Regional Integration and Global Responses to US Protectionism

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Summary

US trade policy in the Trump administration is protectionist, raising tariffs outside of WTO rules, threatening trade wars, withdrawing from existing trade agreements, and negotiating new bilateral trade deals rather than free trade agreements. The reaction of the rest of the world has been to support the WTO rules-based trading system and to pursue new and expanded regional trade agreements that do not include the US. While some regions have retaliated against the US, none have engaged in a global trade war. The result is likely to be US disengagement from the world trading system, with countries diverting trade around the US.

Currently, international trade is dominated by three interconnected regional economies (ICREs): Europe, East and Southeast (E&SE) Asia, and North America. They each account for about a quarter of global GDP but differ in their shares of global exports. Europe has the largest share (37%), followed by E&SE Asia (28%) and North America (14%). The implication is that the US is no longer hegemonic in the world trading system and that the world can continue regional integration and globalization within the WTO system without the US.

We use a global computable general equilibrium (CGE) model to analyze changes in trade and production patterns that may result from US protectionist policies. We consider several scenarios of US policies and response by trading partners. We find that adjustment to US disengagement is feasible—the changes in trade shares as countries divert trade are modest and achievable, with very little impact on the volume of global trade. If the US engages in trade wars with major partners, the best response for other trade partners is to sit out the trade war, accept higher US tariffs, and gain markets from global trade diversion around the US. In a trade war between the US and its major partners, prices in world markets change and turn against the US. Prices of US exports fall relative to import prices, reflecting its smaller share of global trade and hence market power. In this environment where there are policy wedges between prices of imports and exports, standard measures of the real exchange rate no longer provide a good summary measure of what is driving domestic commodity markets—the large changes in relative prices are hidden by any single aggregate measure.

The US loses in all trade-war scenarios, with declines in welfare (aggregate final demand, which equals GDP + imports – exports) arising from changes in world prices and from efficiency losses due to market distortions and adverse trade-productivity links. Because of indirect effects, widespread tariffs fail to benefit the protected sectors, reducing both imports and exports and shifting labor and capital to nontraded sectors—a fallacy of composition in a widespread protectionist trade policy.

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I. Introduction

While current US trade policy appears contradictory and incoherent, there is a recurring thread in recent actions and the public statements of various officials, including the President, that suggests support for a long-run strategy of bringing manufacturing supply chains back to the US by protecting domestic markets from imports.[1] The US is essentially seeking to withdraw from the globalization process that has enhanced productivity and growth in many sectors over the past thirty years.[2]

The approach that the US has taken is to impose high tariffs on a variety of commodities outside of the World Trade Organization (WTO) framework, and to threaten more in the future. Major US trading partners have responded by retaliating, also outside of the WTO. Tentative truces are in place with major trade partners (e.g., Japan and the European Union) and the only trade war currently underway is with China. The new US approach to trade policy is to negotiate bilateral trade deals with elements of managed trade rather than pursue broader free trade agreements, and to include foreign policy objectives in trade agreements.

The US policy of operating outside of the WTO rules has led to growing concern that the US is seeking to undermine and perhaps destroy the rules-based trading system centered on the World Trade Organization (WTO), returning world trade to the protectionist and chaotic conditions of the 1930s.[3] US withdrawal from participation in global trade under WTO rules would represent a sea change in the workings of the global economy. Can the rest of the world maintain the momentum for global integration and adapt, with little cost, to a reduced role of the US in world trade? Or will US withdrawal bring down the entire rules-based global system?

Tentative answers to these two questions are "yes" and "no". Experience so far is that the rest of the world is moving ahead with many new regional trade agreements, without the US, supporting deeper integration and the rules-based system, except in their relations with the US. Powerful economic forces have been at work over the post war period expanding trade and fostering economic integration that provide the basis for an optimistic view of the world's ability to continue these trends without continued US participation.[4]

In this paper, we first examine the broad trends in global trade in the post-war period, focusing on trends in regional as well as global integration. We then consider long-run scenarios of increased US import protection and of possible reactions by the rest of the world. We consider three questions: (1) Is a policy of trade diversion away from the US toward other markets

[1] Recent US tariff increases under Sections 301 (unfair trade) and 232 (national security), and public statements by President Trump, Wilbur Ross and Peter Navarro, are consistent with this view. Ross and Navarro have explicitly stated that the goal is to support US manufacturing by bringing supply chains back to the US.

[2] See for example, Baldwin (2016). For a timeline on US trade policy in the Trump administration, see Bown and Kolb (2018).

[3] See Posen (2018) in Foreign Affairs for a discussion of scenarios of US withdrawal from the global trading system.

[4] See Sandbu (2018) who argues for this view.

feasible? (2) What are appropriate policy choices for countries in this new global environment? (3) What is the impact on the protected sectors in the US? Our results, using a global computable general equilibrium (CGE) simulation model, suggest that: (1) global adjustment to US disengagement is feasible—the required changes in trade shares are modest and achievable, with little impact on the volume of global trade; and (2) if the US engages in trade wars with its major partners, the best response for other trade partners is to sit out the trade war, accept higher US tariffs, and gain markets from global trade diversion around the US; and (3) there is a fallacy of composition in import protection—widespread tariffs have indirect effects such that they end up damaging the protected sectors.

II. Post-War Evolution of Interconnected Regional Economies (ICREs)

In the immediate period after World War II, the world economy was dominated by the US, which had the largest economy and a hegemonic position in world trade. With post war recovery, Europe grew rapidly and moved from being a region of warring states to become an interconnected regional economy (ICRE) characterized by deep economic, social, and institutional integration.[5] An ICRE can be viewed as a collection of countries with a deep network of trade relations and higher trade shares within the region than with countries outside the region.[6] The formation of ICREs pre-dates any explicit regional trade agreements. The global economy can be characterized as having three ICREs: NAFTA, Europe and East & South East Asia.[7]

In Europe, institutional integration followed economic integration. Deepening of trade relations preceded by many years the formal adoption of regional trade agreements such as the Treaty of Rome (1957) and the formation of the European Union (1992). Economics drove agreements rather than vice versa. Today, Europe is a tightly integrated ICRE whose share of global GDP is as large as NAFTA, and which accounts for a much larger share of global trade than NAFTA (Table 1).

