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Meixin Guo† Lin Lu‡ Liugang Sheng§ Miaojie Yu¶

April 2017

Abstract

President Trump of the United States threats to impose high import tariffs against China's exports during his presidential campaign. This paper evaluates the possible impact on the world economy if President Trump eventually pulls the trigger of trade war against China or the rest of the world. Based on the multi-sector and multi-country general equilibrium Eaton and Kortum (2002) model with inter-sectional linkage, we examine the changes of exports, imports, output, and real wage in 62 major economies in response to American 45% tariffs against imports from China or the rest of the world. By exploring four scenarios in which China and other countries choose to retaliate or not, our calibration results suggest that in all scenarios the high US import tariff will bring a catastrophe to international trade. But in terms of social welfare, China will be barely negatively affected whereas the USA is one of the largest losers. In addition, some small open economies may slightly gain while other may be collateral damage.

Keywords: Tariffs, Gains from Trade, Protectionism

JEL classification: F10, F11

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†SEM, Tsinghua University, guomx@sem.tsinghua.edu.cn

‡SEM, Tsinghua University, lulin@sem.tsinghua.edu.cn

§The Chinese University of Hong Kong, lsheng@cuhk.edu.hk

¶Corresponding author. CCER, NSD, Peking University, mjyu@nsd.pku.edu.cn

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§The Chinese University of Hong Kong, lsheng@cuhk.edu.hk

¶Corresponding author. CCER, NSD, Peking University, mjyu@nsd.pku.edu.cn

1 Introduction

Will the president of United States Donald Trump pull the trigger of the trade war against American's main trade partners, such as China? Protectionism was not only the propaganda when Mr. Trump ran for the Presidential campaign, but also becomes the major threaten to the world economy and international trade system. The new president called for "America First" and for "Buy American, Hire American" in his inaugural speech and immediately after he took the office, he has begun carrying out his campaign pledges to undo American trade ties with neighboring countries and main trade partners. President Trump has formally withdrawn the United States from the Trans-Pacific Partnership (TPP)—an agreement among twelve countries across three continents that took nearly ten years to negotiate under former President Barack Obama. He has signed an executive order to build a wall along the Mexican border and threatened Mexico to impose a tax on its exports to U.S. to pay for it. Meanwhile, he also ordered his team to initiate renegotiation of the North American Free Trade Agreement (NAFTA) between the US, Mexico and Canada. His actions have dispelled any remaining doubt that he meant what he said during the election campaign. In the recent meeting of G20 finance ministers and central bankers, financial leaders of the world's biggest economies dropped a pledge to keep global trade free and open, acquiescing to an increasingly protectionist of the U.S..

China has been one of the main targets in the eye of President Trump during his campaign and administration. In his speech in Monessen, Penn on June 28, 2016, Donald Trump condemned China's entry to WTO as one of the catastrophes for US manufacturing workers. He also proposed the idea of imposing 45 percent of import tariff on Chinese exports to the U.S., during the meeting with members of the editorial board of The New York Times in Jan. 2016. In his well-known tweet, he also blamed China as the "grand champion at manipulation of currency" to boost its exports to

U.S.. Therefore, we need to think and evaluate the possible risk scenarios if President Trump does pull the trigger of trade war against China or the rest of the world (ROW).

In this paper, we adopt a multi-country and multi-sector general equilibrium Eaton and Kortum (2002) model with inter-sectoral linkages a la Caliendo and Parro (2015) to examine the changes of exports, imports, output, and real wage in 62 major economies, in response to a hypothetical US tariff hike to the prohibitive level of 45% on its imports from China or the ROW. We consider four possible cases of the 45% import tariff hike on goods including agriculture, mining and manufacturing products. In the first case, U.S. increases tariff to 45% on imports from China. In the second case, U.S. increases the import tariffs uniformly for goods from the rest of the world; in the third and fourth case China or the ROW would retaliate by increasing its tariffs to the same level on imports from U.S.. For simplicity, we name those four cases as "US against China," "US against ROW", "US vs China," and "US vs ROW".

Our exercise shows that in all scenarios the high US import tariff will bring a catastrophe for international trade. In the case of "US against China," Chinese exports to US will be cut by 73 percent, and among 18 tradable sectors, half of them will experience more than 90 percent of drop in their exports, including textile, metal products, computers, electrical equipment. In the case of "US vs China", Chinese exports to U.S. will drop by 74 percent and the U.S. exports to China will be cut by more than a half (56 percent). Moreover, Chinese imports from U.S. in nine sectors will be cut more than 90 percent including agriculture, mining, petroleum products, computer and electrical equipment. If the U.S. launches the trade war against the ROW and other countries retaliate, the world total imports will drop by about 10.73 percent. In all cases U.S. imports will be swept away and the catastrophic effect will be much stronger if China and ROW retaliate U.S..

The trade war will not only crash international trade but also lead to a slump in output and social welfare. In the case of "US against China," Chinese output in textile and computer will drop by 6.51 and 14.67 percent respectively; and in the case of "US vs ROW", US will lose about 9 percent of agricultural output and 10 percent of machinery products. In our study we use the changes in real wage to measure the welfare loss as it takes into account the rising price index due to the rising import prices. In all scenarios we find that U.S. will be the one of the largest losers and China will bear smaller welfare loss. In the above four cases, U.S. welfare loss will be 0.66, 1.74, 0.85, and 2.25 percent respectively, compared with China's maximum loss at 0.16 percent in the case of "US against ROW". Some other countries in Asia may have the chance to gain due to trade diversion, and some advanced economies may become collateral damage due to the spillover effect through input-output linkage and general equilibrium effect.

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

Note one well-known alternative approach to evaluate 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 adhoc parameters. Our approach is different from this and rather follows the recent development in quantitative trade models, triggered in a large part by the seminal work of Eaton and Kortum (2002). The extension of EK model into multiple-sector with input-output linkage and other features has become the workhorse model for counter-factual analysis. This approach is suitable for trade police changes and it has at least three significant advantages over the traditional CGE models or the recent developed CGE model with Melitz (2003)-type firm heterogeneity (Petri et al., 2012). First, it is more parsimony as it has far less parameters in the model. The latest version of the GTAP model has about 13000 parameters, which makes it impossible to estimate those parameters, while researchers using the new quantitative trade models usually use data to estimate the key parameters and then conduct counter-factual analysis. Second, 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. Last but not least, although the CGE model combined with Melitz (2003)'s model is able to capture the 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 is capable to deliver a national-wide gravity equation even incorporating country's trade deficit/surplus.

Recently many researchers have applied or extended the EK framework for various topics, including the evaluation of the possible gains from trade agreement, technological changes, and infrastructure improvement. For example, Donaldson (2010) takes the EK model to empirical data and assesses the gain from railroad construction in colonial India. Caliendo and Parro (2015) extends EK framework to include the input-output linkage and evaluated the gain from NAFTA.[1] Moreover, Dekle et al. (2008) also shows

[1]Di Giovanni et al. (2014) adopts a similar framework to evaluate the gain from China's trade integration with world market and its fast technological changes. A few recent studies have introduced

that the EK framework can be used to analyze hypothetical case, such as how much US GDP need to adjust in order to eliminating its high current account deficits. The fast 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 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 trade relationship between USA and China

2.1 The bilateral trade relationship

From the establishment of the People's Republic of China (PRC, or China) in 1949, the United States had remained diplomatic recognition on Taipei instead of Beijing. Diplomatic and economic interaction between two countries was in the lowest level during the period of the Cold War. Conflicts in ideology and national security interests greatly impeded bilateral trade.

