NBER WORKING PAPER SERIES

GAINS AND LOSSES FROM POTENTIAL BILATERAL US-CHINA TRADE RETALIATION

Yan Dong
John Whalley

Working Paper 17366
http://www.nber.org/papers/w17366

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
August 2011

We are grateful to the Ontario Research Fund (ORF-3) and CIGI for financial support, and to Chunding Li for discussion and comments. The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

Gains and Losses from Potential Bilateral US-China Trade Retaliation
Yan Dong and John Whalley
NBER Working Paper No. 17366
August 2011
JEL No. F00,F1

ABSTRACT

Two closely related numerical general equilibrium models of world trade are used to analyze the potential consequences of US-China bilateral retaliation on trade flows and welfare. One is a conventional Armington trade model with five regions, the US, China, EU, Japan and Rest of the World, and calibrated to a global 2009 micro consistent data set. The other is a modified version of this model with monetary non neutrals and including China's trade surplus as an endogenous variable.

Who may gain or loss from global trade conflicts spawned by adjustment pressures in the post crisis world is much debated. In a US-China trade conflict, Europe and Japan would seem gainers from preferential access to US and Chinese markets. The loss of markets would hurt the US, but moving closer to an optimal tariff could be the source of terms of trade gains. And the ease of substitution across trading partners practices would determine costs for China.

Results from the conventional model suggest that retaliation between the two countries can be welfare improving for US as it substitutes expenditures into own goods and improve its terms of trade with non retaliatory regions, while China and non retaliatory regions maybe adversely affected. Results in the endogenous trade surplus model from the central case model specification ,however, suggest that both the US and the EU (the deficit regions) have welfare losses in most cases, while the surplus region, China, and the ROW have welfare gains. In both models, when the bilateral tariff rates are very high, gains accrue to the EU and Japan from trade diversion if the substitutions elasticities of imports are high. Costs will are borne by the US and China in lost exports, lowered terms of trade and adjustment costs at home.

Yan Dong
Institute of World Economics and Politics
Chinese Academy of Social Sciences
15th Floor of CASS Building
No.5 Jianguomen Nei Avenue
Beijing, China, 100732
dongyan@cass.org.cn

John Whalley
Department of Economics
Social Science Centre
University of Western Ontario
London, ON N6A 5C2
CANADA
and NBER
jwhalley@uwo.ca

1. Introduction

Concerns permeate the global trade policy community today over the possibilities of major trade confrontations occurring over the next few years centered on, but not exclusively including, the US and China. These reflect a number of deep structural features in today's global economy.

One is the continued high growth rate of and level of China's exports and the seemingly remorselessly growing adjustment resisting pressures in major export markets in North America and Europe. With Chinese export growth currently running at around 30% per year, exports are roughly doubling every two years and China now accounts for over 10% of world trade. The adjustment consequence for labor markets in the US and EU seem major and even growing larger, and with them will come more political pressure for protection.

A second is the size of both the Chinese trade surplus and the US trade deficit and the perceived linkage to the onset of the 2008 financial crisis. As a result, the G20 process which the crisis has spawned has centered on the claimed need for rebalancing and with this pressures build for reduced trade growth by China. A third is memories of the 1930's and the major trade compression which accompanied the breakdown of international economic cooperation at the time. Kindleberger(1970) documents a near 80% reduction in US trade that accompanied the 1929 depression and this past event reinforce the perceived need to contain retaliation today.

Previous simulation literature has only explored the potential consequences of retaliatory trade sequences in simple two country stylized settlings. (see Johnson(1953), Kuga(1973), Hamilton and Whalley(1983), Krugman(1991)). Here we go beyond this by considering bilateral retaliation in a 5 country model where non participants in the retaliation potentially benefit from preferential access to bilaterally protected markets. We also explicitly explore the impacts of retaliation in models both of classical form with exogenous trade imbalances (as in Whalley & Wang (2011)) and with monetary non-neutralities, fixed exchange rates and endogenous trade imbalances. These two forms of model both use the Armington assumption of product heterogeneity by country.

We calibrate these models to 2009 data for US, China, EU, Japan and the Rest of the World. We use nested CES functions in preferences and draw on literature estimates for key elasticity parameters, and exploring conventional CES production functions. Factors are assumed immobile across countries.

Our results suggest a number of key themes relevant to the global policy debate on the consequences of potential retaliatory episodes. One is that relative to existing 2 country simulation literature, generally the impacts of bilateral trade retaliation on trade and welfare seem much smaller once other non retaliatory countries enter the analysis. Also, the impacts on the two countries directly engaged in bilateral retaliation can (depending on parameter specification) be welfare improving for both as they substitute expenditures into own goods and improve their terms of trade with both retaliatory and non retaliatory regions. Non retaliatory region can thus be adversely affected even though they have preferential access to markets of retaliating countries, since while they seemingly benefit from preferred access to retaliatory regions they suffer the adverse terms of trade consequences of the bilateral retaliation. Finally, the impacts of bilateral retaliation emerge as highly dependent on the chosen model structure. In models with endogeneity of the trade surplus (accommodated via a fixed exchange rate regime, non accommodative monetary policy and reserve accumulation) retaliation abroad which reduces exports and large reserve accumulation can reverse the sign of welfare impacts relative to conventional models.

We do not claim to produce definitive analysis of the potential impacts of a possible US-China retaliatory trade episode. But relative to available literature we are able to show the potential numerical consequences through the various sources of channels of impact involved.

2. The Impacts of Bilateral Trade Retaliation between US and China using a Traditional Approach

We first describe a traditional five region Armington competitive numerical trade model which we have calibrated to 2009 data. We thus use a calibration generated parametric model specification to compare counterfactual equilibria and different tariff retaliation scenarios to assess the effects of potential bilateral trade retaliation between US and China on the welfare of major world major economies. We do not explicitly compare post retaliation Nash equilibria, since in a multi country (more than 2) model, these are complex to compute. Existing numerical calculation literature for Nash equilibria does not extend beyond 2 countries.

Armington Trade Model Structure

More formally, the model incorporates 5 regions (US, China, EU, Japan and ROW) indexed by j or m ($j = 1,2,3,4,5$, $m = 1,2,3,4,5$) to denote region ,and 2 traded goods (manufactures and non-manufactures indexed i ($i = 1, 2$) to denotes goods. Goods produced across the five regions are treated as heterogeneous (the Armington assumption).