In North America, economic integration of Canada, Mexico and the US proceeded rapidly after World War II—indeed, preceded the war. From data on trade shares, it is evident that NAFTA was fully formed as an ICRE by the 1960s, thirty years before the NAFTA agreement was signed. As with the EU, agreements followed the economic trends, not led them.[8]

In East Asia, rapid growth by a group of high performing East Asian economies (Hong Kong, Indonesia, Japan, Malaysia, the Republic of Korea, Singapore, Taiwan, and Thailand) started in the mid-1960s and was described as the Asian Miracle. In the 1980s, with the addition

[5]The description of ICREs in this section draws on the discussion in Robinson and Thierfelder (2019).

[6] Finding ICREs using data on bilateral trade flows involves searching for high trade-share "clusters" in large country-by-country trade matrices. Technically, it involves a mathematical procedure (integer programming) to define and determine "membership" in clusters in large trade matrices.

[7] Some countries have not aligned into an ICRE and are aggregated into the group "All Other" in the tables. For the composition of the regions, see Table A3. E&SE Asia includes Japan, Korea, China, high-income Asia, and low-income Asia.

[8] See chapter 2 in The Global Economic Prospects, World Bank (2005) for description of the emergence of ICREs.

of Australia and New Zealand (after the UK joined the EU) and China (with its new policy of reform and opening to trade), and others, the region evolved into an East and South East Asia (E&SE Asia) ICRE. As with the EU and NAFTA, integration was driven by economic trends, preceding the development of formal regional trade agreements (RTAs) by decades.

This history suggests that policy follows trade—regional trade agreements (RTAs) followed trade trends rather than led them. The multiplicity of RTAs can be categorized into four types:

- ICRE formalization (e.g. EU, NAFTA agreements)
- ICRE accession/expansion (e.g. EU expansion)
- ICRE consolidation (e.g. EU complete market, elements of the Comprehensive and Progressive Agreement for Trans-Pacific Partnership, CPTPP)
- Market access (e.g. many bilateral agreements and components of multilateral RTA agreements such as CPTPP)

Today, E&SE Asia has an aggregate GDP equal to that of NAFTA and Europe, and accounts for a much higher share of global trade than NAFTA (Table 1). In terms of global trade, Europe is the largest player (37% of global exports), followed by E&SE Asia (28%), and then NAFTA, a far third (14%). The remaining countries, in "All Other," have diversified trade patterns, are not integrated into an ICRE, and account for 22% of global exports.[9]

Table 2 shows the export shares by major member countries to the ICREs. For each ICRE, the within-region trade share is larger than the share of trade between the ICRE and any other region. Within NAFTA, Canada and Mexico have very high within-region export shares, exporting much less to other regions. For NAFTA, the US is the major platform for exports outside the region, drawing heavily on imported inputs from Mexico and Canada.

NAFTA exports outside its region are split fairly evenly across destinations, while EU exports to NAFTA are a smaller share of its total exports than is the share of US exports going to Europe. The implication is that NAFTA and the US are more dependent on the European market than is Europe on the US market.

E&SE Asia also divides it exports out of its region evenly across the other regions. Within E&SE Asia, all member countries have higher export shares within the region than to any other region—all but China have within-region trade shares over 50%. NAFTA is a major destination, but only accounts for 19% of E&SE Asia exports.[10]

The conclusion from this look at global trade patterns and the emergence of ICREs is that the US is no longer hegemonic in the world economy. It is a large economy, and a significant market, but it is not in a position to dictate to the rest of the world about the operation of the global trading economy. While it would not be easy, and sectors deeply involved in US trade will

[9] Inter-state trade in the US is not counted as international trade, which biases the comparison with other regions. Netting out intra-regional trade in all three ICREs, NAFTA accounts for only about 15% of global inter-regional trade, close to its share of global trade (14a%, see Table A1).

[10] We report tables of ICRE production and trade for manufacturing sectors only in Robinson and Thierfelder (2019) and find similar patterns.

have a difficult adjustment, it would be feasible for the world to divert trade around the US if it moves to a high import protection industrial policy.

III. Modeling the Global Economy

The analysis in this paper is based on a structural simulation model of the global economy, a global computable general equilibrium (CGE) model that captures direct and indirect economic connections, within and between countries. The CGE model includes 16 countries/regions, 42 sectors, 5 labor categories, and 3 other factors of production (land, capital, and natural resources).[11] We use the model to do scenario analysis: "what if" simulations of the impact on the global economy of different trade policy regimes. The scenario results are not forecasts, but projections of alternative futures under different assumptions about US policy behavior and reactions by other countries.

Global CGE models have been widely used to analyze the effects of broad changes in trade policies, starting with the Tokyo Round of GATT negotiations, the Uruguay Round, the Doha Round, regional trade agreements (e.g., NAFTA, Trans Pacific Partnership—TPP), and now various trade war scenarios.[12] Many of these models incorporate features such as changes in productivity linked to participation in trade, imperfect competition, unemployment, foreign direct investment, macro shocks and "Smithian" efficiency gains arising from fine specialization (e.g. from value chains).[13] We follow this literature and assume that sectoral total factor productivity (TFP) is linked to trade.

The focus of this paper is on the implications of US withdrawal from international trade and on how the global economy reacts and adjusts. In all scenarios, we assume that the US shifts to an inward-looking, protectionist, trade policy regime, and it is successful. All countries return to full employment and full capacity utilization in the long run (around 10 years), adjusting to the new policy environment. US industry successfully produces substitutes for many imported intermediates and final goods.[14] We specify that trade diversion—switching trade across national markets—involves adjustment costs. The measure of welfare we use is aggregate final demand (Q), which is the total supply of goods and services available for use in the country.[15]

[11]The model is called GLOBE, data are an aggregation of the GTAP data base. See McDonald et al., (2007) and McDonald and Thierfelder (2016) for a description of the model and Aguiar (2106) for a description of GTAP data base, version 9. The country/region and sectoral aggregation is shown in Appendix tables.

[12] See Anderson and Martin (2005) for surveys of the earlier models. More recent example of models considering trade agreement and trade war scenarios include Petri and Plummer (2019), Freund *et al.* (2018), Balistreri *et al.* (2018), Robinson and Thierfelder (2018).