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

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).

resumed the trade relation between two countries.

Following China's 1978 market oriented economic reform, 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, which ended the Smoot-Hawley Act that had stipulated high tariff rates on imports from China since 1930. U.S. soon became the second largest importers for China and was China's third largest partner in 1986. Despite China's MFN status, the Sino-US 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 annual congressional renewal of China's MFN status.

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

The decade and a half following China's access to the WTO has been the honeymoon for two countries, and the bilateral trade has grown much faster than before. Two countries have become the most important trade partner for each other. However, it does not mean there are no trade conflicts between two countries. 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. During the Bush and Obama administrations, quotas and high tariffs were imposed on the imports of Chinese textile and other low-end industrial products to protect U.S. domestic industries. However, those trade conflicts have not changed the direction toward free trade for two countries, until the new administration of President Trump in 2017, which openly supported protectionism.

2.2 Bilateral trade flow and trade imbalance

We examine the Sino-US trade via three perspectives: bilateral trade flow and trade imbalance, bilateral trade structure and trade dispute in some key industries like steel, and current trade conflicts.

Trade volume between China and the United States 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 at 11.11%. Indeed, China and U.S. have become the most important trade partner for each other.

The annual bilateral trade volume growth has slowed down since 2008, partly due to the financial crisis that hindered the global economy. China-US trade volume shrunk by 6.26% in 2016, the first time with a negative growth since 2009. While export edged down by 5.13% in 2016, import decreased by 9.79% consecutively following a decline of 5.9% in 2015.

[Insert Table 1 Here]

Apart from the fast-growing trade volume, there has been a persistent bilateral trade surplus in favor of China. As shown in Table 1, the China's trade surplus reached 254 billion USD in 2016, whereas it was only 30 billion USD surplus in 2000 for China. The unbalanced trade turns out to be a long-lasting dispute in the Sino-US relationship. However, as bilateral trade volume growth slowed down recently, trade surplus growth also started to cool down. China's bilateral trade surplus narrowed by 2.45% to 254 billion USD in 2016, reflecting a tendency toward a more balanced bilateral trade structure.

[Insert Figures 2 and 3 here]

2.3 Bilateral trade structure and trade dispute

Machine and electronic equipment is the leading industry (USD 173 billion) in China's export to the United States, accounting for 44.45% of China's total exports in 2016. Textile products ranked the second in China's export to the U.S., with approximately USD 42 billion that accounts for 11% of Chinese total exports to U.S.. This illustrates China's competitive edge in light product manufacturing. However, export in traditionally competitive industries shrunk in recent years in accordance with the slowing pace in bilateral trade. Machinery and electronic equipment dropped 3.89% in 2016 while textile decreased by 5.35%. Both industries remained at the same export level as in 2013.

In terms of China's imports from the United States, machine and electronic equipment are also the largest sector, with USD 31.26 billion imports accounting for 23.13% in total imports in 2016.[2] This reflects the intra-industry trade and the global production integration between two countries, and therefore a trade war is more likely to hurt those industries.

One of the highly disputed issues in the bilateral trade relationship is the steel products. The United States criticized that China's official supports on steel and aluminum products had distorted the global markets, by accusing China of dumping 100 million tons steel into global market. While at the same time, the U.S. filed 29 anti-dumping and 25 anti-subsidy investigations against Chinese companies in 2011-15, including 11

[2]The proportion of machine and electronic equipment imports also dropped in recent years, from 25.11% in 2013 to the current 23.13% of total imports.

anti-dumping and 10 anti-subsidy on steels. As a result, the export of steel products to the United States dropped by about 75%, from 6.92 billion USD in 2008 to 1.71 billion USD in 2016. In fact, Chinese steel exports to the U.S. as percentage of total exports has fallen from 2.74% in 2008 to 0.44% in 2016. Although this coincided with China's commitment to reduce excess capacity, the anti-dumping on Chinese steel products reflects the devastating effect of anti-dumping tariff and its associated policy uncertainty on Chinese exports.

[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 USA and China realize significant gains from trade liberalization and the expanding bilateral markets. However, after Mr. Trump's inauguration, trade dispute has intensified in the following aspects.

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

Second, the United States has criticized China of 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 towards domestic firms, such as "secure and controllable" policies for information and communications technology; and (iii) the techno-nationalism under the auspices of "Made in China 2025".

China, in response, has denied the "secure and controllable" policies to limit foreign trade and notified the WTO Technological Barrier to Trade (TBT) committee. In the case of "Made in China 2025 initiative", the Chinese government has stated that it will bring equal opportunities to foreign and domestic enterprisers and will strengthen the role of the market.

Third, the United States has argued a significant market barrier for their exporting firms. It has alleged export restraints (e.g., quota, licensing) imposed by China to benefit domestic downstream firms at the expense of foreign competitors. Also, it has accused China of using anti-monopoly law investigations to protect domestic industries.

Fourth, the intellectual property rights has been a heated topic in recent years. The U.S. has complaint of its enterprises being required to transfer technology as conditions for securing investment approvals. It also accused the poor protection and enforcement of trade secrets by Chinese government.

3 Model

In this section, we follow Caliendo and Parro (2015) to build a multiple-country and multiple-sector world. Then we can study how tariff changes influence output and trade flows via the rich input-output linkage across sectors.

3.1 Basic setup

The world consists of N countries and in each country, there is a measure of L_n representative households. They collect 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-Douglass utility function on consuming final goods from each sector

$$U(C_n) = \prod_{j=1}^{J} C_n^{j\,\alpha_n^j}, \text{where } \sum_{j=1}^{J} \alpha_n^j = 1. \tag{3.1}$$

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

$$q_n^j(\omega^j) = z_n^j(\omega^j)[l_n^j(\omega^j)]^{\gamma_n^j} \prod_{k=1}^{J} [m_n^{k,j}(\omega^j)]^{\gamma_n^{k,j}} \tag{3.2}$$

where $m_n^{k,j}$ is the composite intermediate good from sector k used in the production of sector j. $z_n^j(\omega^j)$ indicates the efficiency in producing intermediate 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 4]

Because the production of intermediate goods is at constant returns to scale and market are perfectly competitive, the unit production cost is given by,

$$c_n^j = B_n^j w_n^{\gamma_n^j} \prod_{k=1}^{J} P_n^{k\,\gamma_n^{k,j}} \tag{3.3}$$

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

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

$$Y_n^j = \left[\int y_n^j(\omega^j)^{1-1/\sigma^j} d\omega^j \right]^{\frac{\sigma^j}{\sigma^j - 1}} \tag{3.4}$$

