackson-Vanik Amendment and the congressional renewal of China's MFN status came to an end in 1999, and the U.S. granted China with "Permanent Normal Trade Relations,"thereby paving the road for China to join the WTO in 2001.

The decade and a half following China's accession to the WTO has been a honeymoon for two countries, and their bilateral trade has grown much faster than before. The U.S. and China have become the most important trade partner of each other. However, these countries still faced trade conflicts. For instance, China's large trade surplus and inflexible exchange rate have been criticized frequently by the U.S. government. The U.S. also often accused China of dumping textile, steel, and other manufactured products at unfairly low prices. The Bush and Obama administrations imposed quotas and high tariffs on the imports of Chinese textile and other low-end industrial products to protect U.S. domestic industries. However, these trade conflicts have not changed the direction toward free trade for these two countries until the 2017 U.S. presidency of Trump, who openly supported protectionism.

2.2 Bilateral trade flow and trade imbalance

We examine the Sino-U.S. trade from three perspectives, namely, bilateral trade flow and trade imbalance, bilateral trade structure and trade dispute in some key industries such as steel, and current trade conflicts.

The trade volume between China and the U.S. has grown rapidly over the the last three decades, especially after China's participation in WTO in 2001. The bilateral trade volume has surged from 97 billion USD in December 2001 to more than 524 billion USD in 2016, with an average annual growth rate of 11.11%. Indeed, China and the U.S. have become the most important trade partner of each other.

The annual growth of bilateral trade volume between these two countries has slowed down since 2008, partly due to the financial crisis that hindered the global economy. The China-U.S. trade volume shrunk by 6.26% in 2016, the first time with a negative growth since 2009. While the exports edged down by 5.13% in 2016, the imports decreased by 9.79% consecutively following a decline of 5.91% in 2015.

[Insert Table 1 Here]

The fast-growing trade volume between the U.S. and China has been accompanied by a persistent bilateral trade surplus in favor of the latter. As shown in Table 1, China's trade surplus reached 254 billion USD in 2016 from only 30 billion USD in 2000. This unbalanced trade eventually resulted in a long-lasting dispute in the Sino-U.S. relationship. However, as the bilateral trade volume growth slowed down recently, the trade surplus growth also started to cool down. China's bilateral trade surplus narrowed by 2.45% to 254 billion USD in 2016, thereby reflecting a tendency toward a more balanced bilateral trade structure.

2.3 Bilateral trade structure and trade dispute

Machine and computer are the leading exports of China to the U.S. that account for 44.45% (173 billion USD) of its total exports in 2016. These products are followed by textile products, which account for 11% (42.42 billion USD) of China's exports to the U.S.. These figures illustrate China's competitive edge in light product manufacturing. However, the exports of China in traditionally competitive industries shrunk in recent years in accordance with the slowing pace in bilateral trade. Specifically, China's exports of machinery and computer as well as textile products decreased by 3.89% and 5.35% in 2016, respectively. Both industries remained at the same export level as of 2013.

In terms of China's imports from the U.S., machine and computer also come in first place accounting for 23.13% (31.26 billion USD) of its total imports in 2016.[3] This proportion reflects the intra-industry trade and the global production integration between these two countries, and therefore a trade war is more likely to hurt the related industries.

Steel products are among the highly disputed issues in the bilateral trade relationship between the U.S. and China. The U.S. criticized that China's official supports on steel and aluminum products had distorted the global markets and accused China of dumping 100 million tons of steel into global market. At the same time, the U.S. filed 29 anti-dumping and 25 anti-subsidy investigations against Chinese companies from 2011 to 2015, including 11 anti-dumping and 10 anti-subsidy on steels. The case of anti-dumping on Chinese steel products reflects the tension of the trade conflicts between these two countries.

[Insert Table 2 Here]

2.4 Current trade conflicts

In the past two decades and especially after China's WTO accession in 2001, both the U.S. and China realized significant gains from their trade liberalization and expanding

[3]The proportion of machine and computer imports also dropped in recent years from 25.11% in 2013 to 23.13% in 2016.

bilateral markets. However, after President Trump's inauguration, the trade dispute between these countries has intensified in the following aspects.

First, the U.S. government blamed its long period of slow GDP growth, weak employment growth, and sharp net loss of manufacturing employment to the accession of China to the WTO. The U.S. government also argued that multilateral trade agreements (e.g., WTO rules) should be intended for countries that pursue free-market principles and implementing transparent and functional legal and regulatory systems.

Second, the U.S. has criticized China for its unequal treatment of foreign companies with measures in favor of domestic firms and state-owned enterprises (SOEs, including: (i) state-driven industrial policies that groom domestic firms, particularly favoring SOEs; (ii) government procurement process that is biased toward domestic firms, such as "secure and controllable" policies for information and communication technology; and (iii) the techno-nationalism under the auspices of "Made in China 2025."

In response to these criticisms, China has denied the "secure and controllable" policies to limit foreign trade and notified the WTO Technological Barrier to Trade committee. In the case of the "Made in China 2025" initiative, the Chinese government promised to bring equal opportunities to foreign and domestic enterprises as well as to strengthen the role of the market.

Third, the U.S. named China as a significant market barrier for their exporting firms. Specifically, the U.S. alleged that China has imposed export restraints (e.g., quotas and licensing) to benefit domestic downstream firms at the expense of foreign competitors. The U.S. also accused China of using anti-monopoly law investigations to protect its domestic industries.

Fourth, intellectual property rights have become a hot topic in recent years. The U.S. complained that its enterprises are being required to transfer their technology as a condition to secure investment approvals. The U.S. also criticized the poor protection and enforcement of trade secrets by the Chinese government.

3 Model

We follow Caliendo and Parro (2015) to build a multiple-country and multiple-sector model to study how tariff changes influence the output and trade flows via the rich input-output linkage across different sectors.