[13] See Cline (2004) and Winters (2004) for reviews of studies on the links between productivity and trade. See Robinson and Thierfelder (2002) for an early survey of how such features were used in global CGE models.

[14]These long-run scenarios are optimistic in that they do not consider short-run macro adjustment problems. For a short-to-medium term analysis of trade war scenarios with a macro model, see Zandi et al. (2018) and Zandi (2018).

[15]In international trade theory, aggregate final demand is called total "absorption" which equals real GDP plus imports minus exports.

Trade-focused CGE models incorporate two major mechanisms by which changes in trade policy work through the real economy: (1) intersectoral linkages through intermediate inputs (domestic and imported—national and international value chains) and (2) changes in the real exchange rate that affect the balance of prices between traded and nontraded goods. The first, intersectoral linkages, implies that changes in trade policy will reverberate across the entire economy, with indirect as well as direct effects. Sectors that use imported intermediates will be affected by changes in import prices, even if they do not directly engage in international trade, and export sectors with high direct and indirect import content will be damaged by import tariffs.

Second, trade policy can affect the real exchange rate, defined as the price of traded commodities relative to nontraded commodities. The imposition of a tariff on a single import will benefit domestic producers of a substitute for the import, will have little impact on prices in other sectors, and will have a negligible impact on the exchange rate. However, a policy of broad-based import protection, with high tariffs on many imports (e.g., a Smoot-Hawley tariff regime), will have repercussions that work through an appreciation of the real exchange rate, which will partly offset the impact of the tariff on import prices and will effectively tax exports.[16]

CGE models solve for equilibrium relative commodity and factor prices that "clear" all commodity and factor markets. They typically specify perfect competition and an "efficient" solution that captures comparative advantage gains from trade. The models only solve for relative prices and the solution values for all real variables are independent of any measure of the aggregate price level. A particular aggregate price index is specified as fixed, defining the benchmark against which relative prices are measured—typically some aggregate index such as the consumer price index.[17]

CGE models all include an equilibrating mechanism to determine the equilibrium balance of international trade in goods and non-factor services. The simplest specification is to assume that the trade balance is fixed exogenously and there is a real exchange rate variable (either explicit or implicit) whose value determines the average prices of traded good (exports and imports) relative to the average price of non-traded goods sold on the domestic market.[18] The mechanism can be described with a few equations: see the Box: "Simplified trade, production, and demand equations."

If the trade balance, B, and world prices, PWE and PWM, are all assumed fixed, then the exchange rate variable ER will adjust to ensure that the trade-balance constraint is met.[19] The

[16]This is the "Lerner effect" discussed in standard trade theory texts. With some simplifying assumptions, Lerner showed that a broad-based tariff is equivalent to a broad-based export tax. See, for example, Bhagwati and Srinivasan (1998), chapter 12.

[17]This price index is called the "numeraire" price index in the general equilibrium literature and defines a commodity bundle whose fixed composite price anchors the price system. Choosing different numeraire price indices will have no effect on the solution equilibrium values of all real variables.

[18] See Devarajan et. al (1993) for a description of the analytics of the real exchange rate in a CGE model. The specification of a fixed trade balance is discussed below.

[19] This simple specification describes a single country CGE model, in which the country is considered "small" on world markets so it faces fixed world prices. In a global model, the relationship between the exchange rate and the

equilibrating mechanism is through changes in relative prices PE/PD and PM/PD. If the exchange rate ER devalues (rises), then PE and the ratio PE/PD rise, encouraging a shift in production away from nontraded goods D and toward exports E. The price of imports PM and the ratio PM/PD also rises, shifting demand away from imports M and toward nontraded goods D.

Typically, either PX or PQ is set as the anchor price in CGE models, defining the numeraire. In many trade theory models and some empirical CGE models, the exchange rate ER is fixed as the anchor price. In this case, the equilibrating mechanism for achieving a fixed trade balance, B, is the same but the equilibrating variable is the domestic price of nontraded goods, PD. The prices PE and PM are now fixed, so the ratios PE/PD and PM/PD will vary with PD instead of ER.

trade balance constraint is more complex because world prices are endogenous; there is a bilateral PWE and PWM for all pairs of regions in the model

Box: Simplified trade, production, and demand equations

1. $PM = (1 + tm) \cdot ER \cdot PWM$ domestic price of imports
2. $PE = ER \cdot PWE$ domestic price of exports
3. $B = PWM \cdot M - PWE \cdot E$ balance of trade in foreign currency units
4. $E/D = f(PE/PD)$ export supply function (upward sloping)
5. $M/D = g(PM/PD)$ import demand function (downward sloping)
6. $PX \cdot X = PE \cdot E + PD \cdot D$ value of aggregate production
7. $PQ \cdot Q = PM \cdot M + PD \cdot D$ value of aggregate demand
8. $PQ \cdot Q = PX \cdot X + B \cdot ER$ expenditure/income balance

Where:

PWM is the world price of imports in foreign currency
PWE is the world price of exports in foreign currency
PM is the domestic price of imports
PE is the domestic (border) price of exports
PD is the domestic price of non-traded goods
ER is the exchange rate
tm is the tariff rate
E is real exports
M is real imports
D is real nontraded goods
B is the balance of trade (value of imports minus exports in foreign currency)
X is aggregate real production (GDP)
Q is aggregate real demand (or "absorption")
PX is the price of production (e.g., GDP or producer price index)
PQ is the price of aggregate demand (e.g., consumer price index)

In this model, the exchange rate variable is the real price-level-deflated (PLD) exchange rate, deflating by the price index chosen for the numeraire. With no change in tariffs, both PM and PE will be symmetrically affected by changes in the exchange rate. However, if a scenario involves a change in tariffs, then PM/PD will be affected both by the tariffs and by the exchange rate, putting a wedge between changes in domestic prices PE and PM. Changes in the exchange rate will no longer provide a clear indication of what is going on in commodity markets. In this situation, to understand the mechanisms at work in a protectionist trade policy regime, it is necessary to look at what happens to the PE/PD and PM/PD ratios separately.