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

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

$$P_n^j = A^j \left[\sum_{i=1}^{N} \lambda_i^j (c_i^j \tau_{ni}^j)^{-\theta^j} \right]^{-1/\theta^j} \tag{3.5}$$

where τ_{ni}^j is the bilateral trade cost for country i's exports shipping to country n (paid in exports), and 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

$$\pi_{ni}^j = \frac{\lambda_i^j [c_i^j \tau_{ni}^j]^{-\theta^j}}{\sum_{h=1}^{N} \lambda_h^j [c_h^j \tau_{nh}^j]^{-\theta^j}} \tag{3.6}$$

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, which is given by

$$X_n^j = \sum_{k=1}^{J} \gamma_n^{j,k} \sum_{i=1}^{N} X_i^k \frac{\pi_{in}^k}{1 + \tau_{in}^k} + \alpha_n^j I_n \tag{3.7}$$

where

$$I_n = w_n L_n + R_n + D_n \tag{3.8}$$

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 $M_{ni}^{j} = X_i^j \frac{\pi_{ni}^j}{1+\tau_{ni}^j}$ are country n's imports of sector j goods from country i. The summation of trade deficits across countries is zero and national deficits are the summation of sectoral deficits, $D_n = \sum_{k=1}^{J} D_n^k$. Sectoral deficits are the difference between total imports and total exports and 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

Changes in wages and prices can be solved once we know the changes in tariff (trade costs) from $(1 + t_{in}^j)$ to $(1 + t_{in}^{j'})$ (τ to τ'), without estimating 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.

$$\hat{\tau}_{ni}^j = (1 + t_{ni}^{j'})/(1 + t_{ni}^j) \tag{3.9}$$

$$\hat{c}_n^j = \hat{w}_n^{\gamma_n^j} \prod_{k=1}^{J} (\hat{P}_n^k)^{\gamma_n^{k,j}} \tag{3.10}$$

$$\hat{P}_n^j = \left\{ \sum_{i=1}^{N} \pi_{ni}^j [\hat{c}_i^j \hat{\tau}_{ni}^j]^{-\theta^j} \right\}^{-1/\theta^j} \tag{3.11}$$

$$\hat{\pi}_{ni}^j = \left[\frac{\hat{c}_i^j \hat{\tau}_{ni}^j}{\hat{P}_n^j} \right]^{-1/\theta^j} \tag{3.12}$$

$$X_n^{j'} = \sum_{k=1}^{J} \gamma_n^{j,k} \sum_{i=1}^{N} X_i^{k'} \frac{\pi_{in}^{k'}}{1 + \tau_{in}^{k'}} + \alpha_n^j I_n' \tag{3.13}$$

$$\sum_{j=1}^{J}\sum_{i=1}^{N} X_n^{j'} \frac{\pi_{ni}^{j'}}{1 + \tau_{ni}^{k'}} - D_n' = \sum_{j=1}^{J}\sum_{i=1}^{N} X_i^{j'} \frac{\pi_{in}^{j'}}{1 + \tau_{in}^{k'}} \tag{3.14}$$

$$I_n' = \hat{w}_n w_n L_n + R_n' + D_n' \tag{3.15}$$

Given changes in tariffs, we can solve for changes in output, total and bilateral trade flows and real (nominal) wages for each country. Using the changes in real wages, we can study 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 values of α_n^j, $\gamma_n^{j,k}$, γ_n^j, π_{ni}^j and θ_n^j. The data required are on bilateral expenditure X_{ni}^j (or bilateral trade flows M_{ni}^j- imports of n from i on sector j in Caliendo and Parro (2015)), value added (V_n^j), gross production (Y_n^j), and I-O tables.

We rely on the most updated 2015 edition of OECD Inter-Country Input-Output database (ICIO) to obtain bilateral expenditures X_{ni}^j and trade share $\pi_{ni}^j = \frac{X_{ni}^j}{\sum_{i=1}^N X_{ni}^j}$. The OECD ICIO 2015 data provides complete input-output matrix among 34 ISIC Rev. 3 sectors for 61 countries and rest of the world in year 2011. These 61 countries cover 34 OECD countries and 17 non-OECD but main emerging economies. Our countries sample includes the BRICS (Brazil, Russia, India, China, and South Africa), Asian four dragons (Korea, Taiwan, Hong Kong, and Singapore), 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 most latest available data set. Due to the global financial crisis in 2008, the international trade recovered slowly. Thus, the current global trade flow and trade structure are close to their counterparts in 2011. Thus, we believe that data in 2011 is 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 zero in half of countries. In the end, we end up with a sample of $N = 62$ countries and $J = 33$ sectors (18 tradable sectors and 15 service sectors).[3]

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 total expenditure of sector j goods subtract the intermediate goods expenditure and divide by 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 Quantifying effects of tariff increases

4.1 Tariff increases

Since we use 2011 trade and production as the base year; our sample countries are all WTO members and use the most-favored-nation (MFN) tariffs for each other. The sectoral mean or median of MFN tariffs are all less than 3% except the three sectors: Agriculture (3.47%), Food (8.07%), and Textiles (8.77%). Therefore, we treat the initial tariff is zero for all countries and sectors.[4]

Mr. Trump threatened to impose prohibitive high tariffs up to 45 percent to some products imported from China. In this paper, we consider an extreme case in which the USA will impose such prohibitive tariffs to *all* imports from China. An alternative but equivalent interpretation is that Mr. Trump labels China as a currency manipulation

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

[4]Admittedly, China's current average import tariff is around 9%. So a hypothesis 45% high import tariffs against China is similar to an effective 36% import tariffs against China, which is a typical number of China's special safeguard imposed by the USA in the past years.

country and force Chinese Yuan to apprecaite around 45%. Consider an increase in policy from zero tariff to 45% USA 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 $\hat{\mathbf{w}}$, then we plug wages in the equilibrium conditions above to solve $\hat{c_n}^j(\hat{\mathbf{w}})$ and $\hat{P_n}^j(\hat{\mathbf{w}})$. Accordingly, 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.[5] If not, we adjust our guess $\hat{\mathbf{w}}$ until equilibrium condition obtained.

4.2 Sectoral bilateral trade between USA and China

Before we discuss the effects of tariff increase on trade flows and output, we provide the information on the relative tradability of USA and China across different sectors. Table 3 illustrates the Sino-US bilateral trade flows in 18 tradable goods sectors in 2011. Particularly, the table presents shares of bilateral import over total import and exports in each sector for the USA and China, respectively. The second column, $\frac{M^j_{USA,CHN}}{M^j_{USA}}$, provides the share of USA imports from China in a sector j over the USA total imports in the sector j. Two sectors, Computer and Textiles, have the largest sectoral import shares, both above 45%. China is the largest trade partner of the USA in these two sectors. Electrical and Minerals are the next two large sectors that the USA imports intensively from China. The four sectors are also among the sectors in which China exports to the USA a lot. The third column, $\frac{M^j_{USA,CHN}}{E^j_{CHN}}$, shows share of USA imports from China in a sector j over the Chinese total exports in the sector j. China export to USA a lot in sectors like Computer, Wood, Plastic, Papers and Textiles, more than 23% of Chinese exports arrive in USA in these sectors. On the other hand, China

[5] One of the reasons that Mr. Trump proposed high import tariff is to reduce the large U.S. current account deficit. Here we solve the new equilibrium with the total trade balance for each country and then compare the new equilibrium with the real data.

imports from the USA intensively in sectors Paper, Other Transport (such as aircraft) and Agriculture (the fourth column). Furthermore, in sector Agriculture, 18.07% of the USA total exports are consumed in China (the fifth column). To sum up, the capability to export for USA and China varies across sector. The USA intensively imports from China in sectors Computer , Textiles and Electrical while China intensively imports from the USA in sectors Paper, Other Transport and Agriculture.