For each good i produced in region j ,we define the seller's price (net of tariff) as P_i^j , and allow each region *m* to impose tariffs at rate t_i^{mj} (region *m*'s tariff on good i imported from region j) on each imported good. These change as we consider alternative retaliatory scenarios. Tariffs are set to zero for exports. Internal (gross of tariff) prices for good i produced in region *j* are thus

$$p_i^{mj} = [1 + t_i^{mj}]P_i^j \qquad (1)$$

On the production side, we use a two sector (manufactures and non-manufactures), two factor (capital and labor) structure. We assume production is CES, and the production function for each good in each region is given by

$$Y_i^j = \gamma_i^j \left[\delta_i^j (K_i^j)^{-\rho_i^j} + (1 - \delta_i^j)(L_i^j)^{-\rho_i^j}\right]^{-1/\rho_i^j} \qquad j\text{=region, } i\text{=sector} \qquad (2)$$

where Y_i^j is the output of good *i* produced in region *j* and ρ_i^j is the substitution term among components of value added (capital and labor) in sector *i* in region *j*, K_i^j and L_i^j refer to the factors capital and labor used in production of good *i* in region *j*. γ_i^j is productivity parameter of sector i in region j, and δ_i^j are share parameters in CES functions.

First order conditions for profit maximization imply:

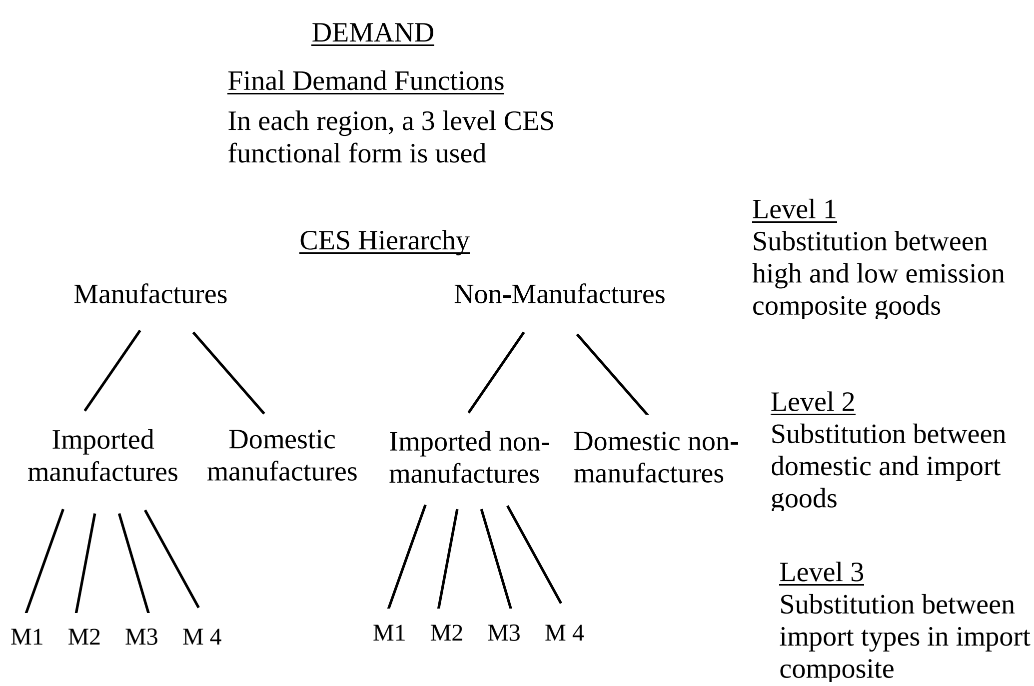
$$K_i^j = Y_i^j (\gamma_i^j)^{-1} (\delta_i^j)^{\frac{1}{\rho_i^j+1}} (P_j^K)^{\frac{\rho_i^j}{\rho_i^j+1}} \left[(\delta_i^j)^{\frac{1}{\rho_i^j+1}} (P_j^K)^{\frac{\rho_i^j}{\rho_i^j+1}} + (1-\delta_i^j)^{\frac{1}{\rho_i^j+1}} (P_j^L)^{\frac{\rho_i^j}{\rho_i^j+1}} \right]^{1/\rho_i^j} \quad (3)$$

$$L_i^j = Y_i^j (\gamma_i^j)^{-1} (1-\delta_i^j)^{\frac{1}{\rho_i^j+1}} (P_j^L)^{\frac{\rho_i^j}{\rho_i^j+1}} \left[(\delta_i^j)^{\frac{1}{\rho_i^j+1}} (P_j^K)^{\frac{\rho_i^j}{\rho_i^j+1}} + (1-\delta_i^j)^{\frac{1}{\rho_i^j+1}} (P_j^L)^{\frac{\rho_i^j}{\rho_i^j+1}} \right]^{1/\rho_i^j} \quad (4)$$

where P_j^K and P_j^L are market factor prices for capital and labor in region *j*. We assume factors are mobile across sectors and immobile across regions.

On the demand side a single set of final demand functions applies for each region resulting from maximizing a nested CES utility function subject to a regional budget constraint. Within this functional form, a hierarchy of substitution possibilities applies, and between the two kinds of goods (manufactures and non-manufactures), then between composites of imports across sources and comparable domestic products, and finally between similar products imported from the various trading areas. This is set out in Figure 1.

Figure 1 : HIERARCHY OF SUBSTITUTION POSSIBILITIES IN THE MODEL



In equilibrium, goods and factor markets clear. Goods market clearing implies:

$$\sum_m X_i^{mj} = Y_i^j \qquad j, m = 1,2,3,4,5, \quad i = 1,2 \tag{5}$$

where X_i^{mj} is region m's consumption of goods i produced in region j ($j = 1,2,3,4,5$, $m = 1,2,3,4,5$ to denote regions) ,and the 2 traded goods (manufactures and non-manufactures) are indexed i ($i = 1, 2$) .

Factor markets clearing implies:

$$\sum_i K_i^j = \overline{K}^j \tag{6}$$

$$\sum_i L_i^j = \overline{L}^j \tag{7}$$

$\overline{K}^j$ and $\overline{L}^j$ and are endowments of capital and labor in region j.

Model Calibration and Counterfactual Experiments

We have constructed a model admissible data set for 2009 for this structure which we use to determine model parameters through calibration . We use calibrated model parameters to experiments for changes in country tariffs for the US and China as part of an assumed retaliatory bilateral trade policy sequence . Alternative equilibria associated with different bilateral tariff levels can then easily be computed. Our base case data captures 2009 trade, production, and consumption by region.

In Table 1, we report the 2009 base year date used to calibrate the model. GDP data is from the World Bank's WDI database. The EU-27's GDP data is calculated by adding GDP of member countries. Trade data is taken from the UNCOMTRADE database. F.o.b. exports values as reported by exporting regions are used. Tariff data is from WTO Statistic Database. Labor input data is from China's NBS data .The U.S. Bureau of Labor of Statistics, Eurostat stastistics and International Labor Statistics.