In a multi-country model such as GLOBE the mechanisms at work are essentially the same, but world prices are not assumed fixed. Instead, world prices are assumed to vary to equilibrate supply and demand of commodities on world markets. Each country CGE model is specified with a country numeraire price (the consumer price index), and so still has a real exchange rate variable. The global model also solves only for relative world prices, so we must specify a global numeraire exchange rate index that anchors the system. We specify that a weighted average of exchange rates for a selected set of OECD countries (US, Japan, and Europe) is fixed. The country real exchange rate variables are essentially real effective exchange rates (REERs) as defined by the IMF, deflated by the producer price index.

In all scenarios, we assume no changes in the balances of trade of all countries, which must sum to zero across all regions.[20] Trade balances are largely determined by macro forces, operating in asset markets, while we focus on trade in commodities and non-factor services. CGE models do not include assets and so are not well suited to explore issues of asset flows—what we do not include we specify as exogenous.[21]

In a multi-country trade model, changes in aggregate welfare due to protectionism come from a variety of sources:

1. Allocative inefficiency—tariffs distort market incentives, leading to welfare-reducing changes in the structure of production, demand, and trade.
2. Trade/productivity links—a reduction in exports or imports leads to a loss of total factor productivity in the affected sectors. There are many examples of trade/productivity links considered in CGE models:
    a. Assumption that expanded import competition or increased exports causes firms to move to the efficiency frontier, or to kill off firms that are not on the frontier.[22] Some studies assume a frontier production function, others assume that inefficient firms exit, and efficient firms expand. This specification is often linked to an assumption of imperfect competition in the sector.

[20] This global adding-up constraint is a requirement in the model and in the base data.

[21]The standard version of the GTAP model does include trade balance changes based on changes in country-level returns to investment. This approach is discussed in USITC (2019), p 308, which describes analysis of the new USMCA agreement. The ITC decided to specify fixed country trade balances in their multi-country model, arguing that the overall trade balance is determined by macro forces. In a recent empirical analysis of the macroeconomic effects of tariffs, Furceri et al. (2019) argue that the trade balance is independent of tariffs and that the real exchange rate is the equilibrating variable.

[22]See for example Melitz (2008). A good example of the use of the Melitz model in a global CGE model is the Latorre et al. (2019) study of Brexit.

b. Assumption of a generic link between export/import shares and sector TFP, perhaps based on econometric studies of trade-productivity links. Also, a generic link because of an assumed benefit/cost from reduced/increased "uncertainty" or expansion/shrinking of supply chains. Increased sectoral exports can lead to productivity gains by expanding the market, generating increasing returns to scale through specialization—a mechanism first suggested by Adam Smith.
c. Assumption of sectoral economies of scale and imperfect competition. Expanded trade has a pro-competitive impact, allowing firms to take advantage of economies of scale.[23]

3. International terms-of-trade effects—tariffs distort global markets, causing changes in world prices (export prices compared to import prices) that affect welfare by changing the amount of exports required to buy a given amount of imports.
4. Adjustment costs from trade diversion—changes in tariffs and world prices lead to changes in the structure of trade for all countries: sectoral imports by country of origin and exports by country of destination. Trade-focused CGE models assume that traded goods are imperfect substitutes for domestically produced goods, and that traded goods are also differentiated by country of origin and destination. Trade diversion that changes the country-composition of trade—shifting trade to and from different national markets—is costly.

In our model, instead of trying to capture the variety of possible trade-productivity links, we follow Cline (2004) and specify a simple elasticity relationship between sectoral productivity and export performance. This specification is a reasonable proxy for the impact of changes in global value chains, where imports are linked to exports—with increased protection, imports and exports both fall as value chains unwind, leading to a loss of productivity.

IV. Scenarios of US Disengagement in the Long Run

We explore the impact of a long run US policy of increased import protection under four different scenarios of reaction by the rest of the world. The scenarios are described in Table 3. The core scenario is that the US imposes an additional tariff of 30 percentage points on all imports from all its trading partners—a rate similar to the Smoot-Hawley tariffs of the 1930s.[24] In all scenarios, US trade partners do not change tariffs among themselves—trade disputes are limited to trade with the US.[25] In the first simulation, no trade partner changes tariffs in response to the US action—they adjust to the US policy. In the second, all trade partners reciprocate against the US, matching the US tariff increases, but do not change tariffs against non-US countries. This scenario is a full trade war between the US and its trade partners. In the third, only major trade partners of the US reciprocate: Canada, Mexico, Europe, China, Japan, South

[23]The Michigan global model (Deardorff and Stern 1986) is an early example with this specification.

[24] See Irwin (2017) for a history of the Smoot-Hawley tariffs. Bown and Irwin (2018) discuss the potential impact on US tariffs of US withdrawal from the WTO, citing the Smoot-Hawley tariffs. See also Devarajan et al. (2018) who consider a similar scenario.

[25] There are studies of scenarios where trade wars spread globally, with larger impacts than we find in our more limited trade war scenarios. See, for example, Kutlina-Dimitrova and Lakatos (2017) and Bouet and Laborde (2017).

Korea, and the other high-income E&SE Asian economies. This scenario is a limited trade war. In the fourth simulation, there is a limited trade war as in the third simulation and, in addition, all non-US economies eliminate all tariffs among themselves—non-US trade liberalization

Bilateral exports and trade diversion

Changes in tariffs reverberate across national and global goods markets, affecting real exports and imports in all countries. When the US unilaterally increases tariffs, bilateral exports from the NAFTA region decline – both within NAFTA and to all other regions, with a total decline of 7.92%. (see Table 4). Total exports increase slightly for other regions—Europe, E&SE Asia, and "All other"—despite a decline in exports to NAFTA because exports to Europe and E&SE Asia expand. Global trade declines slightly, by 0.78%.

When there is a global trade war, total exports from all regions decline, with the biggest decline for the NAFTA region, at 8.86% (Table 4). Global trade declines 2.32%. Exports to the NAFTA region decline substantially from all regions, ranging from 11.42% for NAFTA trade with NAFTA to 15.06% for "All Other" region exports to NAFTA. All regions other than NAFTA expand trade with other ICRE regions (Europe and E&SE Asia)—there is trade diversion around NAFTA. Furthermore, total exports from regions other than NAFTA do not decline substantially. For E&SE Asia, the decline is 1.88 for Europe the decline is 1.21%, and for "All Other" the decline is less than one percent. This result suggests that trade diversion around the US will not damage total exports for other regions. It is relatively easy to divert trade away from NAFTA markets in the long run.