[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 USA has massive imports in sectors Textiles, Computer, and Electrical, the import share of output is 68.91%. These goods mainly exported by China (shown in previous Table 3). Particularly, the imports in the Textiles' sector is 1.4 times of USA output. In the third column, we find that the USA has revealed advantages in exporting Other Transport, Machinery nec and Computer, where more than 1/3 of the output is exported. It's worth to note that USA produces more than 20% world output in the sectors including Paper, Petroleum and Other Transport. On the contrary, China has a very different trade structure and production patterns. First, China imports and exports heavily in sectors including Computer (33.55% vs 47.92%, respectively). This may be resulted from the global value chain and processing trade. Second, China imports a lot in sector Mining (29.81% import share), but exports intensively in sectors Textiles (20.83%) and Other Transport (28.6%). Third, China produces much more than the USA in all sectors except the three sectors, i.e., Paper, Petroleum, and Other Transport, where the USA has the advantages.

[Insert Table 4]

Considering both Table 3 and Table 4, we can draw following conclusions on the Sino-US production and trade patterns in 2011. First, the two countries together produce more than 40% of the world tradable goods on average and are specialized in different sectors. Second, the total trade of the two countries contribute to more than 20% of the world trade on average. Third, trade in sectors including Textiles, Computer, and Electrical Machinery nec, and Other Transport are essential to understand the Sino-US trade relationship.

4.3 Case 1: US against China

First, we discuss how output and trade can be affected if Mr. Trump imposes 45% import tariff on Chinese goods unilaterally. Table 5 shows the changes in output and bilateral trade between USA and China. Column Y^j_{USA} (L^j_{USA}) presents the US output (labor) changes.[6] With such a large tariff increases, the USA imports less and produces more. Domestic production significantly increases in sectors including Computer, Textiles, and Electrical, (more than 20%) although the USA imports those goods heavily (mainly from China) before the tariff hike. While the USA output grows, all sectoral imports decrease except the two sectors Basic Metals and Other Transport (Column M^j_{USA}). Particularly imports in sectors including Petroleum, Textiles, Wood and Computer decline most, at least by a quarter.

On the other hand, Chinese gross output declines in 11 sectors because China loses the large US market (Column Y^j_{CHN}). However, the effect on production is not very large, less than 5%. The only two exceptions are sectors of Textiles and Computer, dropping by 6.51% and 14.67% respectively. This large declines on selected Chinese

[6] 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 a country, the changes in labor shares across different sectors within a country is proportional to the sectoral output changes. This result holds for all four cases.

sectoral output and exports are consistent to the large expansion of those sectoral output in the USA. The last two columns focus on the bilateral trade instead of the total trade. Given an unilateral import tariff, Chinese exports to the USA collapse, 83% decrease on average. In contrast, Chinese imports from USA increase in 17 sectors. Except five sectors such as Petroleum, Mining and Paper, the increase of USA exports is limited, less than 5%.

From Table 5, we find that the US produces more and imports less from other countries, particularly less from China.[7] However, due to higher tariff and then higher import price, the US real wage declines. The welfare loss measured by decreasing in real wage in USA is about 0.66% as shown in Table 6. China also encounters a welfare loss but much smaller than the USA, as its real wage declines by only -0.04%. Some small countries, such as Singapore and Luxembourg, gain from this tariff increase due to trade diversion. China might increase its exports to those countries since the USA imports from China decline dramatically. On the other hand, the USA also produces more and expands its exports. This large supply of goods in non-USA world market reduces the goods price in equilibrium, thus small countries who import significantly can benefit from the lower prices.

[Insert Tables 5 and 6]

4.4 Case 2: US against ROW

We now consider a case that US imposes high 45% tariffs against the rest of the world (ROW) unilaterally. Table 7 shows its consequent changes in trade and output. With such prohibitive high tariffs, the imports from all tradable industries shrink significantly, as shown from column (2). In particular, the USA no longer imports

[7] Table A.16 in the appendix presents countries' changes of real wages for all four cases.

petroleum anymore. This finding echoes the stylized facts shown in Table 4: The USA is one of the most important petroleum production countries. It produces around 21% of global petroleum. Simultaneously, the import-output ratio of petroleum is only 12%. The next sectors with largest decreases in imports are paper, mining, wood, and even electrical products.

If the USA insists on the isolated trade policy, can it increase its own productions for all sectors? The findings in column (1) of Table 7 propose an affirmative answer indeed. The most expanding sector is textiles which doubles its size, followed by the computer sector with an 80 percentage increase and the electrical sector with an 70 percent increase. It is easy to understand the rapid increase in both computer sector and the electrical sector as the USA has strong comparative advantage in the TMT sectors. However, the significant expansion of the textile is just because the USA has only a small production capacity today. As shown in Table 4, the American import-output ratio of the textile sector is 1.41 whereas its production only accounts for 3% of textiles global production.

The impact of the USA's global isolation policy seems no large impact on China's production, as shown in column (3) of Table 7. This is intuitive. Although currently the USA is the largest trading partner of China (i.e., account for 13% of China's trade volume), China can still rely on both enlarging domestic market and the rest of the world to maintain its role of "the world factory". Without a doubt, China's export to the USA will decrease significantly. The top five sectors that were severely affected include petroleum, mining, paper, wood, and electrical products. As a key feature of global supply chain, China today indeed imports huge intermediate imports from the USA and re-export the final products to the USA after local processing in China. As a result, the declining American import from China will consequently cause a decrease in Chinese import of raw and intermediate inputs from the USA (Ludemay et al., 2016). The last column in Table 7 witnesses this feature. The top three Chinese sectors with largest declines in import from the USA are petroleum, electrical, and mining, respectively.

Who gain and who loses if Mr. Trump imposes high tariffs against the rest of the world? Table 8 lists the top 10 countries with potential trade gain and the bottom 10 counterparts with strongest welfare losses. Without loss of generality, we use changes in real wage to proxy the welfare changes following previous works like Caliendo and Parro (2015). Clearly, the USA is the biggest loser in its global isolation game. The American real wage declines around 2 percentage compared to the case of free-trade. Since Canada and Mexico are the same trading bloc with the USA, they both also suffer significantly from the American isolation policy. By contrast, small open economies (e.g., Luxembourg, Singapore) and petroleum-abundant countries (e.g., Brunei, Norway, Netherlands, and Saudi Arabia) gain from the American isolation. The bottom-line take-away message in Table 8 is that the USA never gain from its global isolation policy, which once again, confirm Ricardian orthodox–The free trade is the best.