Table 1
Base Case Data For 2009 for Five Regions Used in Calibrating the Basic Model

Table 1-1 2009 GDP by Sector by Region (Billion $)

	US		China		EU-27		Japan		ROW	
	Manu	Non-Man	Manu	Non-Manu	Manu	Non-Manu	Manu	Non-Manu	Manu	Non-Manu
Value added by sector	2647.45	11608.85	2292.98	2691.75	4339.92	12048.22	1469.58	3597.95	5207.59	12323.90
GDP	*14256.30*		*4984.73*		*16388.15*		*5067.53*		*17531.49*	

Source: World Bank WDI database.

Table 1-2 2009 Factor Inputs by Sector by Region (Billion $)

	US		China		EU-27		Japan		ROW	
	Labor input	Capital input	Labor input	Capital input	Labor input	Capital input	Labor input	Capital input	Labor input	Capital input
Manu	1087.699	1559.751	217.092	2075.884	2923.913	1416.011	600.917	868.667	2125.110	3082.480
Non-Manu	5251.513	6357.337	373.728	2318.026	7701.835	4346.388	2366.184	1231.762	5681.159	6642.744
Total	*6339.212*	*7917.088*	*590.820*	*4393.910*	*10625.748*	*5762.399*	*2967.101*	*2100.429*	*7806.269*	*9725.224*

Source: China's NBS , the U.S. Bureau of Labor of Statistics, Eurostate stastistics and International Labor Statistics.

Table 1-3 2009 Bilateral Trade Data (Billion $)

Export by (Billion $)		**Import by US**	**China**	**EU-27**	**Japan**	**ROW**	**World**
	Man	0	39.464	175.114	30.624	493.169	738.371
US	N-Man	0	30.107	40.996	20.536	212.725	304.364
	Total	*0*	*69.571*	*216.11*	*51.16*	*705.894*	*1042.735*
	Man	215.155	0	289.353	87.183	545.38	1137.071
China	N-Man	6.140	0	9.573	10.728	38.133	64.574
	Total	*221.295*	*0*	*298.926*	*97.911*	*583.513*	*1201.645*
	Man	236.732	98.869	0	41.186	881.783	1258.57
EU-27	N-Man	43.017	13.924	0	7.935	257.429	322.305
	Total	*279.749*	*112.793*	*0*	*49.121*	*1139.212*	*1580.875*
	Man	88.222	96.455	75.277	0	258.417	518.371
Japan	N-Man	7.079	13.208	2.430	0	35.147	57.864
	Total	*95.301*	*109.663*	*77.707*	*0*	*293.564*	*576.235*
	Man	607.945	480.27	501.961	139.713	0	1729.889
ROW	N-Man	388.877	233.257	600.060	213.256	0	1435.450
	Total	*996.822*	*713.527*	*1102.021*	*352.969*	*0*	*3165.339*
	Man	1148.054	715.058	1041.705	298.706	2178.749	0
Total	N-Man	445.113	290.496	653.059	252.455	543.434	0
	Total	*1593.167*	*1005.554*	*1694.764*	*551.161*	*2722.183*	*0*

Source: UNCOMTRADE database

For the central case model analyses there is limited literature yielding elasticity parameters and so these are set as follows. The production elasticities are all set equal to 0.5. The top level consumption substitution elasticity between manufactures and non-manufactures goods is set equal to 0.5 in all regions. The second level trade elasticities between domestic and imported commodities follow a "rule of two" as discussed in Hertel al. (2009), that is the substitution elasticity between domestic and imported goods is set equal to 2. This rule was first proposed by Jomini et al.(1991) and later tested by Liu, Arndt,and Hertel(2002) in a back-casting exercise with a simplified version of the GTAP model. The third level elasticities, ie substitution elasticities between the four imported goods in each country are also set at 0.5. We then change the third level substitution elasticities in sensitivity analysis to change the strength of terms of trade effect.

We have used our calibrated model to analyze the effects of bilateral trade retaliation between US and China on welfare, terms of trade, production and trade flows. The scenario we analyze is one of assumed progressive trade retaliation. In step 1, the US first imposes a tariff at rate 25% on import of China's goods, and in step 2 China's reaction is a 25% tariff rate on import of US's goods. In step 3, the US increases its tariff rates to 50% on imports of China's goods and so on. This continues until in step 8 for which US and China each use a 100% bilateral tariff rate.

All the results of impact of retaliation are calculated as relative to the base year dataset.The welfare impacts of this trade retaliation sequence are measured as equivalent income variations (EVs) by region, with the arithmetic sum of EVs reported as the worldwide welfare gain or loss.

Underlying the welfare effects given by the model are the effects of trade retaliation between US and China on terms of trade. An improvement of the terms of trade raises the price of a region's exports relative to its imports; while a deterioration has the opposite effect. If protection is below the level implied by a set of optimal tariffs, the terms of trade will typically improve, but if the opposite holds they can deteriorate relative to the base case data. The combined welfare effects can attributed to only changes in the terms of trade and the domestic welfare impact of tariff distortion and these combine to produce the total effect.

This simple decomposition provides a convenient point of reference for interpreting model results. The measure used here is the net barter terms of trade, which measures using fixed quantity weights the relative price in index-number form of a composite of imports in terms of a composite of exports for each region. Here benchmark domestic production quantities are used as weights, and the terms of trade are calculated as a producer price index.

Model Results

Results for bilateral retaliation between the US and China using the central case specification of the Armington model are reported in Tables 2 and 3. These results show that increasing protection in US and China yields substantial gains to the US and losses to China, Japan and ROW. The EU experiences either small gains or losses under different levels of bilateral retaliation between US and China.

Table 2

Welfare Impacts of a China-US Trade Retaliation Scenario in a Traditional Armington Model
(Central Case Specification)

	Step1	Step2	Step3	Step4	Step5	Step6	Step7	Step8
US' tariff on China	25%	25%	50%	50%	75%	75%	100%	100%
China's tariff on US	0%	25%	25%	50%	50%	75%	75%	100%
Welfare impacts (EVs in $billion)								
US	67.215	59.753	112.222	106.55	149.314	144.798	180.723	177.007
China	-39.021	-18.744	-50.767	-34.908	-62.158	-49.175	-72.962	-61.989
EU	3.089	-0.666	1.741	-1.509	0.453	-2.437	-0.786	-3.404
Japan	-5.098	-5.278	-9.669	-9.943	-13.832	-14.158	-17.671	-18.028
ROW	-29.58	-31.176	-56.178	-58.261	-80.063	-82.394	-101.817	-104.276
Total	**-3.395**	**3.889**	**-2.651**	**1.929**	**-6.286**	**-3.366**	**-12.513**	**-10.69**
Percentage change in terms of trade								
US	4.143	3.444	6.97	6.425	9.519	9.075	11.848	11.476
China	-2.595	-0.896	-2.999	-1.537	-3.308	-2.013	-3.545	-2.374
EU	-0.018	-0.313	-0.355	-0.614	-0.668	-0.903	-0.964	-1.179
Japan	-0.55	-0.704	-1.19	-1.338	-1.778	-1.921	-2.324	-2.462
ROW	-0.396	-0.621	-0.971	-1.178	-1.494	-1.688	-1.977	-2.159