3.1 Basic setup

The world consists of N countries, and country n has a measure of L_n representative households. These households collect their total income I_n from wages $w_n L_n$, a lump-sum transfer of tariff revenue, and trade surplus/deficit. They have standard Cobb-Douglas utility function on consuming final goods from each sector:

$$U(C_n) = \prod_{j=1}^{J} C_n^{j\,\alpha_n^j}, \text{where } \sum_{j=1}^{J} \alpha_n^j = 1. \tag{1}$$

Each sector j in each country n also produces a continuum of tradable intermediate goods ω^j. As illustrated in Figure 1, the labor and composite intermediate goods in each sector are combined in the production of each tradable intermediate ω^j in country n.

$$q_n^j(\omega^j) = z_n^j(\omega^j)[l_n^j(\omega^j)]^{\gamma_n^j} \prod_{k=1}^{J} [m_n^{k,j}(\omega^j)]^{\gamma_n^{k,j}} \tag{2}$$

where $m_n^{k,j}$ is the composite intermediate good from sector k used in the production of sector j, while $z_n^j(\omega^j)$ indicates the efficiency in producing the intermediate good ω^j in each country n. The summation of shares of materials from each sector k used in the production of intermediate good (ω^j) $\gamma_n^{k,j} \geq 0$, and the share of valued added $\gamma_n^j \geq 0$ is equal to one, i.e., $\sum_{k=1}^{J} \gamma_n^{k,j} + \gamma_n^j = 1$.

[Insert Figure 1]

Given that the production of intermediate goods is at constant returns to scale and that the market is perfectly competitive, the unit production cost is expressed as follows:

$$c_n^j = B_n^j w_n^{\gamma_n^j} \prod_{k=1}^{J} P_n^{k\gamma_n^{k,j}} \tag{3}$$

where P_n^k is the price of a composite intermediate good from sector k, while B_n^j is a constant.

A sectoral composite intermediate good is then produced using a continuum of tradable intermediate goods ω^j, which are imported from the lowest cost suppliers across countries:

$$Y_n^j = \left[\int y_n^j(\omega^j)^{1-1/\sigma^j} d\omega^j \right]^{\frac{\sigma^j}{\sigma^j - 1}} \tag{4}$$

where $\sigma^j > 0$ is the elasticity of substitution across intermediate goods within sector j, while $y_n^j(\omega^j)$ is the demand for each intermediate good.

Given the Frèchet distribution of productivity, the price of a sector j good in region n is then given by

$$P_n^j = A^j \left[\sum_{i=1}^{N} \lambda_i^j (c_i^j \tau_{ni}^j)^{-\theta^j} \right]^{-1/\theta^j} \tag{5}$$

where τ_{ni}^j is the bilateral trade cost for country i's exports shipping to country n (paid in exports), while θ^j and λ_i^j are the shape and location parameters of the Frèchet distribution.

Eaton and Kortum (2002) shows that equilibrium trade share can be written as

$$\pi_{ni}^j = \frac{\lambda_i^j [c_i^j \tau_{ni}^j]^{-\theta^j}}{\sum_{h=1}^{N} \lambda_h^j [c_h^j \tau_{nh}^j]^{-\theta^j}} \tag{6}$$

Bilateral trade costs τ_{ni}^j include tariff (t_{ni}^j) and any other variable transaction costs from distance and information frictions. Any changes in tariffs can affect trade shares via these trade costs.

The total expenditure on goods j is the sum of firms' expenditures on composite intermediate goods and households' expenditure on final goods:

$$X_n^j = \sum_{k=1}^{J} \gamma_n^{j,k} \sum_{i=1}^{N} X_i^k \frac{\pi_{in}^k}{\tau_{in}^k} + \alpha_n^j I_n \tag{7}$$

where

$$I_n = w_n L_n + R_n + D_n \tag{8}$$

represents the total final income or absorption, including labor income, tariff revenues (R_n), and trade deficits (D_n). In particular, $R_n = \sum_{j=1}^{J} \sum_{i=1}^{N} t_{ni}^j M_{ni}^j$, where $M_{ni}^j = X_i^j \frac{\pi_{ni}^j}{\tau_{ni}^j}$ is country n's imports of sector j goods from country i. The summation of trade deficits across countries is equal to 0, while the national deficits are the summation of sectoral deficits, $D_n = \sum_{k=1}^{J} D_n^k$. Sectoral deficits denote the difference between total imports and total exports as defined by $D_n^j = \sum_{i=1}^{N} M_{ni}^j - \sum_{i=1}^{N} M_{in}^j$.

3.2 Relative changes in equilibria

We assume the bilateral trade cost consists of import tariffs and non-tariff components which do not change with the trade war. Thus, the change in trade cost τ is only from the changes in tariffs. The changes in wages and prices can be solved after identifying the changes in tariffs from $(1+t_{in}^j)$ to $(1+t_{in}^{j'})$ (and τ to τ'), without estimating the technology parameters, using the so-called exact-hat algebra used in the literature. We can express equilibrium conditions in relative terms as follows, where $\hat{x} = \frac{x'}{x}$ denotes the relative change of the variable x.

$$\hat{\tau}^j_{ni} = (1 + t^{j'}_{ni})/(1 + t^j_{ni}) \tag{9}$$

$$\hat{c}^j_n = \hat{w}_n^{\gamma^j_n} \prod_{k=1}^{J} (\hat{P}^k_n)^{\gamma^{k,j}_n} \tag{10}$$

$$\hat{P}^j_n = \left\{ \sum_{i=1}^{N} \pi^j_{ni} [\hat{c}^j_i \hat{\tau}^j_{ni}]^{-\theta^j} \right\}^{-1/\theta^j} \tag{11}$$

$$\hat{\pi}^j_{ni} = \left[\frac{\hat{c}^j_i \hat{\tau}^j_{ni}}{\hat{P}^j_n} \right]^{-1/\theta^j} \tag{12}$$

$$X^{j'}_n = \sum_{k=1}^{J} \gamma^{j,k}_n \sum_{i=1}^{N} X^{k'}_i \frac{\pi^{k'}_{in}}{\tau^{k'}_{in}} + \alpha^j_n I'_n \tag{13}$$

$$\sum_{j=1}^{J} \sum_{i=1}^{N} X^{j'}_n \frac{\pi^{j'}_{ni}}{\tau^{j'}_{ni}} - D'_n = \sum_{j=1}^{J} \sum_{i=1}^{N} X^{j'}_i \frac{\pi^{j'}_{in}}{\tau^{j'}_{in}} \tag{14}$$

$$I'_n = \hat{w}_n w_n L_n + R'_n + D'_n \tag{15}$$

Given the changes in tariffs, we can solve for the changes in output, total and bilateral trade flows, and real (nominal) wages for each country. Using the changes in real wages, we can study the welfare implications of trade conflicts. In the following sections, we consider four experiments on tariff changes.