[Insert Tables 7 and 8]

4.5 Case 3: US vs China

Case 3 studies the effect of Sino-US trade war on production, trade flows and welfare. Compared with Case 1 'USA against China', China also charges 45% import tariff on the USA exports in the tradable goods sectors. There are four similarities between Case 1 and Case 3. First, because the USA impose the same tariff to Chinese goods, the USA output, total imports, and imports from China show similar patterns to those in Case 1. In three sectors, Computer, Textiles and Electrical, the USA expands their productions. Secondly, The USA reduces their imports in most sectors; imports in sectors, such as Petroleum, Textiles, Wood and Computer, decline most. Thirdly, Chinese output and total exports changes with similar magnitude as in Case 1. Productions and exports in sectors Textiles and Computer significantly decline. Furthermore, small countries still gain from the tariff war like in the Case 1.

The differences between Case 1 and Case 3 lies in the bilateral Sino-US trade and the changes in their real wage (welfare). Contrast with unilateral decrease in the USA imports from China, both the imports of USA from China and the imports of China from the USA collapse because of the tariff competition between the two countries. More importantly, with China's repatriation to the U.S high tariffs, China does not suffer from the welfare loss whereas the USA clearly bear welfare loss. This is different from the corresponding findings in Case 1 in which the USA unilaterally imposes high tariffs against China. The intuition that China will not suffer from its retaliation is due to the possible terms-of-trade gain. With high import tariffs, China face softer import competition from the USA. Accordingly, the aggregate price goes up. But according to the Stopler-samuelson theorem, the real return on the factors that used intensively to produce the importable goods will increase. As a result, China's welfare increase, although insignificantly when taking the input-output multi-sectoral linkages into account.

[Insert Tables 9 and 10]

4.6 Case 4: US vs ROW

We consider an extreme case when both U.S. and ROW increase their import tariff to 45% level for their bilateral trade, while the bilateral tariffs remain the same for countries within ROW. This is the case when U.S. withdraws its membership from WTO, and our calibration results show that this would be the worst scenario for U.S. economy.

Table 11 shows our calibration results for sectoral changes in output, import, and bilateral imports between US and China. One important feature distinguishing this case from the three above is that the agricultural output in US would shrink by about 9 percent. In the case of US vs China, even China imposes high tariff on agriculture goods imported from US, Americans still can sell to other countries which have low import tariff. Thus the impact of Chinese tariff hike on US agriculture output is limited. However, in this case, all countries in ROW will charge the high import tariff on US exports, and thus the world demand for US agriculture goods would be cut significantly.

The effect of this world-wide trade war on US imports and exports will be significantly larger than previous three cases. For example, the last column in Table 11 shows that the Chinese imports from US in 9 out of 18 tradable sectors will experience more than 90 percent reduction. Given the role of international trade in US economy has been significantly reduced, US domestic production must expand, particularly for sectors previously relying on imports. For instance, US textile output needs to increase by 86 percent to fill up the gap between consumer demand and limited domestic supply. This hints that President Trump is less likely to trigger a world-wide trade war against ROW, such as withdrawing from WTO.

Table 12 show the welfare loss for a selected group of countries. Clearly in this case the welfare loss will be the largest for US; the real wage will drop by 2.2 percent. Canada and Mexico would be the largest collateral damage as the US is their most important trade partner. By contract, the welfare loss for China is ignorable, and some small open economies might gain slightly due to the lowering import prices as the demand from US shrinks.

[Insert Tables 11 and 12]

5 Conclusion remark

President Donald Trump threatened to trigger a trade war toward China or the rest of the world (by withdrawing from WTO). This paper takes a serious examination of the possible catastrophic impact on international trade and social welfare of Trump's trade war, by using a standard multi-country and multi-sector general equilibrium model. We have simulated four different scenarios depending on how other countries respond, and in all scenarios international trade will be devastatingly struck, and the U.S. will be one of the largest loser in terms of social welfare, compared with limited loss for China.

Two possible extensions merit special considertaion. First, regional trade agreements and regional integration is another tropical topic for both academia and policy makers. It is possible that the USA can build new trading bloc or reconstruct the NAFTA to concrete its trading bloc. Simultaneously, China now is actively engaging regional trade agreements such as the ongoing regional comprehensive economic partnership (RCEP) and the one-belt-one-road initiatives. So it is possible that the USA imposes high tariffs against China and its associated trading blocs, and vice versa. Second, in the current paper we persume no dramatical exchange rate adjustment in responses to Trump's trade war. Admittedly, we cannot rule out such a possibility. However, these two issues are beyond the scope of the current paper, which will be reserved for our future research.[8]

[8]We thank Professors Wing Tye Woo and Fuku Kimura for this insightful suggestion.

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Figure 1: China-US bilateral Trade