Table 3
Changes in Trade Flows from Trade Retaliation in the Traditional Armington Model

(Central Case Specification)

	US tariff on Chinese goods	Chinese tariff on US goods	Exports by	Imports by US	China	EU	Japan	ROW
			US	0	-6.34%	-1.76%	-2.84%	-2.58%
Step 1	25%	0%	China	-12.87%	0	-4.66%	-5.55%	-5.16%
			EU	-0.76%	-7.64%	0	-4.43%	-4.24%
			Japan	-1.47%	-7.93%	-3.80%	0	-4.38%
			ROW	0.43%	-7.90%	-3.68%	-4.77%	0
			US	0	-15.04%	-2.00%	-2.78%	-2.54%
Step 2	25%	25%	China	-12.59%	0	-3.94%	-4.61%	-4.17%
			EU	-1.31%	-5.80%	0	-4.30%	-4.04%
			Japan	-1.95%	-6.03%	-3.85%	0	-4.15%
			ROW	-0.09%	-6.27%	-3.56%	-4.41%	0
			US	0	-19.50%	-3.46%	-5.12%	-4.63%
Step 3	50%	25%	China	-22.07%	0	-7.67%	-9.04%	-8.27%
			EU	-2.10%	-11.78%	0	-7.87%	-7.43%
			Japan	-3.35%	-12.22%	-6.91%	0	-7.65%
			ROW	0.15%	-12.42%	-6.53%	-8.24%	0
			US	0	-25.72%	-3.71%	-5.13%	-4.65%
Step 4	50%	50%	China	-21.85%	0	-7.14%	-8.34%	-7.54%
			EU	-2.55%	-10.40%	0	-7.85%	-7.35%
			Japan	-3.74%	-10.80%	-7.03%	0	-7.55%
			ROW	-0.26%	-11.22%	-6.50%	-8.03%	0
			US	0	-29.06%	-4.96%	-7.12%	-6.42%
Step 5	75%	50%	China	-29.19%	0	-10.24%	-12.02%	-10.93%
			EU	-3.34%	-15.29%	0	-10.84%	-10.17%
			Japan	-5.06%	-15.85%	-9.61%	0	-10.47%
			ROW	-0.13%	-16.23%	-8.98%	-11.23%	0
			US	0	-33.75%	-5.20%	-7.18%	-6.47%
Step 6	75%	75%	China	-29.01%	0	-9.83%	-11.48%	-10.35%
			EU	-3.72%	-14.20%	0	-10.88%	-10.15%
			Japan	-5.40%	-14.73%	-9.76%	0	-10.43%
			ROW	-0.47%	-15.30%	-9.01%	-11.11%	0
			US	0	-36.37%	-6.29%	-8.91%	-8.00%
Step 7	100%	75%	China	-34.91%	0	-12.48%	-14.62%	-13.24%
			EU	-4.49%	-18.31%	0	-13.44%	-12.56%
			Japan	-6.64%	-18.98%	-11.97%	0	-12.93%
			ROW	-0.41%	-19.50%	-11.14%	-13.85%	0
			US	0	-40.05%	-6.54%	-8.99%	-8.08%
Step 8	100%	100%	China	-34.75%	0	-12.15%	-14.19%	-12.76%
			EU	-4.83%	-17.42%	0	-13.53%	-12.59%
			Japan	-6.94%	-18.07%	-12.15%	0	-12.94%
			ROW	-0.70%	c-18.76%	-11.19%	-13.79%	0

For step 1,when US initially increases its tariffs on China to 25%, the US has a welfare gain of $67.215 billion, but while China has a welfare loss of $39.021 billion. For step 2, when China retaliates and increases its tariff on US to 25%, US suffers a small welfare loss compared to step1 and the US welfare gain relative to the base year falls to $59.753 billion, China in contrast, has a welfare gain compared to step 1, China's welfare loss relative to the base year falls to 18.744 billion dollars.

With increasing bilateral retaliation, US welfare gains increases, and China's welfare losses also increase, as shown in step 4 and 8, US has a welfare gain of 106.55 billion dollars when the bilateral tariff rate is 50% in both US and China, and 177.007 billion dollars when the bilateral tariff rate is 100%, China has a welfare loss of 34.908 billion dollars when the bilateral tariff rate is 50% in both US and China, and 61.989 billion dollars when the bilateral tariff rate is 100%. Japan and ROW have increasing welfare losses with increasing bilateral trade retaliation between the US and China. Japan and ROW have welfare losses of 18.028 billion dollars and 104.276 billion dollars respectively when the bilateral tariff rate is 100% in both US and China. The welfare change in the EU is small, a 3.089 billion dollar gains in for step 1 and a -3.404 billion dollar loss for step 8.

These welfare changes are collinear with terms of trade effects generated by the model. Table 2 also reports the terms of trade effects for the bilateral trade retaliation cases. The US always receives a terms of trade gain, because bilateral tariff retaliation diverts US expenditures to US goods. Other regions suffer a deterioration in there terms of trade, but the result is sensitive to the specifications of demand elasticities.

Changes in trade flows by region from the bilateral trade retaliation between US and China are reported in Table 3. Bilateral trade between U.S. and China decrease significantly. In step 4, when the bilateral tariff rate is 50% in both US and China, China's exports to U.S fall 21.85% percent, and U.S.'s exports to China fall 25.72%. In step 8, when the bilateral tariff rate is 100% in both US and China, China's exports to the U.S fall 34.75% percent, U.S.'s exports to China fall 40.05%. U.S.'s exports to other regions also fall with increasing retaliation. World trade also shrinks with increasing bilateral retaliation.

3. Analyzing Bilateral Retaliation in a Model with Trade Surplus Adjustments

An Endogenous Trade Surplus Model

The traditional Armington model set out above can be extended on to incorporate non neutral monetary and exchange rate policy as in Whalley & Wang(2011). This endogenous trade surplus model reflects a managed Chinese exchange rate and a monetary regime with a peg and RMB inconvertibility. Monetary policy is non accommodative to the chosen fixed exchange rate, and the excess supply of foreign exchange is accommodated by the Central Bank as additions to reserves .