3.3 Taking the model to the data

In order to solve the equilibrium in relative changes, we need the values of α^j_n, $\gamma^{j,k}_n$, γ^j_n, π^j_{ni}, and θ^j_n. The data on bilateral expenditure X^j_{ni} (or bilateral trade flows M^j_{ni}- imports of n from i on sector j in Caliendo and Parro (2015)), value added (V^j_n), gross production (Y^j_n), and I-O tables are required.

We rely on the most updated 2015 edition of the OECD Inter-Country Input-Output database (ICIO) to obtain the data for bilateral expenditures X^j_{ni} and trade share $\pi^j_{ni} = \frac{X^j_{ni}}{\sum_{i=1}^{N} X^j_{ni}}$. The OECD ICIO 2015 data provide a complete input-output matrix for the 34

ISIC Rev. 3 sectors of 61 countries and ROW in 2011. These 61 countries cover 34 OECD countries and 17 non-OECD but main emerging economies. Our country sample includes the BRICS (Brazil, Russia, India, China, and South Africa), the Asian four dragons (Korea, Taiwan, Hong Kong, and Singapore), the Asian four emerging tigers (i.e., Indonesia, Malaysia, Philippines, and Thailand), and even low-income Asian countries like Cambodia and Vietnam. It is worth to emphasize that data in 2011 are the latest available data set. The international trade has slowly recovered from the effects of the 2008 global financial crisis. Thus, the current global trade flow and trade structure are close to their counterparts in 2011. In this case, the data in 2011 provide a good proxy for us to examine the global trade structure and trade policy. We drop the last sector (private households with employed persons) since this sector is not the intermediate input to produce goods in all other sectors and its output is equal to 0 in half of the countries in our sample. In the end, we obtain a sample of $N = 62$ countries and $J = 33$ sectors (18 tradable sectors and 15 service sectors).[4]

To calculate final consumption share, α_n^j, we take the final expenditure of sector j goods over the total final expenditure of all sectors (equal to the total expenditure of sector j goods minus the intermediate goods expenditure and divided by the total final absorption) from the OECD STAN input-output database. From the OECD STAN input-output matrix, we also obtain the value added share $\gamma_n^j = V_n^j / Y_n^j$ and the share of intermediate consumption of sector j in sector k over the total intermediate consumption of sector k times one minus the share of value added in sector j, $\gamma_n^{j,k}$. The parameters θ_n^j are taken from Table 1 in Caliendo and Parro (2015).

[4] Athukorala and Khan (2016) suggested that the American relative price of parts and components are remarkably less sensitive to changes in relative prices compared with that of final goods. In line with this, it would be a plus if we could cover more disaggregated industrial data in future research.

4 Quantifying effects of tariff increases

4.1 Tariff increases

Given that we use 2011 trade and production as our base year, our sample countries are all WTO members and impose MFN tariffs on one another. The sectoral mean or median of MFN tariffs are all less than 3% except for three sectors, namely, agriculture (3.47%), food (8.07%), and textiles (8.77%). Therefore, we treat the initial tariff as equal to 0 for all countries and sectors.[5]

President Trump threatened to impose prohibitive high tariffs of up to 45% on some products imported from China. In this paper, we consider an extreme case in which the U.S. will impose such prohibitive tariffs on *all* imports from China. An alternative but equivalent interpretation is that President Trump labels China as a currency manipulator and forces the Chinese Yuan to appreciate by around 45%. Consider an increase from a zero tariff to a 45% U.S. tariff rate on all Chinese goods, $\hat{\tau}^j_{USA,CHN} = 1.45$. We borrow the procedures in Caliendo and Parro (2015) to solve for the equilibrium. First, we guess a vector of wages $\hat{\mathbf{w}}$, and then we plug wages in the equilibrium conditions above to solve $\hat{c_n}^j(\hat{\mathbf{w}})$ and $\hat{P_n}^j(\hat{\mathbf{w}})$. Second, we solve $\pi^{j'}_{ni}(\hat{\mathbf{w}})$. Given $\pi^{j'}_{ni}(\hat{\mathbf{w}})$, t', α^j_n, $\gamma^{j,k}_n$, and γ^j_n, we solve for the total expenditure in each sector $X^{j'}_n(\hat{\mathbf{w}})$, and then verify if the trade balance holds. If not, we adjust our guess $\hat{\mathbf{w}}$ until we achieve the equilibrium condition.

4.2 Sectoral bilateral trade between the U.S. and China

Before we discuss the effects of tariff increase on trade flows and output, we discuss the relative tradability of the U.S. and China across different sectors. Table 3 presents the Sino-U.S. bilateral trade flows in 18 tradable goods sectors in 2011. Particularly, the table presents the shares of bilateral import over the total imports and exports in each sector for

[5] Admittedly, China's current average import tariff is around 9%. Therefore, a hypothesized 45% high import tariff against China is similar to the effective 36% import tariff against the same country, which is a typical number of China's special safeguard imposed by the USA in the past years.

the U.S. and China. The second column, $\frac{M^j_{USA,CHN}}{M^j_{USA}}$, provides the share of U.S. imports from China in sector j over the U.S. total imports in sector j. Two sectors, computer and textiles, have the largest sectoral import shares that are both above 45%. China is the largest trade partner of the U.S. in these two sectors. Electrical equipment and minerals are the next two large sectors that the U.S. imports intensively from China. These four sectors are also among the biggest exporting sectors of China to the U.S.. The third column, $\frac{M^j_{USA,CHN}}{E^j_{CHN}}$, shows the share of U.S. imports from China in sector j over the Chinese total exports in the same sector. China exports to the U.S. in many sectors, including computer, wood, plastic, papers, and textiles. Additionally, more than 23% of Chinese exports to the U.S. are from these sectors. Meanwhile, China intensively imports from the U.S. in the paper, other transport (such as aircraft), and agriculture (fourth column) sectors. Moreover, 18.07% of the total agricultural exports of the U.S. are consumed in China (fifth column). To sum up, the capability to export for the U.S. and China varies across each sector. The U.S. intensively imports from China in the computer, textiles, and electrical equipment sectors, while China intensively imports from the U.S. in the paper, other transport, and agriculture sectors.