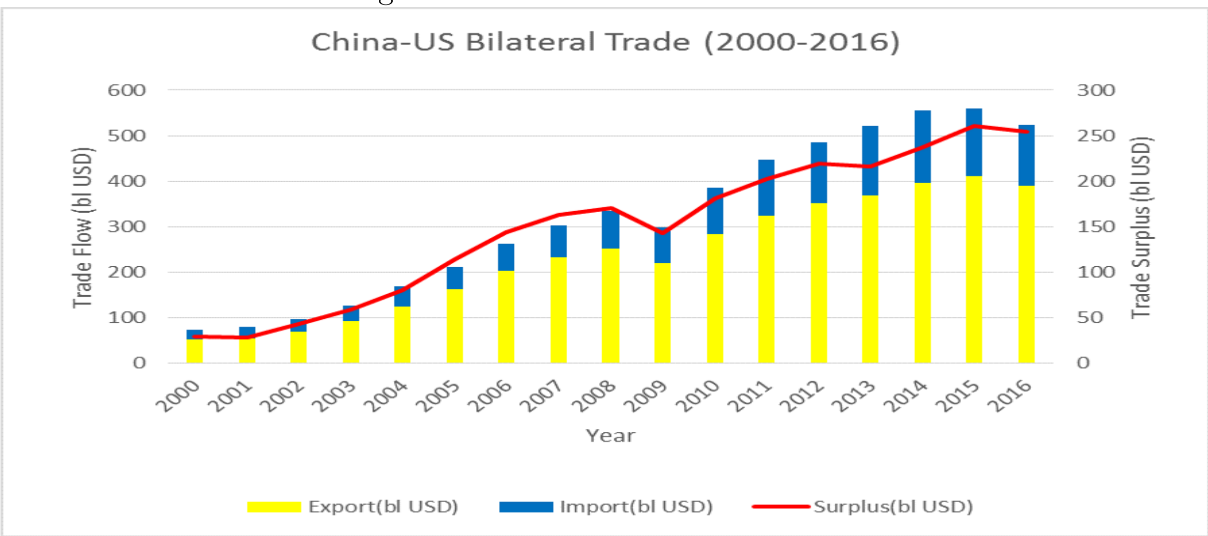

Figure 2: China-US bilateral Trade Growth

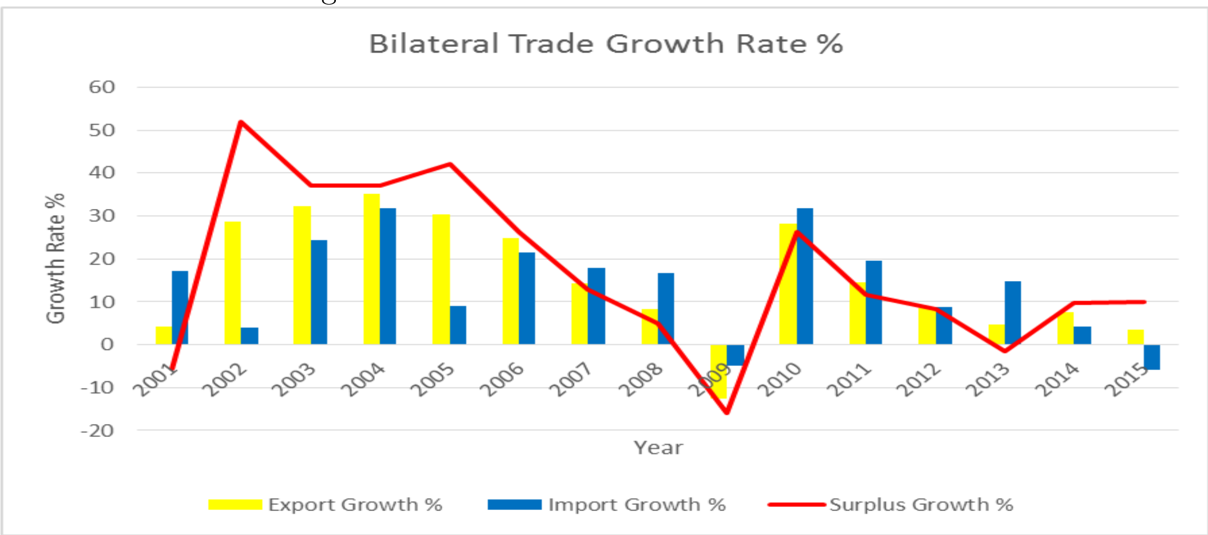

Figure 3: Chinese steel exports and imports from US

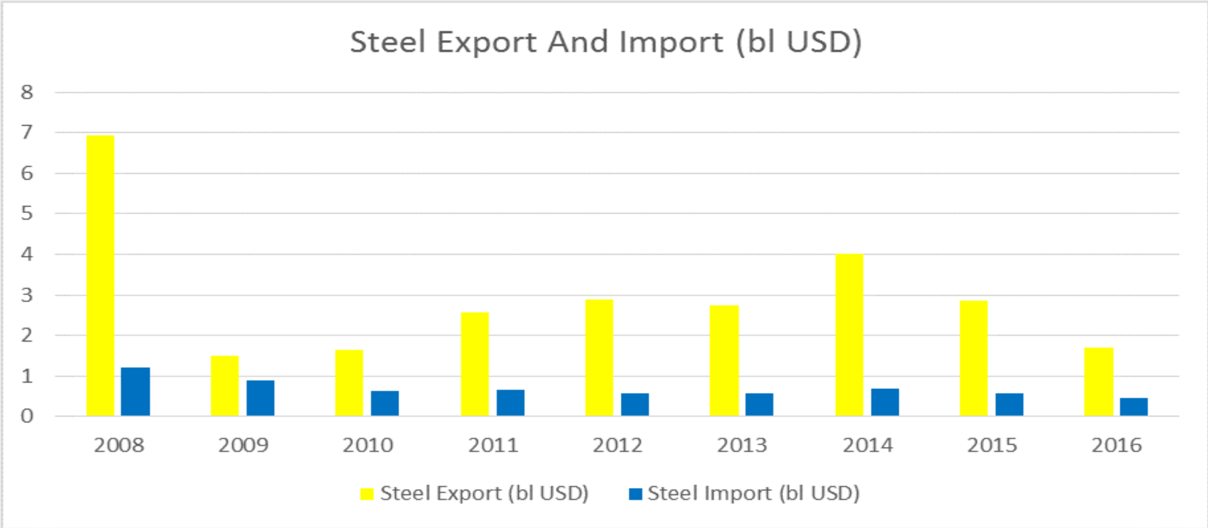

Figure 4: Multi-sector Model Production

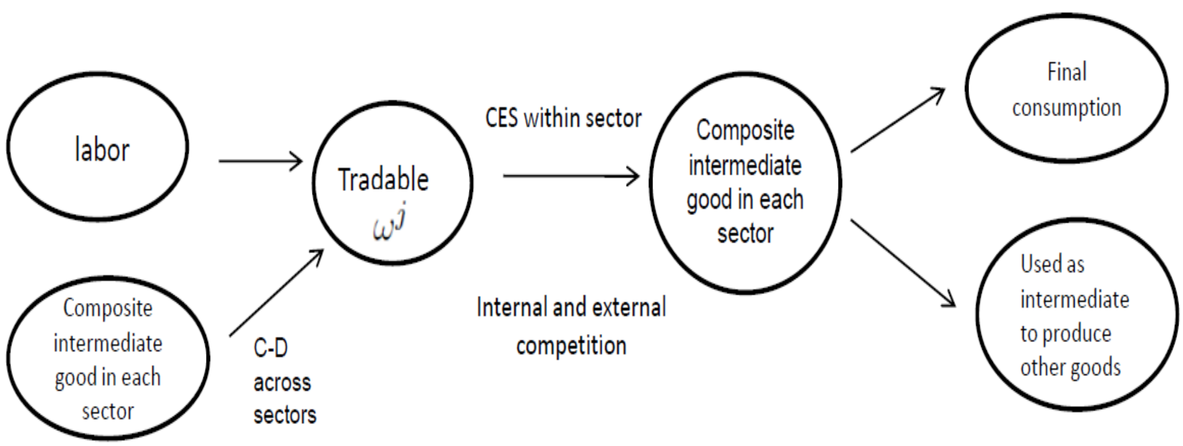

Table 1: Sino-US bilateral trade volume and growth since 2000

Year	Trade Flows, Billion US Dollars		Growth Rate, %	
	$M_{USA,CHN}$	$M_{CHN,USA}$	$M_{USA,CHN}$	$M_{CHN,USA}$
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

$M_{USA,CHN}$ is the total imports of the USA from CHN. $M_{USA,CHN} + M_{CHN,USA}$ defines the total trade volume. $M_{USA,CHN} - M_{CHN,USA}$ is the Chinese trade balance.

Table 2: Sino-US bilateral trade flows on selected sectors from 1993-2016, billion US Dollars.