This model characterizes reserve accumulation as driven by government or central bank policy which sets non accommodative monetary policy given the exchange rate and simply absorbs any excess supply of foreign currency it is offered at the set exchange rate maintaining inconvertibility of domestic currency. This model embodies a simple monetized extension of a conventional trade model but with the added structure that the trade surplus is endogenously determined. The model we use specifies a monetary regime using monetary non-neutralities reflecting the actual Chinese exchange rate and monetary regime. Given a large trade surplus in China, if this is endogenously determined in the model the effects of bilateral trade retaliation can appear as quite different.

On the demand side of the model, utility functions are same as in the Armington model with a 3 level nested CES form. To extend the traditional Armington trade model to incorporate a endogenously determined trade surpluses (and deficits for others) we use a simple monetized extension to a pure barter trade model with a transactions demand for money and unitary velocity of circulation. In the 5 region model with the U.S, China, EU, Japan and rest of the world, we assume that there are two kinds of currencies: the Renminbi and the US dollar. The US, EU ,Japan and ROW are assumed to use the US dollar as their currencies, and the money supply of the US meets the money demand of US, EU, Japan and ROW.

This two currency treatment is adopted for convenience, and to help us focuses on the role of an endogenously determined Chinese trade surplus can play in assessing the impacts of bilateral retaliation. China is thus assumed to fix its exchange rate and has non-accommodative monetary policy, US is assumed to fix its money stock.

For country 1 (China), maximizing country 1's utility, ie:

$$\max U_m\{C_m(X_1^{m1}, X_1^{m2}, X_1^{m3}, X_1^{m4}, X_1^{m5}, X_2^{m1}, X_2^{m2}, X_2^{m3}, X_2^{m4}, X_2^{m5},)\} \qquad (8)$$

$$\text{s.t. } \sum_i p_i^{mm} X_i^{mm} + \sum_i \bar{e} p_i^{mj} X_i^{mj} = I_m$$

$$I_m = \sum_i P_i^m Y_i^m + \bar{e} S_m + TR_m \qquad m = 1,\ j = 2,3,4,5, i = 1,2 \qquad (9)$$

yields demands, C_m is the nested CES composite of demands in region m, X_i^{mj} is region *m*'s consumption of goods *i* produced in region j, $\bar{e}$ is the fixed exchange rate, S_m is the trade surplus of region m, and TR_m is the tariff revenue in region m.

For other regions (regions 2,3,4,5 are referred as US, EU, Japan, ROW) that use the US dollar as their currency, the demand functions are derived from:

$$\max U_m\{C_m(X_1^{m1}, X_1^{m2}, X_1^{m3}, X_1^{m4}, X_1^{m5}, X_2^{m1}, X_2^{m2}, X_2^{m3}, X_2^{m4}, X_2^{m5},)\} \qquad (10)$$

$$\text{s.t. } \sum_i p_i^{mm} X_i^{mm} + \sum_i \frac{1}{\bar{e}} p_i^{mj} X_i^{mj} = I_m$$

$$I_m = \sum_i P_i^m Y_i^m + S_m + TR_m \qquad m = 2,3,4,5,\ j = 1,2,3,4,5, i = 1,2, m \neq j \qquad (11)$$

From the 2009 data used for calibration the model, the surplus countries are region 1(China), region 4(Japan) and region 5 (ROW), while the deficit countries are region 2(U.S) and region 3(EU). The sum of trade surpluses across all regions is zero:

$$\sum_m S_m = 0 \qquad m = 1,2,3,4,5 \qquad (12)$$

We assume the money supplies of region1 (China) and region 2 (US) are fixed at $\overline{M_1}$ and $\overline{M_2}$. For simplicity, each of these two regions is assumed to have a constant unit velocity in their transactions demand for money. In equilibrium, this implies:

$$\sum_i P_i^1 Y_i^1 = \overline{M_1} \qquad (13)$$

$$\sum_i P_i^2 Y_i^2 + \sum_i P_i^3 Y_i^3 + \sum_i P_i^4 Y_i^4 + \sum_i P_i^5 Y_i^5 + S_2 + S_3 = \overline{M_2} \qquad (14)$$

where P_i^j is the seller's price of goods *i* produced in region j, Y_i^j is the output of goods *i* produced in region *j*.

The production functions are the same as in the traditional Armington model.

Calibration and Conterfactual Analysis

We use the same data set and elasticities in calibration with this extended model as in the traditional Armington model for our central case analyses .To convert Chinese data into units consistent with other regions data in $, we construct an artificial Chinese currency unit, RMB^*, which implies that 1 unit of RMB^* equals 1 US dollar. To do this, ,we set as $RMB^* = 6.83RMB$, the exchange rate of the US dollar to Renminbi in 2009. This convention is adopted so that in calibration all equilibrium prices will be unity for both Chinese and other regions goods and factors. We then examine a similar sequence of bilateral retaliatory steps.

Table 4
Base Case Data in 2009 in Calibrating the Endogenous Trade Surplus Model

	China (in billion RMB*[1])	US (in billion US $)	EU (in billion US $)	Japan (in billion US $)	ROW (in billion US $)	Total (in billion US $)
Value of Production	4984.730	14256.300	16388.147	5067.530	17531.493	58228.20
Surplus	-196.091	550.432	113.889	-25.074	-443.156	0
Money Supply	4984.730	53907.791				

Results

Table 5 reports the welfare impacts of bilateral trade retaliation in the endogenous trade surplus model. Results are strikingly different with the exogenous trade surplus model. The deficit regions, US and EU have welfare losses in most cases, while the surplus region, China and ROW have welfare gains. Japan has small gains or losses under different levels of bilateral retaliation between US and China. Bilateral trade retaliation reduces global imbalances, as both the US and EU trade deficits falls and these two countries suffer welfare losses. China and ROW have large trade surplus in base case, and bilateral trade retaliation reduces their surplus, and they receive welfare gains unlike in the traditional model. Japan has a relatively small surplus in the base case, and the sign of the effects of bilateral retaliation on Japan's welfare varies. China receives terms of trade gains with increasing bilateral retaliation, US receives terms of trade gains, while the EU, Japan and ROW experience terms of trade losses in most cases.

[1] We construct an artificial Chinese currency unit, RMB*, we set it as RBM*=6.83 RMB, which is the exchange rate of the US dollar to Renminbi in 2009, this implies that 1 unit RMB^* equals 1 US dollar. This convention is adapted so that in calibration all equilibrium prices will be unity.