When there is a limited trade war, the NAFTA region diverts some of its exports to the "All Other" region, which does not engage in the trade war. However, NAFTA exports to all other regions decline further, compared to the global trade war, and NAFTA total exports decline more, at 9.85%. When there is a limited trade war and non-US regions remove tariffs among themselves, global trade declines slightly more than one percent. The NAFTA region diverts trade to the "All Other" region, which does not raise its tariffs on the US. However, the other regions divert trade from NAFTA to Europe and E&SE Asia. Overall exports by each region decline less (or in the case of "All Other" expand more) than in the case of a limited trade war. When other countries continue to embrace free trade, in contrast to the US position, it is relatively easy to divert trade around the US. Total exports decline by less than 0.75% for Europe and E&SE Asia while exports from the "All Other" region expand.

Total Exports

When the US protects, its real exports decline 12.74% (see Table 5). The imposed tariffs reduce imports and exports decline as the real exchange rate appreciates (see Table 8)—the "Lerner Effect" at work, see footnote 15. There are modest export gains in other regions, the biggest gainers being Mexico (3.61%) and Canada (2.41%). Global trade declines 0.78%. When there is a global trade war, US exports decline by 9.19%, less than when the US unilaterally raises tariffs ("US Protects"). Exports decline more for all other regions, except for India and the aggregate group, "other countries," whose exports decline slightly less in the global trade war. Total trade declines 2.32% in the global trade war, the largest decline for all scenarios considered. A limited trade war is worse than a global trade war for US total exports, which decline 11.69%. In the limited trade war, the real exchange rate for the US depreciates less than

in the global trade war (see Table 8) so there is less pressure to expand exports in a limited trade war and the net effect is a bigger export decline, compared to a global trade war. All participants in the limited trade war, other than the US, are better off than in the global trade war (their exports decline less).[26] The non-participants (with the exception of the residual group, "other countries" which has a negligible loss) gain markets from trade diversion; in terms of exports, they are better off sitting out the global trade war and the participants are better off when the smaller countries do not participate in the trade war.

The world may choose to continue to pursue free trade agreements without US participation, as in the case of the Trans-Pacific Partnership (TPP)—after the US withdrew, the remaining eleven countries formed the CPTPP. We consider the case of a limited trade war and an FTA among all regions except the US. In this case, global trade declines modestly, 1.32%. Compared to the response of a global trade war, all regions except the US are better off in terms of trade volumes when there is a limited trade war and a non-US FTA. Furthermore, all regions that do not participate in the limited trade war see total exports expand when there is a non-US FTA in addition to the limited trade war. Even the US gains (loses less) when there is a limited trade war and non-US FTA, compared to a limited trade war alone, because global trade declines less when there is a limited trade war and a non-US FTA.

Table 6 reports the bilateral export changes by country to aggregate regions when there is a limited trade war and a non-US FTA. Total exports from Canada and Mexico, countries closely linked to the US, decline 5.79% and 4.68% respectively, despite substantial increases in exports to Europe and E&SE Asia. All regions divert trade away from NAFTA and towards Europe and E&SE Asia. The non-ICRE countries see significant gains in total exports, benefiting from the trade diversion around the trade war countries.

Macroeconomic results

Table 7 provides scenario results for aggregate real GDP, final demand (welfare) and the international terms of trade for all countries/regions included in the global model. The model includes a link between sectoral export growth and productivity. When the share of the value of exports in the value of production increases, it is assumed that the sector becomes more productive. This linkage is more important than allocative efficiency costs and drives percent changes in real GDP.

In the first scenario ("US Protects"), the US achieves a significant (6.17%) gain in terms-of-trade, the prices of its exports relative to the prices of its imports. In international trade theory, this is the "optimal tariff" argument that countries with market power can gain through restricting imports, if there is no retaliation. The net effect is to require less exports to achieve the same level of imports. Given the decline in US exports and the subsequent productivity loss, real GDP declines 1.18%. The net effect on aggregate real final demand (welfare) in the US is negative, with a 0.28% decline. In all the other scenarios, with retaliation by trade partners, the terms-of-trade effect is reversed, and the US loses significantly. The US share in global trade is much smaller than its major partners, it does not dominate world markets, and in a trade war it loses, largely due to terms-of-trade effects. Aggregate final demand in the US falls by 1.97 to

[26] The participants in the limited trade war are United States, Canada, Mexico, Europe, China-Hong Kong, Japan, South Korea and other High-income Asia.

2.90% largely due to terms-of-trade losses in the three scenarios with retaliation. GDP losses for the US are between 1.23 and 1.24 in the three scenarios with retaliation.

For US trade partners, changes in their terms of trade vary widely, depending largely on their dependence on trade with the US. Canada and Mexico are tightly integrated with the US and have the largest negative terms-of-trade shocks in the first scenario (terms-of-trade decline 5.23% and 6.01% respectively). They also gain the most in the second scenario (Global Trade War), when retaliation hurts the US terms of trade (terms of trade improve 7.343 for Canada and 7.38% for Mexico). When the US protects, a few countries have slight terms- of-trade gains along with the US (Japan, South Korea, and India), but the values are very small. A couple of countries gain welfare (measured as an increase in real final demand) even though they have a small terms-of-trade losses (Europe and "other countries"), indicating that they have some improvements in productivity that offset their small terms-of-trade losses.

In the Global Trade War scenario, the US terms of trade decline substantially, 17. 09%. The other trade-warring countries, except Africa, Russia, and the "other countries" region improve their terms of trade and experience a net welfare gain as a result. However, real GDP declines for all regions (except Africa which has a slight increase), which suggests that the gains in final demand (welfare) are dominated by terms-of-trade effects.

In the limited trade war scenario, there are winners and losers. Major US trading partners (Canada and Mexico) gain, and they gain even more when there is a limited trade war and non-US trade liberalization. Africa, Middle East & North Africa (MENA), Russia, and the region "other countries" all have low trade shares with the US and experience small welfare losses. Further liberalization outside of the US, the fourth scenario, is good for major US partners (including all of E&SE Asia), and has mixed results for other countries. Africa, MENA, Russia, and "other countries" lose in the fourth scenario, due to bigger terms-of-trade losses, but again the magnitudes are small.