[Insert Table 3]

Table 4 examines the two countries' import and export shares of gross outputs and their relative output shares in the world. The second column shows that the U.S. has massive imports in the textiles, computer, and electrical equipment sectors, which have a 68.91% total import share. These goods are mainly exported by China (shown in Table 3). The imports from China's textiles sector is 1.4 times larger than that from the U.S.. The third column of Table 4 shows that the U.S. has exporting advantages in the other transport, machinery N.E.C., and computer sectors, which export more than $1/3$ of their output. The U.S. also produces more than 20% of the world output of the paper, petroleum, and other transport sectors. On the contrary, China follows a very different trade structure and production pattern. First, China imports and exports heavily in sectors including computer (33.55% versus 47.92%, respectively, which may have resulted from the global value chain and processing trade. Second, China imports heavily in the mining sector (29.81% import share), but exports intensively in the textiles (20.83%) and other transport sectors (28.6%). Third, China produces much more output than the U.S. in all sectors, except for the paper, petroleum, and other transport sectors.

[Insert Table 4]

Based on Tables 3 and 4, we can draw three conclusions on the Sino-U.S. production and trade patterns in 2011. First, the U.S. and China together produce more than 40% of the world tradable goods on average and are specialized in different sectors. Second, the total trade of these two countries contribute to more than 20% of the world trade on average. Third, the trade in the textiles, computer, electrical equipment, machinery N.E.C., and other transport sectors is essential to understand the Sino-U.S. trade relationship.

4.3 Case 1: U.S. against China ($D_n = 0$)

We first discuss how output and trade would be affected once President Trump imposes a 45% import tariff on Chinese goods unilaterally, assuming that all countries achieve balanced trade afterward. In this case, China's exports to the U.S. faces a higher tariff but China does not raise its tariff for the imports from the U.S., which facilitates trade rebalance. Table 5 presents our calibration results on the changes of the output, imports, exports, and bilateral trade between the U.S. and China. First and as expected, the US imports from China in most sectors have plummeted, and the bilateral imports in half of 18 sectors have experienced more than 90 percent decline. This also leads to a significant decline in the sectoral imports for the U.S.. For example, the imports in the petroleum, textiles, wood, and computer sectors have declined more than a quarter. To compensate the fall in imports, domestic production in the U.S. increases, particularly in the sectors of computer, textiles, and electrical equipment which heavily relied on imports from China before the tariff hike.[6] The US exports increase moderately due to the effect of trade rebalance.

By contrast, the high unilateral tariff hike in US has a catastrophic effect on Chinese exports. The total exports is cut about 13%, where the textile, woods, and computer sectors receive the hardest hit. This negative external shock also leads to a significant decline in Chinese gross output. For instance, the outputs in textile and computer sectors have decreased by 6.51% and 14.67% respectively. China's imports from the U.S. increase in 17 sectors, particularly in the petroleum sector.

We use the real wage to measure the social welfare for each country. Table 6 shows that the U.S. experiences a 0.66% welfare loss while China also encounters a welfare loss yet at a much smaller magnitude at 0.04%. The results seems to be counter-intuitive, however, the trade rebalance prevents US residents from financing their consumption by borrowing abroad, and thus lowers their consumption demand and eventually the real wage. By contrast, the trade rebalance benefits Chinese as they do not need to save for other countries, which partially offsets the negative effect of trade war on Chinese domestic production. If we do not impose the trade rebalance and assume the trade imbalance remains the same, then the U.S. real wage would decline by 0.28% and Chinese real wage would drop by 0.21%.

While some countries also get worse off due to the global value chain and the general equilibrium effect, some small countries, such as Singapore and Luxembourg, indeed get gains from the unilateral tariff hike due to trade diversion. China might increase its exports to those countries in response to the sharp decline in its exports to the U.S.. By contrast, the U.S. produces more and expands its exports as well. This would reduce

[6] Column Y^j_{USA} (L^j_{USA}) presents the changes in the U.S. output (labor). We use Cobb-Douglas production function with labor and intermediate inputs for all sectors. The changes in sectoral labor inputs are equal to the output changes minus the changes in nominal wage. Since wage is equalized in all sectors within country, the changes in labor shares across different sectors in a country is proportional to the sectoral output changes. This result holds for all cases.

the prices of goods in equilibrium, thereby allowing those small importing countries to benefit from the lower prices.

[Insert Tables 5 and 6]

4.4 Case 2: U.S. vs. China ($D_n = 0$)

Next we consider the case when China chooses to retaliate by increasing its tariff to 45% for imports from the U.S., with the same assumption that all countries achieve trade rebalance afterward. Our calibration results in Table 7 show that the bilateral trade between two countries collapses due to the trade war. The bilateral imports in half of 18 sectors have dropped more than 90%, particularly in the sectors that the countries have comparative advantages, such as the US exports of agriculture, wood, paper, and computers, and China's exports of textile, computer, and electrical products. In total, the imports of US and China decrease by 17% and 6% respectively. While the declines in imports in two countries are consistent, their exports show sharp differences due to the trade rebalance. The U.S. exports of petroleum and mining products increase significantly and the overall exports raise by 9% in order to achieve trade balance. By comparison, Chinese exports in most of sectors decline and the overall exports decrease by 15%, far exceeding the decline in imports.

In this scenario, the U.S. faces more severe challenges than China, because it needs to boost its exports to restore trade balance, despite that one of its most important trade partners-China raises its import tariffs against its exports. As shown in Table 8, the real wage in the U.S. decreases by 0.75%, more than the welfare loss in the first case. By contrast, China actually gains slightly, i.e., the real wage increases by 0.08%, because the income effect of the trade rebalance dominates the negative effect of import tariff hike in the U.S..

[Insert Tables 7 and 8]

4.5 Case 3: U.S. vs. China ($D_n! = 0$)

The previous two cases show that trade rebalance plays an important role in reshaping the trade pattern, output, and real wage for the U.S. and China. Thus, we consider the third case where the trade remain unbalanced and the U.S. and China both increase their bilateral import tariffs against each other to 45%. More specifically, we assume the U.S. maintains a trade deficit while China remains a trade surplus as before the trade war. Table 9 and 10 present our calibration results, demonstrating three differences compared with the case 2 in previous subsection.