Table 5

Welfare Impacts of a bilateral China-US Trade Retaliation Scenario in the Endogenous Trade Imbalance Model

(Central Case Specification)

	Step1	Step2	Step3	Step4	Step5	Step6	Step7	Step8
US tariff on Chinese goods	25%	25%	50%	50%	75%	75%	100%	100%
Chinese tariff on US goods	0%	25%	25%	50%	50%	75%	75%	100%
Welfare impacts (EVs in $billion)								
US	-70.131	-2.757	-56.554	-0.353	-43.872	4.673	-31.842	11.097
China	26.448	11.332	31.735	17.753	34.324	21.276	35.214	22.949
EU	-28.632	-15.297	-37.852	-26.881	-45.543	-36.148	-52.107	-43.842
Japan	5.019	-0.624	2.88	-1.921	0.664	-3.559	-1.579	-5.377
ROW	84.219	21.007	83.582	30.841	80.004	34.376	74.518	34.063
Total	16.923	13.661	23.791	19.439	25.577	20.618	24.204	18.89
Percentage change in terms of trade								
US	-0.2048	1.4543	1.5041	2.9472	3.1385	4.4294	4.7052	5.8819
China	-0.437	0.1077	-0.1898	0.2747	0.0615	0.4707	0.3129	0.6813
EU	-0.652	-0.6102	-1.1635	-1.1395	-1.6254	-1.612	-2.0482	-2.0415
Japan	0.2416	-0.3413	-0.2109	-0.7156	-0.6501	-1.1001	-1.0755	-1.4846
ROW	0.5623	-0.1862	0.1915	-0.4451	-0.1785	-0.7373	-0.5433	-1.0444

The results reflect the feature that in the trade imbalance endogenous model, countries running surplus receive paper in return for put of their export of goods and the paper does not directly yield welfare. Trade policy which reduces trade surplus thus yields welfare gains to surplus countries and welfare losses to deficit country.

The changes in trade flows by region that results from the bilateral trade retaliation between US and China are shown in Table 6. Bilateral trade between U.S. and China decreases significantly. For step 4, when the bilateral tariff rate is 50% in both the US and China, China's exports to U.S fall by 21.15%, U.S. exports to China fall by 19.68%. For step 8, when the bilateral tariff rate is 100% in both US and China, China's exports to U.S fall by 33.26% percent, and U.S. exports to China fall by 31.36%. U.S. exports to other regions also fall with increasing retaliation. World trade shrinks with increasing bilateral retaliation, similar to the Armington model.

Table 6
Changes in Trade Flows from Trade Retaliation in the Extended Model (Central Case Specification)

	US tariff on Chinese goods	Chinese tariff on US goods	Exports by	Imports by US	China	EU	Japan	ROW
Step 1	5%	0%	US	0	0.15%	-0.94%	0.77%	1.41%
			China	-14.47%	0	-0.93%	0.77%	1.27%
			EU	-4.10%	0.04%	0	0.63%	1.19%
			Japan	-3.95%	0.46%	-0.64%	0	1.58%
			ROW	-2.98%	0.39%	-0.88%	0.95%	0
Step 2	25%	25%	US	0	-11.34%	-0.48%	0.02%	0.44%
			China	-12.30%	0	-1.10%	-0.58%	-0.10%
			EU	-1.69%	-1.14%	0	-0.86%	-0.43%
			Japan	-1.93%	-1.03%	-1.28%	0	-0.30%
			ROW	-0.49%	-1.33%	-1.16%	-0.67%	0
Step 3	50%	25%	US	0	-11.13%	-1.23%	0.59%	1.51%
			China	-22.82%	0	-1.92%	-0.11%	0.79%
			EU	-4.97%	-1.10%	0	-0.53%	0.35%
			Japan	-5.14%	-0.69%	-1.92%	0	0.79%
			ROW	-2.79%	-1.02%	-1.95%	-0.08%	0
Step 4	50%	50%	US	0	-19.68%	-0.86%	-0.07%	0.69%
			China	-21.15%	0	-2.09%	-1.26%	-0.36%
			EU	-2.94%	-2.19%	0	-1.81%	-1.02%
			Japan	-3.44%	-2.04%	-2.48%	0	-0.80%
			ROW	-0.65%	-2.57%	-2.20%	-1.47%	0
Step 5	75%	50%	US	0	-19.46%	-1.49%	0.36%	1.55%
			China	-29.24%	0	-2.83%	-0.96%	0.30%
			EU	-5.68%	-2.17%	0	-1.64%	-0.48%
			Japan	-6.16%	-1.76%	-3.10%	0	-0.02%
			ROW	-2.52%	-2.32%	-2.92%	-1.09%	0
Step 6	75%	75%	US	0	-26.14%	-1.18%	-0.22%	0.84%
			China	-27.90%	0	-2.98%	-1.98%	-0.71%
			EU	-3.91%	-3.18%	0	-2.77%	-1.67%
			Japan	-4.69%	-3.01%	-3.60%	0	-1.40%
			ROW	-0.64%	-3.74%	-3.15%	-2.31%	0
Step 7	100%	75%	US	0	-25.93%	-1.72%	0.12%	1.55%
			China	-34.37%	0	-3.65%	-1.79%	-0.20%
			EU	-6.27%	-3.16%	0	-2.71%	-1.29%
			Japan	-7.05%	-2.78%	-4.19%	0	-0.81%
			ROW	-2.21%	-3.53%	-3.82%	-2.07%	0
Step 8	100%	100%	US	0	-31.36%	-1.45%	-0.41%	0.91%
			China	-33.26%	0	-3.80%	-2.71%	-1.09%
			EU	-4.70%	-4.11%	0	-3.73%	-2.35%
			Japan	-5.75%	-3.94%	-4.65%	0	-2.05%
			ROW	-0.51%	-4.85%	-4.03%	-3.16%	0

4. Sensitivity Analysis

Results from both exogenous trade surplus model and endogenous trade surplus model change as the parameter values used for the functions adopted vary. The key parameters are the substitution elasticities between domestic and foreign goods (σ_d^2), and the elasticity of substitution between imported goods (σ_d^3). Tables 7 and 8 give sensitivity results for welfare and terms-of –trade impacts for 3 alternative elasticity specifications of both models.

In the exogenous trade surplus model, in the central case, we use the settings $\sigma_d^2 = 2.0$, $\sigma_d^3 = 0.5$. In the first sensitivity variation we set $\sigma_d^2 = 2.0$, $\sigma_d^3 = 2.0$, Increasing the substitution elasticity between imported goods, the welfare gain to U.S. falls, and EU, Japan and ROW receive welfare gains. The welfare loss to China increases a little. For the second sensitivity variation are set $\sigma_d^2 = 1.0$, $\sigma_d^3 = 2.0$. Here, the welfare gain to the U.S. falls further, and with increasing tariff retaliation, the U.S. receives a welfare loss, while the EU, Japan and ROW receive gains. China suffers further welfare losses. These welfare changes are collinear with terms of trade effects. Decreasing substitution elasticities between domestic and foreign goods, the diversion of US's import demand to domestic consumption is less, and with a higher elasticity of substitution between imports, US demand is more heavily diverted to EU, Japan, and ROW goods.