Trade wars affect production and exports through changes in the real exchange rate and the price indices of traded to non-traded goods, which are reported in Table 8. The reported PE/PD is an index of the ratio of the average export price to the average domestic price (as defined by the producer price index in the domestic market), PM/PD is an index of the ratio of the average import price to the producer price index, and the real exchange rate (RER) is the solution exchange rate deflated by the producer price index.[27] The exchange rate is the equilibrating variable that adjusts to maintain the assumed fixed trade balance. When a country imposes a tariff, there is an incentive to reduce imports; to maintain the current account balance, the nominal exchange rate must appreciate to reduce exports.

When the US protects, the index of PM/PD increases because PM includes the tariffs. The real exchange rate, however, declines (appreciates) to maintain the current account balance—it provides incentives for exports to decline since imports decline and the trade balance is fixed. A similar change is apparent in the index of PE /PD which declines, sending the signal to reduce exports. For all other regions the index of PE/PD and the index of PM/PD move in the same direction.

[27] The weights for the average export price are the sector's share of the value of total exports in the base; the weights for the average import price are the sector's share of the value of total imports in the base.

In all scenarios, for the US, the index of PE/PD declines and the index of PM/PD increases. When there is a trade war, the index of PE/PD declines for the US because US trade partners have imposed a tariff on only US goods—demand for US goods decline on world markets and this results in a decline in PE levels. In the trade war scenarios, the US real exchange rate depreciates (increases) to promote exports and offset the decline in world demand as US partners impose tariffs on the US.

In the global trade war scenario, the US real exchange rate depreciates and the real exchange rates for all other regions appreciate. In the limited trade war scenarios, the changes in real exchange rates reverberate around the global economy and their signs and magnitudes depend largely on bilateral trade shares.

Since the PM/PD and PE/PD ratios can have different signs (for example, for the US in all scenarios), there is "noise" in the system. The real exchange rate is no longer a good indicator of what is happening in commodity markets.

Production changes in the US

The impact of US import tariffs and responses by trade partners on the sectoral structure of production is complicated. In the US, the manufacturing sectors are linked in a network of intermediate input flows including both domestic production and imports, and also are important exporters. Attempts to protect domestic manufacturing through increasing import tariffs is problematic, given this complex web of indirect and direct linkages across sectors. There is also a "fallacy of composition" at work. Imposing a tariff on imports of a single commodity should protect the domestic industry producing that commodity. Imposing tariffs on many commodities generates a complex mix of direct and indirect effects, including a potential appreciation of the real exchange rate, leading to general damage to the traded-goods sectors in the economy, both import substitutes and exports. Essentially, all of US manufacturing is dependent, directly and/or indirectly, on international trade, and is hurt by a policy of wide-spread import protection.

Table 9 presents the changes in US real sectoral production of goods and services for all scenarios: US protects, Global trade war, Limited trade war and Limited trade war plus non-US FTA. The results indicate the strength of indirect effects and the failure of across-the-board tariffs to benefit protected sectors. The net effect of a policy of broad-based tariff protection is to damage US manufacturing and agriculture. The only gainer is the very large "business services" sector, which includes most non-traded services. The policy leads to "deindustrialization" of the US—exactly the opposite of what was intended.[28]

We also ran an additional simulation, a variant of the Limited trade war scenario in which the US imposes tariffs only on manufactured imports. The effect is very similar to the scenario with broad-based import tariffs, except that the agriculture and processed food sectors gain instead of losing. All other manufacturing sectors lose. Agriculture and the processed food sectors gain because it is assumed that trade partners reciprocate and only raise tariffs on manufacturing goods. In practice, it is likely that partners would retaliate by raising tariffs in sectors different from the sectors the US protects. For example, in the current US trade war with

[28] Note, the sector Other Services accounts for over 70% of value added, see appendix table A2.

China, China has retaliated against US tariffs on steel and aluminum by imposing tariffs on agricultural products such as soybeans.

V. Conclusion

In this analysis, we simulate possible responses to a US policy of disengagement from the global economy. We represent US protectionist leanings as a 30-percentage point increase in all US tariffs. Other countries have various options: retaliate (protecting their domestic markets), do not retaliate (sit out the trade war), and continue to pursue free trade agreements without the US. Our analysis considers the changes in GDP, welfare, bilateral trade flows, and US production in different response scenarios.

If no country retaliates against US protectionism, there are welfare gains for the US from terms-of-trade changes (the 'optimal tariff' argument) that just offset the efficiency losses from adverse trade-productivity links. However, these terms-of-trade gains are reversed when all or major partners retaliate in kind. The terms of trade then move against the US and all major trading partners gain—the US has a much lower share of global trade compared to Europe and East and Southeast (E&SE) Asia—the other two major interconnected regional economies (ICREs)—and hence has less market power. In the trade-war scenarios, some poor countries have terms-of-trade losses and small welfare losses—collateral damage from trade wars. In all trade-war scenarios, the US loses by far the most.

Countries that participate in trade wars have mixed results—welfare gains from terms-of-trade improvements but lower total exports. The best policy for other countries in terms of international trade is to "sit out" the trade war, accepting increased US protectionism without retaliation and gaining markets from the resulting trade diversion.[29] If all non-US countries pursue a policy of increased trade liberalization among themselves, they increase trade, fostering deeper regional and global integration within the rules-based WTO system excluding the US. In this environment, a policy of not engaging in trade negotiations with the US if it insists on operating outside the WTO framework would make sense.

In the longer run, diversion of global trade flows away from the US as it moves to a protectionist trade regime, and perhaps withdraws from the WTO, is feasible. The US, with a low share of global trade, is no longer the hegemon in the world trading system that it was in the middle of the last century. In time, US trading partners can divert trade around the US with modest changes in their bilateral trade shares and a modest impact on the volume of global trade.

A policy of broad-based import protection does not achieve its stated goal of expanding production in the protected sectors. There is a fallacy of composition. Direct and indirect effects of US policies of import protection for manufacturing and withdrawal from the global economy end up damaging rather than helping US manufacturing. All traded sectors are damaged, and the result is US deindustrialization and diversion of employment to non-traded service sectors.