Year	Steel		Textile		Machine and Electronic	
	$M^j_{USA,CHN}$	$M^j_{CHN,USA}$	$M^j_{USA,CHN}$	$M^j_{CHN,USA}$	$M^j_{USA,CHN}$	$M^j_{CHN,USA}$
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

$M^j_{USA,CHN}$ is the imports of the USA from CHN in sector j.

Table 3: Bilateral trade flows between USA and CHN 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

$\frac{M^j_{USA,CHN}}{M^j_{USA}}$ (or $\frac{M^j_{USA,CHN}}{E^j_{CHN}}$): USA imports from CHN in sector j over USA total imports in sector j (CHN total exports in sector j) in 2011.

Table 4: Trade shares in country's output, and country's output shares of the world,%

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

M_i^j/Y_i^j: import share in country i's output and Y_i^j/Y_w is the output share in the world.

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

sector	$Y^j_{USA}(L^j_{USA})$	M^j_{USA}	$Y^j_{CHN}(L^j_{CHN})$	E^j_{CHN}	$M^j_{USA,CHN}$	$M^j_{CHN,USA}$
Agriculture	2.37	-8.04	0.83	-1.63	-97.80	8.57
Mining	12.31	-4.11	2.22	3.84	-99.55	14.63
Food	-3.42	-11.03	1.32	-10.12	-75.37	3.31
Textiles	24.85	-29.34	-6.51	-21.30	-95.69	1.24
Wood	5.46	-28.42	-0.68	-23.53	-99.06	7.54
Paper	5.48	-19.57	-2.84	-21.75	-99.86	11.24
Petroleum	14.47	-45.05	2.45	17.27	-100.00	61.40
Chemicals	1.85	-8.19	-2.39	-9.55	-78.54	0.21
Plastics	4.94	-12.42	-3.31	-14.96	-61.17	-1.94
Minerals	6.55	-18.63	1.03	-10.56	-70.31	2.99
Basic Metals	6.81	3.07	-0.87	-2.41	-78.33	0.25
Metal Prod.	7.65	-24.63	-3.09	-16.94	-94.69	3.49
Machinery nec	-3.05	-18.28	-0.26	-11.30	-62.37	1.18
Computer	31.84	-27.53	-14.67	-25.63	-96.05	0.47
Electrical	22.24	-18.27	-2.43	-17.97	-99.32	6.08
Auto	-0.28	-3.96	0.55	-14.26	-65.33	1.00
OtherTrans.	3.58	1.46	1.03	-1.43	-37.59	1.67
Others	-0.07	-27.89	-4.83	-19.96	-84.91	2.59

Y^j_{USA} is the output of USA in sector j. 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, the changes in labor shares across different sectors within a country is proportional to the sectoral output changes.

Table 6: Changes in Real Wage—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			

w_n/P_n is the real wage in country n.

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

sector	$Y^j_{USA}(L^j_{USA})$	M^j_{USA}	$Y^j_{CHN}(L^j_{CHN})$	E^j_{CHN}	$M^j_{USA,CHN}$	$M^j_{CHN,USA}$
Agriculture	8.96	-95.63	0.64	-5.81	-96.12	-29.30
Mining	55.28	-98.33	-0.74	-3.95	-98.63	-46.53
Food	3.86	-68.88	0.97	-10.62	-69.48	-9.00
Textiles	103.84	-86.86	-6.78	-21.95	-87.23	-34.82
Wood	18.58	-97.83	-1.35	-27.49	-98.08	-38.39
Paper	4.46	-99.60	-1.35	-23.65	-99.69	-46.18
Petroleum	-0.34	-100.00	0.50	-0.76	-100.00	-97.32
Chemicals	16.80	-67.67	-2.66	-10.38	-67.57	-16.86
Plastics	15.62	-50.56	-3.63	-14.62	-51.05	-11.81
Minerals	18.23	-60.90	0.51	-11.28	-61.58	-9.93
Basic Metals	43.03	-58.27	-1.65	-6.06	-59.63	-23.51
Metal Prod.	21.24	-89.35	-3.71	-18.58	-89.80	-36.16
Machinery nec	5.90	-48.22	-0.33	-9.87	-48.46	-9.50
Computer	80.68	-89.68	-15.52	-27.34	-89.79	-35.45
Electrical	70.27	-97.01	-3.32	-21.31	-97.24	-55.75
Auto	12.85	-48.71	0.56	-11.79	-48.91	-16.34
OtherTrans.	6.05	-31.98	0.74	-1.77	-32.06	-1.37
Others	11.43	-75.44	-4.33	-18.37	-76.04	-17.79

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

Rank	Name	w_n/P_n, %	Rank	Name	w_n/P_n,%
1	Luxembourg	1.64	53	India	-0.61
2	Singapore	1.45	54	Israel	-0.62
3	Brunei	0.96	55	Greece	-0.74
4	Iceland	0.63	56	Viet Nam	-0.75
5	Ireland	0.62	57	Turkey	-0.81
6	Norway	0.59	58	Cambodia	-0.92
7	Switzerland	0.54	59	Costa Rica	-1.22
8	Netherlands	0.50	60	Canada	-1.33
9	Malaysia	0.45	61	Mexico	-1.43
10	Saudi Arabia	0.40	62	USA	-1.74
33	China	-0.16			

w_n/P_n is the real wage in country n.

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

sector	$Y^j_{USA}(L^j_{USA})$	M^j_{USA}	$Y^j_{CHN}(L^j_{CHN})$	E^j_{CHN}	$M^j_{USA,CHN}$	$M^j_{CHN,USA}$
Agriculture	-1.14	-10.67	2.45	-4.84	-97.94	-97.27
Mining	14.05	-4.75	1.93	-0.27	-99.57	-99.44
Food	-4.18	-11.85	2.28	-10.80	-75.81	-72.45
Textiles	23.80	-30.31	-6.29	-22.47	-95.84	-96.40
Wood	3.75	-30.15	0.38	-25.56	-99.11	-98.90
Paper	3.12	-22.26	2.30	-25.71	-99.88	-99.81
Petroleum	16.51	-50.34	2.32	2.23	-100.00	-100.00
Chemicals	-0.30	-9.58	-0.67	-10.28	-79.08	-77.61
Plastics	4.02	-13.27	-2.46	-15.42	-61.73	-62.96
Minerals	5.43	-19.47	1.69	-11.04	-70.80	-70.45
Basic Metals	4.72	1.35	-0.13	-2.98	-78.88	-79.13
Metal Prod.	6.48	-26.16	-2.35	-18.20	-94.89	-94.46
Machinery nec	-4.52	-18.98	0.56	-11.66	-62.84	-58.59
Computer	27.49	-29.13	-14.26	-26.98	-96.24	-96.88
Electrical	19.87	-19.95	-1.95	-19.90	-99.36	-99.35
Auto	-1.27	-4.65	1.42	-14.72	-65.76	-64.25
OtherTrans.	3.05	0.89	1.60	-1.55	-38.04	-38.69
Others	-0.60	-28.69	-4.13	-21.01	-85.29	-83.27

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

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			

w_n/P_n is the real wage in country n.