In endogenous trade surplus model, sensitivity results are similar to those from the exogenous trade surplus model. Decreasing elasticities between domestic and imported goods and increasing of substitution of imported goods , the U.S suffers welfare losses and a deterioration in their terms of trade, while the surplus regions of Japan and ROW gain. China suffers a further welfare losses and deterioration in their terms of trade. The EU also suffers a welfare losses.

When elasticities between domestic and imported goods are low and substitution elasticities among imported goods are high, (eg. $\sigma_d^2 = 1.0$, $\sigma_d^3 = 2.0$) , increasing bilateral US-China retaliations suggests that U.S. may lose in both exogenous and endogenous trade surplus model. In Table 7 and 8, when both U.S and China have bilateral tariff rates as high as 100% (in case 8), the U.S. suffers a welfare losses and a deterioration of terms of trade in both models. Because a tariff by the US against China is effectively a tax on US exports to China, the gains to the US alone from trade diversion will be smaller if the substitutions elasticities between imports are high. The major loser may thus be the U.S.

Table 7 Sensitivity Analysis: Welfare Impacts of Possible US-China Trade Retaliation (EV $billion)

	US tariff on Chinese goods	Chinese tariff on US goods	Traditional Armington Model					Endogenous Trade Imbalance Model				
$\sigma_d^2 = 2.0$ $\sigma_d^3 = 0.5$			US	China	EU	Japan	ROW	US	China	EU	Japan	ROW
Step1	25%	0%	67.215	-39.021	3.089	-5.098	-29.580	-70.131	26.448	-28.632	5.019	84.219
Step2	25%	25%	59.753	-18.744	-0.666	-5.278	-31.176	-2.757	11.332	-15.297	-0.624	21.007
Step3	50%	25%	112.222	-50.767	1.741	-9.669	-56.178	-56.554	31.735	-37.852	2.880	83.582
Step4	50%	50%	106.550	-34.908	-1.509	-9.943	-58.261	-0.353	17.753	-26.881	-1.921	30.841
Step5	75%	50%	149.314	-62.158	0.453	-13.832	-80.063	-43.872	34.324	-45.543	0.664	80.004
Step6	75%	75%	144.798	-49.175	-2.437	-14.158	-82.394	4.673	21.276	-36.148	-3.559	34.376
Step7	100%	75%	180.723	-72.962	-0.786	-17.671	-101.817	-31.842	35.214	-52.107	-1.579	74.518
Step8	100%	100%	177.007	-61.989	-3.404	-18.028	-104.276	11.097	22.949	-43.842	-5.377	34.063
$\sigma_d^2 = 2.0$ $\sigma_d^3 = 2.0$			US	China	EU	Japan	ROW	US	China	EU	Japan	ROW
Step1	25%	0%	37.814	-39.088	5.804	-0.508	-6.636	-199.621	53.003	-49.407	10.667	196.883
Step2	25%	25%	25.931	-28.877	4.058	0.159	0.215	-134.430	33.798	-33.239	7.754	138.189
Step3	50%	25%	38.823	-52.394	7.672	-0.059	-2.961	-249.825	61.723	-58.946	13.386	241.585
Step4	50%	50%	32.187	-50.483	6.674	0.308	0.762	-214.311	47.051	-50.213	11.830	210.017
Step5	75%	50%	34.456	-65.500	9.055	0.223	-0.771	-288.694	63.525	-65.294	15.185	271.265
Step6	75%	75%	30.421	-66.591	8.436	0.445	1.467	-267.320	52.093	-60.059	14.261	252.407
Step7	100%	75%	27.982	-76.668	10.079	0.424	1.616	-318.901	62.599	-69.651	16.429	291.744
Step8	100%	100%	25.364	-78.845	9.670	0.570	2.207	-305.043	53.457	-66.265	15.837	279.579
$\sigma_d^2 = 1.0$ $\sigma_d^3 = 2.0$			US	China	EU	Japan	ROW	US	China	EU	Japan	ROW
Step1	25%	0%	33.863	-48.652	7.881	0.425	3.423	-238.501	45.366	-65.698	9.031	257.309
Step2	25%	25%	14.368	-39.629	3.864	1.131	22.619	-198.473	33.837	-53.375	7.872	221.407
Step3	50%	25%	22.849	-69.060	8.464	1.599	28.816	-345.942	58.888	-88.782	12.911	362.854
Step4	50%	50%	11.781	-68.417	6.184	2.013	40.133	-328.062	48.800	-83.095	12.443	348.052
Step5	75%	50%	9.401	-87.264	9.011	2.454	46.887	-427.256	63.893	-104.295	15.579	434.809
Step6	75%	75%	2.558	-89.665	7.605	2.720	54.189	-419.623	55.389	-101.616	15.408	429.145
Step7	100%	75%	-4.479	-102.317	9.412	3.106	60.676	-490.433	65.082	-115.269	17.509	486.493
Step8	100%	100%	-8.999	-105.770	8.489	3.296	65.712	-487.896	57.928	-114.082	17.479	485.133

σ_d^2 : elasticity of substitution of between domestic and foreign products

σ_d^3 : elasticity of substitution of imported goods.