Finally, with high tariffs, relative prices in domestic markets of exports, imports, and domestically produced goods change dramatically. A measure of the real effective exchange rate,

[29] In a related study, Devarajan et al. (2018) find that the best response for developing countries is to avoid engaging in a trade war and to continue to pursue free trade agreements.

which involves deflating the nominal exchange rate by a ratio of aggregate indices of world prices and domestic prices, may be valid for macro analysis (e.g., a signal in asset markets), but no longer can provide a good summary measure of what is driving domestic commodity markets—the large changes in relative prices are hidden by any overall aggregate price index.

In our empirical results for these scenarios, we find that terms-of-trade changes have the largest impact on welfare, while changes in GDP due to trade/productivity and allocative efficiency effects tend to be smaller.

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Table 1: ICREs in the global economy

	Bilateral regional trade as a share of total trade					Regional share of:	
	NAFTA	Europe	E&SE Asia	All Other	Total	Global GDP	Global Population
NAFTA ICRE	5.17	3.13	3.00	2.51	13.81	26.00	6.74
Europe ICRE	3.48	23.52	3.81	5.98	36.80	26.32	7.49
E&SE Asia ICRE	5.30	4.95	12.90	4.78	27.91	26.58	31.86
All Other	3.34	6.37	5.74	6.02	21.47	21.10	53.91
Total	17.30	37.97	25.46	19.28	100.00	100.00	100.00

Entries are percent shares of global real exports from row to column region.
ICRE: Interconnected Regional Economy
Source: GTAP 9 database (2011).

Table 2: Export shares by countries to regions

	NAFTA	Europe	E&SE Asia	All Other	Total
NAFTA ICRE	**37.46**	**22.63**	**21.76**	**18.15**	**100.00**
United States	22.79	27.80	27.00	22.40	100.00
Canada	65.58	13.73	13.03	7.65	100.00
Mexico	77.08	7.30	5.77	9.85	100.00
Europe ICRE	**9.47**	**63.92**	**10.36**	**16.25**	**100.00**
East &SE Asia ICRI	**18.98**	**17.72**	**46.20**	**17.11**	**100.00**
China & HK	25.15	22.50	30.41	21.94	100.00
Japan	19.06	14.66	53.73	12.55	100.00
South Korea	14.94	13.11	50.55	21.40	100.00
High-income Asia	12.35	13.66	63.48	10.51	100.00
Low-income Asia	14.62	17.06	53.29	15.02	100.00
All Other	**15.55**	**29.68**	**26.74**	**28.02**	**100.00**
Central America	40.58	21.48	10.86	27.08	100.00
Latin America	21.60	20.21	25.61	32.58	100.00
India	18.94	25.35	22.07	33.65	100.00
Africa	22.99	27.08	24.95	24.98	100.00
Russia	6.94	50.30	17.36	25.40	100.00
MENA	12.08	24.75	35.77	27.40	100.00
Other countries	18.86	40.73	17.39	23.02	100.00

Exports from row country/region to column region.
ICRE: Interconnected Regional Economy
Source: GTAP 9 database (2011).

Table 3: Scenarios

Simulation	Description	Implementation	Comments
Sim 1	US Protects	US increases all tariffs by 30 percentage points. No one reciprocates	The world's response is to "sit out" the trade war.
Sim 2	Trade War	US increases all tariffs by 30 percentage points. All trade partners reciprocate against the US, but do not change tariffs against each other.	Worst case: a full trade war against the US
Sim 3	Limited Trade War (LTW)	US increases all tariffs by 30 percentage points. Only major trade partners reciprocate against the US. No change in tariffs among non-US partners.	Developing countries (i.e. not the major trade partners) "sit out" the trade war
Sim 4	LTW and non-US FTA	Sim 3 plus all regions except US eliminate tariffs among themselves.	Limited trade war with US and all regions continue to liberalize trade among themselves

Table 4: Percent change in real export among regions (ICRE)

Scenario: US Protects	NAFTA	Europe	E & SE Asia	All Other	Total
NAFTA ICRE	-3.56	-10.23	-10.64	-10.79	-7.92
Europe ICRE	-3.47	0.55	0.91	-0.32	0.07
E & SE Asia ICRE	-3.07	1.59	1.25	0.55	0.37
All Other	-4.32	1.98	1.71	1.77	0.87
Total	-3.54	0.04	-0.10	-0.81	-0.78

Scenario: Global Trade War	NAFTA	Europe	E & SE Asia	All Other	Total
NAFTA ICRE	-11.42	-6.96	-7.13	-8.02	-8.86
Europe ICRE	-14.62	0.23	0.73	-0.28	-1.21
E & SE Asia ICRE	-14.37	2.00	0.72	0.92	-1.88
All Other	-15.06	2.12	1.71	2.28	-0.61
Total	-13.67	0.19	0.02	-0.19	-2.32

Scenario: Limited Trade War	NAFTA	Europe	E & SE Asia	All Other	Total
NAFTA ICRE	-13.56	-22.16	-15.07	19.39	-9.85
Europe ICRE	-9.42	1.24	1.74	-5.15	-0.76
E & SE Asia ICRE	-9.26	3.20	1.58	-3.24	-1.01
All Other	-9.26	4.01	2.99	-0.26	0.48
Total	-10.58	0.03	-0.04	0.04	-1.82

Scenario: Limited Trade War & non-US FTA	NAFTA	Europe	E & SE Asia	All Other	Total
NAFTA ICRE	-13.07	-19.57	-14.03	15.75	-9.52
Europe ICRE	-10.23	0.50	5.85	-3.86	-0.67
E & SE Asia ICRE	-11.76	4.69	1.83	0.22	-0.52
All Other	-8.74	5.51	5.52	0.21	1.81
Total	-11.26	0.23	1.39	0.97	-1.32

Exports from row region to column region.
ICRE: Interconnected Regional Economy
Source: Authors' calculations.

Table 5: Percent change in total real exports by scenario

Scenario	US Protects	Global Trade War	Limited Trade War (LTW)	LTW and non-US FTA
United States	-12.74	-9.19	-11.69	-11.38
Canada	2.41	-8.07	-5.86	-5.79
Mexico	3.61	-8.21	-5.54	-4.68
Europe	0.07	-1.21	-0.76	-0.67
China & HK	0.37	-1.26	-0.65	-0.65
Japan	-0.28	-3.03	-2.31	-2.67
South Korea	0.01	-3.20	-2.14	0.53
Other High-income Asia	1.16	-2.40	-1.13	-1.29
Low-income Asia	0.37	-0.81	0.22	2.03
Central America	0.34	-4.61	-0.78	0.96
Latin America	1.07	-1.66	0.20	1.39
India	-0.92	-0.45	-0.41	1.83
Africa	1.07	0.34	1.11	3.29
Russia	1.14	-0.18	0.69	1.56
MENA	1.16	-0.36	0.66	1.66
Other countries	-1.14	-0.21	-0.23	4.00
Total	-0.78	-2.32	-1.82	-1.32

Exports from row region to column region.