Table 11: Changes in Trade and Output— Case 4, %

sector	$Y^j_{USA}(L^j_{USA})$	M^j_{USA}	$Y^j_{CHN}(L^j_{CHN})$	E^j_{CHN}	$M^j_{USA,CHN}$	$M^j_{CHN,USA}$
Agriculture	-8.81	-97.25	2.80	-3.80	-97.57	-97.54
Mining	43.82	-99.07	0.61	-4.03	-99.26	-99.57
Food	-4.00	-73.01	2.63	-9.51	-73.57	-73.32
Textiles	86.25	-90.55	-5.47	-21.12	-90.81	-96.91
Wood	7.18	-98.70	0.67	-26.09	-98.85	-99.06
Paper	-6.94	-99.80	2.41	-21.86	-99.85	-99.84
Petroleum	-4.33	-100.00	1.44	-4.97	-100.00	-100.00
Chemicals	-3.83	-73.89	0.45	-6.53	-73.77	-79.12
Plastics	4.96	-56.85	-1.51	-13.62	-56.90	-64.32
Minerals	8.02	-66.29	2.10	-10.58	-66.87	-71.68
Basic Metals	20.37	-67.74	0.52	-3.46	-68.42	-82.20
Metal Prod.	5.47	-92.67	-1.42	-15.67	-92.79	-95.67
Machinery nec	-10.13	-54.53	1.64	-7.65	-54.40	-60.87
Computer	52.60	-93.22	-11.89	-24.05	-93.15	-97.21
Electrical	50.14	-98.40	-1.17	-17.56	-98.38	-99.59
Auto	3.08	-55.21	2.30	-9.30	-53.38	-68.75
OtherTrans.	-1.90	-37.46	2.46	0.36	-37.29	-39.34
Others	-9.19	-79.86	-1.74	-14.23	-80.17	-84.51

Table 12: Changes in Real Wage—Case 4,%

Rank	Name	w_n/P_n, %	Rank	Name	w_n/P_n,%
1	Singapore	1.30	53	Greece	-0.79
2	Luxembourg	1.24	54	Turkey	-0.90
3	Netherlands	0.55	55	Viet Nam	-0.93
4	Norway	0.54	56	Colombia	-0.95
5	Ireland	0.41	57	Israel	-1.01
6	Czech Republic	0.36	58	Cambodia	-1.24
7	Switzerland	0.34	59	USA	-2.25
8	Russia	0.32	60	Costa Rica	-2.43
9	Denmark	0.31	61	Canada	-2.77
10	Iceland	0.26	62	Mexico	-2.79
22	China	-0.03			

w_n/P_n is the real wage in country n.

Appendices

A Additional Tables

Table A.13: Country list,%

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	HongKong
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 A.14: Sector list,%

ISIC Rev3	sector	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 plastics 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	Electrical	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 and defense and social security
C80	Education	Education
C85	Health	Health and social work
C90T93	Other social service	Other community, social and personal services

Table A.15: Share of intermediate inputs in the total intermediate inputs across sectors, %

sector	Textiles	Machinery nec	Computer	Electrical	Auto
Textiles	12.40	0.22	1.45	0.15	0.25
Machinery nec	0.24	21.77	3.78	4.56	4.76
Computer	0.03	1.02	34.78	3.11	0.67
Electrical	0.03	4.41	6.00	10.29	0.57
Auto	0.82	8.34	4.20	1.03	35.95

This table presents sectoral share of intermediate inputs in the total intermediate inputs and calculated from the USA input-out matrix. Columns are the source sectors and rows are the destination sectors.

Table A.16: Changes in the real wages in four cases, %

Name	case1	case2	case3	case4	Name	case1	case2	case3	case4
ARG	0.35	0.07	0.35	-0.01	ITA	-0.08	-0.26	-0.08	-0.24
AUS	0.07	-0.16	0.10	-0.32	JPN	-0.14	-0.23	-0.12	-0.26
AUT	0.56	0.11	0.57	0.09	KHM	-0.39	-0.92	-0.40	-1.24
BEL	0.27	-0.01	0.26	-0.08	KOR	0.30	-0.23	0.38	-0.35
BGR	-0.13	-0.33	-0.13	-0.29	LTU	-0.02	-0.26	-0.04	-0.28
BRA	-0.07	-0.19	-0.07	-0.26	LUX	2.17	1.64	2.17	1.24
BRN	1.90	0.96	1.93	-0.43	LVA	-0.25	-0.47	-0.25	-0.44
CAN	-0.16	-1.33	-0.20	-2.77	MEX	-0.10	-1.43	-0.15	-2.79
CHE	1.19	0.54	1.19	0.34	MLT	0.44	0.17	0.44	0.11
CHL	0.34	-0.07	0.35	-0.45	MYS	1.40	0.45	1.47	0.21
CHN	-0.04	-0.16	0.08	-0.03	NLD	1.08	0.50	1.07	0.55
COL	-0.08	-0.53	-0.10	-0.95	NOR	1.19	0.59	1.17	0.54
CRI	-0.37	-1.22	-0.37	-2.43	NZL	0.19	-0.13	0.21	-0.31
CYP	-0.08	-0.14	-0.09	-0.28	PHL	-0.32	-0.54	-0.28	-0.64
CZE	0.97	0.27	0.98	0.36	POL	0.15	-0.16	0.15	-0.15
DEU	0.83	0.31	0.83	0.25	PRT	-0.66	-0.59	-0.67	-0.59
DNK	0.75	0.29	0.74	0.31	ROU	-0.51	-0.49	-0.51	-0.41
ESP	-0.07	-0.15	-0.08	-0.18	ROW	0.11	-0.26	0.11	-0.64
EST	0.67	0.15	0.66	0.13	RUS	0.89	0.34	0.89	0.32
FIN	0.18	-0.18	0.19	-0.14	SAU	1.12	0.40	1.13	0.07
FRA	-0.35	-0.38	-0.35	-0.46	SGP	2.58	1.45	2.63	1.30
GBR	-0.07	-0.24	-0.08	-0.49	SVK	0.38	-0.05	0.38	0.02
GRC	-0.99	-0.74	-1.00	-0.79	SVN	0.38	0.00	0.38	0.01
HKG	0.19	0.12	0.21	-0.18	SWE	0.76	0.25	0.76	0.23
HRV	0.10	-0.12	0.10	-0.13	THA	0.34	-0.17	0.38	-0.28
HUN	0.76	0.21	0.76	0.23	TUN	-0.57	-0.60	-0.57	-0.67
IDN	0.25	-0.06	0.27	-0.14	TUR	-1.12	-0.81	-1.12	-0.90
IND	-0.65	-0.61	-0.65	-0.71	TWN	0.75	0.03	0.85	-0.21
IRL	2.04	0.62	2.04	0.41	USA	-0.66	-1.74	-0.75	-2.25
ISL	1.42	0.63	1.42	0.26	VNM	-0.10	-0.75	-0.07	-0.93
ISR	-0.06	-0.62	-0.07	-1.01	ZAF	0.09	-0.17	0.11	-0.34

This table presents the changes of real wage for all 62 countries in four cases.