First, although the bilateral imports decreased dramatically as in the case 2, China suffers more than US in this case, as shown in Table 11. The reason is that China needs to maintain the trade surplus as before and the U.S. can increase their consumption and imports by running trade deficits. Second, the U.S. exports increase in case 2 in order to restore trade balance despite the trade war, while it decreases due to the tariff hike in China.

More importantly, China becomes the largest loser in this case while the U.S. still suffers a significant loss, as the real wage in China and US decreases by 0.37% and 0.32% respectively. Overall, the U.S. and China both lose in this case as they become the two largest losers in the trade war. China is hurt the most in this case because the country needs to maintain the large trade surplus while losing the largest market of US due to the high tariff. The U.S. slightly improves compared with the case 2 because it can still maintain its consumption through external borrowing (by running trade deficits). However, if we take into account the China's future return on their current saving and US future payment on their current debt, the welfare loss would be smaller for China and larger for the U.S..

[Insert Tables 9, 10, and 11]

5 Concluding Remarks

This paper examines the possible effects of the trade war against China that President Trump threatened to trigger on international trade, output, and social welfare by using a standard multi-country and multi-sector general equilibrium model. We simulate three different scenarios depending on whether China chooses to retaliate and trade achieves rebalance or not. All scenarios show that the trade war will have a devastating effect on bilateral trade. The U.S. will be one of the biggest losers in terms of social welfare, and China will lose significantly as well if the trade imbalance remains. However, if China can reduce its trade surplus by importing more from the rest of the world, the economy may not lose from the potential trade war. Thus, our findings have important policy implications. To guarantee that China will not lose from the potential trade war, it is important for China to import more from non-USA countries, especially from the one-belt-one-road (OBOR) countries given that China has huge trade volumes with these countries.

Two possible extensions merit special considerations. First, regional trade agreements and regional integration are two other topics that warrant the attention of both the academia and policy makers. The U.S. may build a new trading bloc or reconstruct NAFTA to strengthen its current trading bloc. Simultaneously, China is actively engaging in regional trade agreements, such as the ongoing regional comprehensive economic partnership (RCEP) and the one-belt-one-road initiative. Therefore, the U.S. may impose high tariffs against China and its associated trading blocs, and vice verse. Moreover, China may achieve progress in the regional trade agreements and thus expand trade with those countries. Second, this paper does not discuss the exchange rate adjustments in responses to President Trump's trade war, which may play an important role in reshaping the trade imbalance (Woo, 2008).[7] However, our case studies with different assumptions on trade balance can still shade lights on the consequences of the trade war with trade imbalance

[7]We thank Professors Wing Tye Woo and Fuku Kimura for these insightful suggestions.

or rebalance. A more careful treatment requires to endogenize the exchange rate and trade imbalance. However, these two issues are beyond the scope of this paper and will be reserved for future research.

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Figure 1: Multi-Sector Model Production

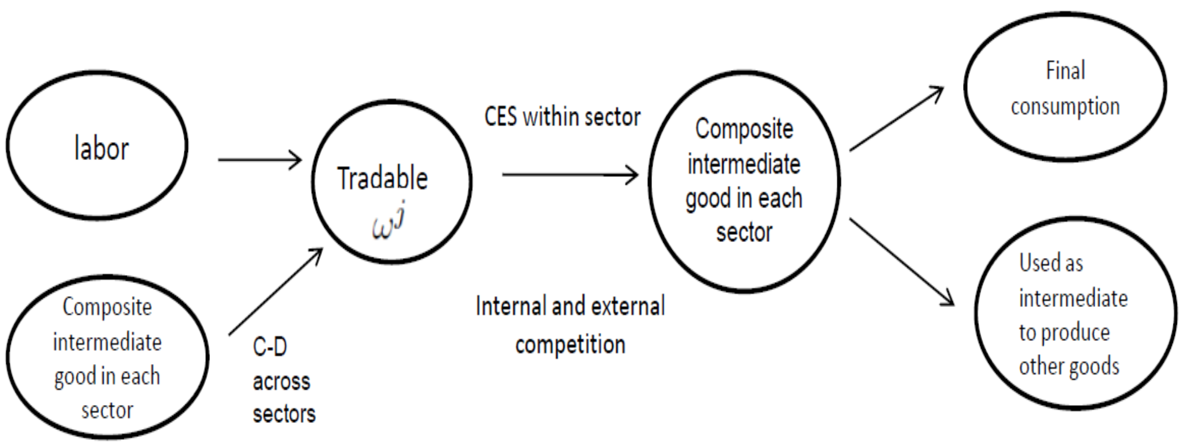

Table 1: Bilateral Trade between the U.S. and China

	Trade Flows, Billion USD		Growth Rate, %	
Year	$M_{USA,CHN}$	$M_{CHN,USA}$	$M_{USA,CHN}$	$M_{CHN,USA}$
2000	52.14	22.36		
2001	54.32	26.20	4.17	17.17
2002	69.96	27.23	28.79	3.91
2003	92.51	33.88	32.23	24.44
2004	124.97	44.65	35.09	31.78
2005	162.94	48.73	30.38	9.14
2006	203.52	59.22	24.90	21.52
2007	232.76	69.86	14.37	17.96
2008	252.33	81.50	8.41	16.66
2009	220.90	77.46	-12.45	-4.95
2010	283.37	102.06	28.28	31.76
2011	324.56	122.14	14.54	19.68
2012	352.00	132.88	8.45	8.79
2013	368.48	152.55	4.68	14.81
2014	396.15	159.19	7.51	4.35
2015	410.15	149.78	3.53	-5.91
2016	389.11	135.12	-5.13	-9.79

Note: $M_{USA,CHN}$ denotes the total imports of the U.S. from China. $M_{USA,CHN} + M_{CHN,USA}$ denotes the total trade volume. $M_{USA,CHN} - M_{CHN,USA}$ denotes China's trade balance.