Table 8 Sensitivity Analysis: Percentage Change in Terms of Trade

	US tariff on Chinese goods	Chinese tariff on US goods	Traditional Armington Model					Endogenous Trade Imbalance Model				
$\sigma_d^2 = 2.0$ $\sigma_d^3 = 0.5$			US	China	EU	Japan	ROW	US	China	EU	Japan	ROW
Step1	25%	0%	4.143	-2.595	-0.018	-0.550	-0.396	-0.2048	-0.4370	-0.6520	0.2416	0.5623
Step2	25%	25%	3.444	-0.896	-0.313	-0.704	-0.621	1.4543	0.1077	-0.6102	-0.3413	-0.1862
Step3	50%	25%	6.970	-2.999	-0.355	-1.190	-0.971	1.5041	-0.1898	-1.1635	-0.2109	0.1915
Step4	50%	50%	6.425	-1.537	-0.614	-1.338	-1.178	2.9472	0.2747	-1.1395	-0.7156	-0.4451
Step5	75%	50%	9.519	-3.308	-0.668	-1.778	-1.494	3.1385	0.0615	-1.6254	-0.6501	-0.1785
Step6	75%	75%	9.075	-2.013	-0.903	-1.921	-1.688	4.4294	0.4707	-1.6120	-1.1001	-0.7373
Step7	100%	75%	11.848	-3.545	-0.964	-2.324	-1.977	4.7052	0.3129	-2.0482	-1.0755	-0.5433
Step8	100%	100%	11.476	-2.374	-1.179	-2.462	-2.159	5.8819	0.6813	-2.0415	-1.4846	-1.0444
$\sigma_d^2 = 2.0$ $\sigma_d^3 = 2.0$			US	China	EU	Japan	ROW	US	China	EU	Japan	ROW
Step1	25%	0%	2.108	-2.960	0.371	0.150	0.160	-2.920	-1.289	-0.501	0.520	1.825
Step2	25%	25%	1.085	-2.143	0.306	0.186	0.246	-2.368	-0.961	-0.288	0.437	1.373
Step3	50%	25%	2.310	-3.921	0.536	0.284	0.357	-3.933	-1.642	-0.543	0.716	2.353
Step4	50%	50%	1.738	-3.461	0.499	0.304	0.404	-3.644	-1.467	-0.426	0.674	2.110
Step5	75%	50%	2.492	-4.602	0.651	0.372	0.484	-4.423	-1.769	-0.501	0.820	2.555
Step6	75%	75%	2.142	-4.321	0.629	0.385	0.513	-4.423	-1.769	-0.501	0.820	2.555
Step7	100%	75%	2.627	-5.092	0.735	0.435	0.574	-5.046	-2.031	-0.590	0.931	2.940
Step8	100%	100%	2.399	-4.908	0.720	0.444	0.593	-4.939	-1.964	-0.545	0.917	2.847
$\sigma_d^2 = 1.0$ $\sigma_d^3 = 2.0$			US	China	EU	Japan	ROW	US	China	EU	Japan	ROW
Step1	25%	0%	1.772	-4.092	0.645	0.355	0.556	-6.619	-2.463	-1.413	0.287	4.342
Step2	25%	25%	0.037	-3.580	0.508	0.415	1.074	-6.558	-2.278	-1.109	0.360	4.048
Step3	50%	25%	0.801	-6.034	0.906	0.647	1.523	-10.269	-3.643	-1.888	0.504	6.581
Step4	50%	50%	-0.176	-5.812	0.831	0.688	1.842	-10.398	-3.596	-1.750	0.554	6.521
Step5	75%	50%	0.105	-7.389	1.095	0.852	2.210	-12.732	-4.442	-2.221	0.641	8.142
Step6	75%	75%	-0.495	-7.294	1.050	0.881	2.423	-12.911	-4.448	-2.158	0.675	8.176
Step7	100%	75%	-0.452	-8.363	1.233	1.002	2.728	-14.497	-5.013	-2.463	0.734	9.284
Step8	100%	100%	-0.846	-8.330	1.205	1.024	2.880	-14.680	-5.041	-2.438	0.759	9.356

σ_d^2 : elasticity of substitution of between domestic and foreign products

σ_d^3 : elasticity of substitution of imported goods.

5. Concluding Remarks

This paper assesses the potential consequences of a US-China trade retaliation scenarios on trade flows and welfare using two related numerical general equilibrium trade models involving five major world trading areas. The first model is a conventional trade Armington model with an exogenous trade surplus. The second model incorporates non neutral monetary and endogenous trade imbalances structure. We calibrate these models to 2009 data, and using the calibrated parameters ,we analyze the impacts of progressively increasing bilateral trade retaliation between US and China.

Results from the first model using a central case elasticity specification suggest that US as the large country would receive both a welfare and terms of trade gain under bilateral U.S and China retaliation. Bilateral tariff retaliation diverts US expenditures to US's goods. Other regions suffer a deterioration in both welfare and the terms of trade despite a preferential trade diversion effect .Bilateral trade between U.S. and China decreases significantly. World trade also shrinks with increasing bilateral retaliation.

Results from the endogenous trade imbalances model using the central case model specification suggest that in contrast US and EU (the deficit regions) will experience welfare losses while the surplus regions, China and ROW, have welfare gains, Japan experiences small gains or losses under different levels of bilateral retaliation between US and China. China receives terms of trade gains with increasing bilateral retaliation. The US receives terms of trade gains, while the EU, Japan and ROW experience terms of trade losses in most cases.

Elasticity values in both models affect the results. The U.S lose in both the traditional Armington and endogenous trade surplus models when the bilateral tariff rates as high as 100% ,since a tariff by the US against China is effectively a tax on US exports to China. The EU and Japan can gain from trade diversion if the substitution elasticities among imports are high. The largest cost will be borne by the US and China in lost exports, lowered terms of trade and adjustment costs at home. With sequential tariff retaliation, Japan, EU and ROW progressively gain preferential access to US and Chinese markets.

References

Hamilton, B., and J. Whalley,1983, “Optimal Tariff Calculations in Alternative Trade Models and Some Possible Implications for Current World Trading Arrangements”. Journal of International Economics, 15, 323-348.

Hertel, T., R. McDougall, B.Narayanan and A.H. Aguiar,2009, “GTAP 7 Data Base Documentation - Chapter 14: Behavioral Parameters”, access at https://www.gtap.agecon.purdue.edu/resources/download/4184.pdf

Johnson, H. G. ,1953, “Optimum Tariffs and Retaliation”. Review of Economic Studies 21, 142-153.

Jomini, P., J.F. Zeitsch, R. McDougall, A. Welsh, S. Brown, J.Hambley and J. Kelly.,1991,“SALTER: A General Equilibrium Model of the World Economy”, Vol. 1. Model Structure, Data Base, and Parameters. Canberra, Australia: Industry Commission.

Kindleberger ,Charles P., 1970,“Power and Money: The Economics of International Politics and the Politics of International Economics”. New York and London: Basic Books.

Kuga, K. 1973, “Tariff Retaliation and Policy Equilibrium. Journal of International Economics 3, 351-366.

Krugman, Paul R., 1991,“Is Bilateralism Bad? ” in Elthanan Helpman and Assaf Razin, eds., International trade and trade policy. Cambridge, MA: MIT Press, pp. 9-23.

Liu, J., Y. Surry, B. Dimaranan and T. Hertel,1998, “CDE Calibration,” Chapter 21 in Robert McDougall, Aziz Elbehri, and Truong P. Truong. *Global Trade, Assistance and Protection: The GTAP 4 Data Base*, Center for Global Trade Analysis, Purdue University, West Lafayette, Indiana.

National Bureau of Statistics, PRC, “Chinese Statistical Yearbook”, www.stats.gov.cn

Whalley,J and L. Wang,2011, “The Impacts of Renminbi Appreciation on Trade Flows and Reserve Accumulation in a Monetary Trade Model”, Economic Modelling,Volume 28, Issues 1-2, January-March 2011, pp. 614-621.

.