Table 2: Bilateral Trade Flows on Selected Sectors (Billion USD)

	Steel		Textile		Machine and Computer	
Year	$M^j_{USA,CHN}$	$M^j_{CHN,USA}$	$M^j_{USA,CHN}$	$M^j_{CHN,USA}$	$M^j_{USA,CHN}$	$M^j_{CHN,USA}$
1993			3.31	0.23	2.93	3.84
1994			3.16	0.86	4.60	4.53
1995			3.17	1.35	5.53	5.13
1996			3.23	1.13	6.52	5.59
1997			3.57	0.99	8.34	5.37
1998			3.80	0.42	10.48	6.54
1999			3.98	0.24	12.48	8.02
2000			4.56	0.31	16.39	9.20
2001			4.57	0.35	17.99	11.38
2002			5.43	0.44	26.24	11.17
2003			7.19	1.08	39.39	11.42
2004			9.06	2.31	56.68	15.46
2005			16.67	2.11	72.79	16.84
2006			19.87	3.00	92.55	21.38
2007			22.90	2.42	107.85	23.72
2008	6.92	1.22	23.28	2.60	113.48	26.17
2009	1.51	0.90	24.60	1.71	104.72	22.32
2010	1.63	0.63	31.45	3.06	132.90	28.74
2011	2.58	0.65	35.06	4.18	150.01	29.45
2012	2.88	0.57	36.18	4.96	163.37	28.96
2013	2.75	0.58	38.95	3.82	169.34	38.31
2014	4.02	0.69	41.88	2.53	182.86	38.30
2015	2.85	0.58	44.79	1.98	179.89	35.67
2016	1.71	0.45	42.42	1.28	172.87	31.26

Note: $M^j_{USA,CHN}$ denotes the imports of the U.S. from China in sector j.

Table 3: The Sectoral Bilateral Trade Flows in 2011,%

Sector	$\frac{M^j_{USA,CHN}}{M^j_{USA}}$	$\frac{M^j_{USA,CHN}}{E^j_{CHN}}$	$\frac{M^j_{CHN,USA}}{M^j_{CHN}}$	$\frac{M^j_{CHN,USA}}{E^j_{USA}}$
Agriculture	2.34	6.24	21.93	18.07
Mining	0.13	4.50	0.71	6.13
Food	7.63	15.17	13.61	7.69
Textiles	45.61	23.89	6.21	8.40
Wood	27.85	26.90	13.08	16.45
Paper	14.48	24.58	43.91	15.70
Petroleum	1.67	6.07	6.20	2.08
Chemicals	7.77	12.93	11.17	9.59
Plastics	25.88	25.82	6.77	6.64
Minerals	31.79	16.57	13.20	11.60
Basic Metals	3.53	4.84	3.57	9.96
Metal Prod.	28.23	19.92	11.01	5.25
Machinery n.e.c.	20.67	20.39	8.86	8.18
Computer	47.06	29.04	5.88	16.52
Electrical	31.18	21.61	6.02	11.61
Auto	5.43	23.47	8.17	5.73
Other Transport	7.44	4.27	27.83	5.18
Others	30.02	24.83	15.55	2.76

Note: $\frac{M^j_{USA,CHN}}{M^j_{USA}}$ (or $\frac{M^j_{USA,CHN}}{E^j_{CHN}}$): Imports of the U.S. from China in sector j over the total imports of the U.S. in sector j (the total exports of China in sector j) in 2011.

Table 4: Summary Statistics on Trade and Output%

Sector	M_i^j/Y_i^j	E_i^j/Y_i^j	Y_i^j/Y_w^j	M_i^j/Y_i^j	E_i^j/Y_i^j	Y_i^j/Y_w^j
		USA			CHN	
Agriculture	7.51	14.48	8.02	3.86	0.91	25.28
Mining	52.90	6.43	9.95	29.81	0.81	18.68
Textiles	141.96	25.87	3.25	2.69	20.83	44.79
Wood	15.49	7.26	8.37	1.79	3.14	42.66
Paper	4.49	12.03	26.30	8.67	5.34	13.04
Petroleum	11.80	15.53	20.56	7.24	4.52	14.85
Chemicals	23.40	24.26	14.98	13.79	9.31	22.67
Plastics	25.04	13.29	10.39	4.02	7.74	33.67
Minerals	17.21	9.70	5.67	1.06	4.09	45.79
Basic Metals	33.99	12.72	7.23	6.77	4.73	37.82
Metal Prod.	13.79	10.78	14.39	3.74	14.23	19.77
Machinery n.e.c.	43.87	36.64	9.11	9.65	12.67	31.97
Computer	86.95	35.13	10.02	33.55	47.92	29.48
Electrical	68.91	26.28	5.84	6.95	13.64	42.57
Auto	42.42	21.10	12.00	7.93	5.25	22.40
Other Transport	14.38	37.82	20.08	8.04	28.60	17.60

Note: M_i^j/Y_i^j denotes the import share in country i's output, while Y_i^j/Y_w denotes the output share in the world.

Table 5: Changes in Trade and Output— Case 1, %

Sector	Y^j_{USA}	M^j_{USA}	E^j_{USA}	$M^j_{USA,CHN}$	Y^j_{CHN}	M^j_{CHN}	E^j_{CHN}	$M^j_{CHN,USA}$
Agriculture	2.37	-8.04	7.29	-97.80	0.83	0.49	-1.63	8.57
Mining	12.31	-4.11	15.90	-99.55	2.22	-5.66	3.84	14.63
Food	-3.42	-11.03	1.94	-75.37	1.32	0.93	-10.12	3.31
Textiles	24.85	-29.34	4.84	-95.69	-6.51	-3.78	-21.30	1.24
Wood	5.46	-28.42	6.66	-99.06	-0.68	-3.90	-23.53	7.54
Paper	5.48	-19.57	14.01	-99.86	-2.84	1.10	-21.75	11.24
Petroleum	14.47	-45.05	60.96	-100.00	2.45	-26.62	17.27	61.40
Chemicals	1.85	-8.19	2.71	-78.54	-2.39	-2.93	-9.55	0.21
Plastics	4.94	-12.42	0.93	-61.17	-3.31	-3.28	-14.96	-1.94
Minerals	6.55	-18.63	2.09	-70.31	1.03	1.01	-10.56	2.99
Basic Metals	6.81	3.07	2.40	-78.33	-0.87	-1.81	-2.41	0.25
Metal Prod.	7.65	-24.63	5.08	-94.69	-3.09	-3.27	-16.94	3.49
Machinery nec	-3.05	-18.28	2.32	-62.37	-0.26	0.16	-11.30	1.18
Computer	31.84	-27.53	8.24	-96.05	-14.67	-7.68	-25.63	0.47
Electrical	22.24	-18.27	9.72	-99.32	-2.43	-4.82	-17.97	6.08
Auto	-0.28	-3.96	0.85	-65.33	0.55	0.38	-14.26	1.00
OtherTrans.	3.58	1.46	1.66	-37.59	1.03	1.51	-1.43	1.67
Others	-0.07	-27.89	3.00	-84.91	-4.83	0.07	-19.96	2.59
Average	7.98	-16.71	8.37	-83.11	-1.80	-3.23	-11.23	7.00

Note: $Y^j_{USA}, M^j_{USA}, E^j_{USA}, M^j_{USA,CHN}$ denotes the sector j's output, imports, exports, and imports from China in the U.S.

Table 6: Changes in Real Wages—Case 1,%

Rank	Name	w_n/P_n, %	Rank	Name	w_n/P_n,%
1	Singapore	2.58	53	France	-0.35
2	Luxembourg	2.17	54	Costa Rica	-0.37
3	Ireland	2.04	55	Cambodia	-0.39
4	Brunei	1.90	56	Romania	-0.51
5	Iceland	1.42	57	Tunisia	-0.57
6	Malaysia	1.40	58	India	-0.65
7	Switzerland	1.19	59	USA	-0.66
8	Norway	1.19	60	Portugal	-0.66
9	Saudi Arabia	1.12	61	Greece	-0.99
10	Netherlands	1.08	62	Turkey	-1.12
38	China	-0.04			

Note: w_n/P_n denotes the real wages in country n.

Table 7: Changes in Trade and Output— Case 2, %

Sector	Y^j_{USA}	M^j_{USA}	E^j_{USA}	$M^j_{USA,CHN}$	Y^j_{CHN}	M^j_{CHN}	E^j_{CHN}	$M^j_{CHN,USA}$
Agriculture	-1.14	-10.67	-10.12	-97.94	2.45	-18.69	-4.84	-97.27
Mining	14.05	-4.75	11.64	-99.57	1.93	-2.75	-0.27	-99.44
Food	-4.18	-11.85	-3.47	-75.81	2.28	-7.84	-10.80	-72.45
Textiles	23.80	-30.31	-1.40	-95.84	-6.29	-7.72	-22.47	-96.40
Wood	3.75	-30.15	-9.12	-99.11	0.38	-14.44	-25.56	-98.90
Paper	3.12	-22.26	-0.26	-99.88	2.30	-41.50	-25.71	-99.81
Petroleum	16.51	-50.34	72.33	-100.00	2.32	-26.74	2.23	-100.00
Chemicals	-0.30	-9.58	-4.20	-79.08	-0.67	-9.16	-10.28	-77.61
Plastics	4.02	-13.27	-2.94	-61.73	-2.46	-6.12	-15.42	-62.96
Minerals	5.43	-19.47	-6.04	-70.80	1.69	-7.64	-11.04	-70.45
Basic Metals	4.72	1.35	-5.20	-78.88	-0.13	-3.21	-2.98	-79.13
Metal Prod.	6.48	-26.16	1.03	-94.89	-2.35	-11.83	-18.20	-94.46
Machinery nec	-4.52	-18.98	-2.32	-62.84	0.56	-3.90	-11.66	-58.59
Computer	27.49	-29.13	-4.97	-96.24	-14.26	-9.67	-26.98	-96.88
Electrical	19.87	-19.95	0.11	-99.36	-1.95	-8.06	-19.90	-99.35
Auto	-1.27	-4.65	-2.89	-65.76	1.42	-3.66	-14.72	-64.25
OtherTrans.	3.05	0.89	-0.34	-38.04	1.60	-8.99	-1.55	-38.69
Others	-0.60	-28.69	1.50	-85.29	-4.13	-11.03	-21.01	-83.27
Average	6.68	-18.22	1.85	-83.39	-0.85	-11.27	-13.40	-82.77

Note: See table notes in Table 5.

Table 8: Changes in Real Wages—Case 2,%

Rank	Name	w_n/P_n, %	Rank	Name	w_n/P_n,%
1	Singapore	2.63	53	France	-0.35
2	Luxembourg	2.17	54	Costa Rica	-0.37
3	Ireland	2.04	55	Cambodia	-0.40
4	Brunei	1.93	56	Romania	-0.51
5	Malaysia	1.47	57	Tunisia	-0.57
6	Iceland	1.42	58	India	-0.65
7	Switzerland	1.19	59	Portugal	-0.67
8	Norway	1.17	60	USA	-0.75
9	Saudi Arabia	1.13	61	Greece	-1.00
10	Netherlands	1.07	62	Turkey	-1.12
37	China	0.08			

Note: w_n/P_n denotes the real wages in country n.

Table 9: Changes in Trade and Output— Case 3, %

sector	Y^j_{USA}	M^j_{USA}	E^j_{USA}	$M^j_{USA,CHN}$	Y^j_{CHN}	M^j_{CHN}	E^j_{CHN}	$M^j_{CHN,USA}$
Agriculture	-3.97	-2.13	-20.56	-97.49	0.24	-28.55	0.66	-97.84
Mining	-3.49	-0.94	-9.41	-99.50	2.46	-6.56	3.63	-99.59
Food	-0.27	-4.78	-6.58	-73.30	-0.56	-12.17	-9.07	-74.62
Textiles	20.83	-19.80	-12.03	-95.05	-5.65	-13.20	-17.45	-96.97
Wood	1.16	-20.36	-20.66	-98.90	-1.12	-21.54	-18.13	-99.14
Paper	-3.14	-9.81	-20.36	-99.83	4.75	-51.70	-14.86	-99.86
Petroleum	-3.02	5.11	-9.93	-100.00	4.22	-40.04	35.44	-100.00
Chemicals	-1.20	-4.31	-8.55	-77.70	-1.45	-11.27	-8.46	-79.15
Plastics	1.84	-13.25	-4.32	-61.40	-3.39	-7.59	-15.26	-64.46
Minerals	1.99	-19.40	-9.42	-70.31	-1.46	-12.05	-10.56	-72.78
Basic Metals	0.00	-0.45	-8.81	-78.72	-1.68	-6.11	-2.30	-80.58
Metal Prod.	2.22	-21.45	-6.82	-94.33	-3.07	-16.18	-14.55	-95.26
Machinery nec	-0.07	-8.97	-5.70	-57.96	-1.48	-6.81	-10.12	-60.77
Computer	12.19	-25.21	-19.23	-95.98	-13.14	-11.53	-24.86	-97.39
Electrical	4.59	-15.29	-16.75	-99.27	-2.71	-13.20	-15.40	-99.50
Auto	-0.65	-1.81	-4.71	-64.24	-1.06	-6.72	-14.05	-66.23
OtherTrans.	-0.43	-2.78	-2.50	-40.11	-0.30	-11.63	-1.76	-40.70
Others	3.58	-17.61	-3.63	-82.40	-4.06	-16.40	-16.30	-85.02
Average	1.79	-10.18	-10.55	-82.58	-1.64	-16.29	-8.52	-83.88

Note: See table notes in Table 5.

Table 10: Changes in Real Wages—Case 3,%

Rank	Name	w_n/P_n, %	Rank	Name	w_n/P_n,%
1	Cambodia	0.22	53	Canada	-0.01
2	Costa Rica	0.11	54	South Africa	-0.01
3	Singapore	0.09	55	Korea	-0.02
4	Viet Nam	0.08	56	Saudi Arabia	-0.02
5	Mexico	0.06	57	Australia	-0.02
6	Israel	0.05	58	Brunei Darussalam	-0.03
7	Cyprus	0.04	59	Chile	-0.03
8	Italy	0.04	60	HongKong	-0.04
9	Taipei	0.03	61	USA	-0.32
10	Estonia	0.03	62	China	-0.37

Note: w_n/P_n denotes the real wages in country n.

Table 11: Comparisons of the three cases,%

	CHN			USA		
Var.	Case1	Case2	Case3	Case1	Case2	Case3
Output	-0.68	-0.07	-1.36	-0.72	-1.080	-0.11
Price Index	0.01	0.38	-0.42	-0.74	-0.98	0.42
Exports	-12.96	-14.70	-10.61	11.39	9.25	-6.68
Imports	-4.17	-6.09	-10.60	-15.05	-16.68	-6.70
Nominal wage	-0.03	0.46	-0.79	-1.39	-1.73	0.10
Real Wage	-0.04	0.08	-0.37	-0.66	-0.75	-0.32

Note: This table compares the output, price index and trade of the two countries: China and the U.S. in three cases.

Appendices

A Data information and source

- 61+1 countries: 34 OECD countries, 27 non-OECD countries, and ROW.
- ISIC-Rev3: 33 sectors.
- Bilateral trade flows in 2011 (initial), $M_{ni}^{j}(= X_{ni}^{j})$ and outputs, Y_{n}^{j} : OECD ICIO (2015) and STAN.
- Parameters to be calculated: α_n^j, π_{ni}^j, $\gamma_n^{j,k}$, and γ_n^j from OECD ICIO (2015), and STAN.
- Parameters borrowed from Caliendo and Parro (2015): θ^j, elasticity of substitution.

B List of Country and Sectors

Table B.1: List of Countries

ID	ISO	OECD	ID	ISO	Non-OECD
1	AUS	Australia	35	ARG	Argentina
2	AUT	Austria	36	BGR	Bulgaria
3	BEL	Belgium	37	BRA	Brazil
4	CAN	Canada	38	BRN	Brunei Darussalam
5	CHL	Chile	39	CHN	China
6	CZE	Czech Republic	40	COL	Colombia
7	DNK	Denmark	41	CRI	Costa Rica
8	EST	Estonia	42	CYP	Cyprus
9	FIN	Finland	43	HKG	Hong Kong
10	FRA	France	44	HRV	Croatia
11	DEU	Germany	45	IDN	Indonesia
12	GRC	Greece	46	IND	India
13	HUN	Hungary	47	KHM	Cambodia
14	ISL	Iceland	48	LTU	Lithuania
15	IRL	Ireland	49	LVA	Latvia
16	ISR	Israel	50	MLT	Malta
17	ITA	Italy	51	MYS	Malaysia
18	JPN	Japan	52	PHL	Philippines
19	KOR	Korea	53	ROU	Romania
20	LUX	Luxembourg	54	RUS	Russia
21	MEX	Mexico	55	SAU	Saudi Arabia
22	NLD	Netherlands	56	SGP	Singapore
23	NZL	New Zealand	57	THA	Thailand
24	NOR	Norway	58	TUN	Tunisia
25	POL	Poland	59	TWN	Taipei
26	PRT	Portugal	60	VNM	Viet Nam
27	SVK	Slovak Republic	61	ZAF	South Africa
28	SVN	Slovenia	62	ROW	Rest of the world
29	ESP	Spain			
30	SWE	Sweden			
31	CHE	Switzerland			
32	TUR	Turkey			
33	GBR	UK			
34	USA	USA			

Table B.2: List of Sectors

ISIC Rev3	Sector	Description
C01T05	Agriculture	Agriculture, hunting, forestry, and fishing
C10T14	Mining	Mining and quarrying
C15T16	Food	Food products, beverages, and tobacco
C17T19	Textiles	Textiles, textile products, leather, and footwear
C20	Wood	Wood and products of wood and cork
C21T22	Paper	Pulp, paper, paper products, printing, and publishing
C23	Petroleum	Coke, refined petroleum products, and nuclear fuel
C24	Chemicals	Chemicals and chemical products
C25	Plastics	Rubber and plastic products
C26	Minerals	Other non-metallic mineral products
C27	Basic Metals	Basic metals
C28	Metal Prod.	Fabricated metal products
C29	Machinery nec	Machinery and equipment, nec
C30T33X	Computer	Computer, electronic, and optical equipment
C31	Electrical	Electrical machinery and apparatus, nec
C34	Auto	Motor vehicles, trailers, and semi-trailers
C35	OtherTrans.	Other transport equipment
C36T37	Other manufacturing	Manufacturing nec; recycling
C40T41	Electricity	Electricity, gas, and water supply
C45	Construction	Construction
C50T52	Wholesale and retail	Wholesale and retail trade; repairs
C55	Hotels and restaurants	Hotels and restaurants
C60T63	Transport	Transport and storage
C64	Post	Post and telecommunications
C65T67	Finance	Financial intermediation
C70	Real estate	Real estate activities
C71	Renting	Renting of machinery and equipment
C72	Computer service	Computer and related activities
C73T74	R&D and other business	R&D and other business activities
C75	Public administration	Public administration, defense, and social security
C80	Education	Education
C85	Health	Health and social work
C90T93	Other social service	Other community, social, and personal services