Source: Authors' calculations.

Table 6: Percent change in real exports from country/region to region, Limited trade war and non-US FTA scenario

	NAFTA	Europe	E&SE Asia	All Other	Total
United States	-17.91	-24.05	-17.81	18.73	-11.38
Canada	-11.61	5.15	8.33	0.45	-5.79
Mexico	-7.17	7.92	11.42	-3.97	-4.68
Europe	-10.23	0.50	5.85	-3.86	-0.67
China & HK	-11.89	6.13	2.49	0.91	-0.65
Japan	-14.88	2.42	0.97	-5.69	-2.67
South Korea	-9.86	1.22	8.19	1.09	0.53
Other High-income Asia	-12.36	1.56	0.59	-3.35	-1.29
Low-income Asia	-8.04	6.63	2.60	4.55	2.03
Central America	-5.68	7.20	9.35	2.59	0.96
Latin America	-6.10	7.68	8.20	-2.90	1.39
India	-10.00	7.58	6.01	1.43	1.83
Africa	-9.63	8.59	9.33	3.39	3.29
Russia	-10.21	3.66	4.35	-1.31	1.56
MENA	-10.65	4.85	4.03	1.10	1.66
Other countries	-5.43	8.64	6.25	1.83	4.00
Total	-11.26	0.23	1.39	0.97	-1.32

Exports from row country/region to column region.

Source: Authors' calculations.

Table 7: Percent change in real GDP, final demand and terms of trade

	US Protects			Global Trade War			Limited Trade War			Limited Trade War and non-US FTA		
	GDP	Final Demand	Terms of Trade	GDP	Final Demand	Terms of Trade	GDP	Final Demand	Terms of Trade	GDP	Final Demand	Terms of Trade
United States	-1.18	-0.28	6.17	-1.24	-2.90	-17.09	-1.24	-1.97	-10.05	-1.23	-2.18	-11.86
Canada	0.05	-1.35	-5.23	-0.73	0.92	7.34	-0.69	-0.08	3.88	-0.61	0.20	4.77
Mexico	0.04	-1.81	-6.01	-0.53	1.17	7.38	-0.52	-0.07	3.45	-0.38	0.04	3.80
Europe	0.03	0.03	-0.06	-0.19	0.38	1.53	-0.15	0.22	1.20	-0.11	0.29	1.24
China & HK	0.03	-0.14	-0.21	-0.14	0.17	0.88	-0.11	-0.01	0.66	-0.13	0.39	1.92
Japan	0.00	0.06	0.23	-0.12	0.43	3.67	-0.11	0.30	3.05	-0.11	0.53	4.53
South Korea	-0.06	0.02	0.21	-0.20	1.59	3.62	-0.25	0.93	2.72	0.94	2.07	3.38
Other High-income Asia	0.04	-0.54	-0.95	-0.21	0.93	2.54	-0.16	0.29	1.56	-0.16	0.75	2.23
Low-income Asia	0.05	-0.17	-0.51	-0.09	0.24	0.75	-0.01	0.20	0.24	0.14	0.13	-0.38
Central America	0.05	-0.56	-2.25	-0.51	1.02	4.22	-0.03	0.67	0.80	0.28	1.00	0.92
Latin America	0.03	-0.29	-1.85	-0.10	0.19	1.99	0.02	0.07	0.10	0.16	0.15	-0.46
India	-0.05	0.29	0.40	-0.08	0.03	0.93	-0.04	0.20	0.52	0.39	0.55	0.56
Africa	0.11	-0.54	-2.12	0.06	-0.26	-1.00	0.11	-0.33	-1.64	0.45	-0.25	-2.58
Russia	0.11	-0.56	-1.24	-0.04	-0.02	-0.36	0.04	-0.28	-0.98	0.23	-0.25	-1.71
MENA	0.20	-0.75	-1.71	-0.01	0.07	0.07	0.13	-0.22	-0.85	0.42	-0.08	-1.33
Other countries	-0.02	0.27	-0.21	-0.02	-0.21	-0.10	-0.03	0.06	-0.18	0.28	-0.11	-1.75

Source: Authors' calculations.

Final demand: GDP + imports − exports

Terms of trade: Aggregate world price of exports over world price of imports

Table 8: Percent change in relative price indices and the real exchange rate

	US Protects			Global Trade War			Limited Trade War			Limited Trade War and non-US FTA		
	PE/PD	PM/PD	RER	PE/PD	PM/PD	RER	PE/PD	PM/PD	RER	PE/PD	PM/PD	RER
United States	-14.81	4.06	-16.01	-6.86	45.64	13.88	-9.79	29.31	2.54	-9.00	33.21	5.08
Canada	2.87	8.43	8.38	-6.09	0.14	-5.81	-3.57	6.33	-1.67	-3.85	4.08	-2.43
Mexico	2.27	8.67	8.07	-3.56	3.76	-3.07	-1.84	9.64	0.37	-1.70	7.52	0.56
Europe	-0.14	-0.10	2.47	-1.39	-1.32	-4.64	-1.02	-0.61	-2.11	-1.02	-1.05	-2.70
China & HK	0.58	0.78	3.69	-0.80	0.20	-3.06	-0.29	0.97	-0.33	-0.29	-3.10	-2.62
Japan	-0.42	-0.68	2.13	-2.49	-3.07	-5.94	-2.13	-2.08	-3.48	-2.70	-4.91	-6.27
South Korea	-0.41	-0.46	2.21	-2.71	-3.97	-6.48	-2.10	-2.33	-3.42	-0.88	-6.64	-3.94
Other High-income Asia	0.65	1.58	3.99	-2.04	-1.54	-5.07	-1.02	0.45	-1.58	-1.64	-2.00	-3.84
Low-income Asia	0.32	0.81	3.54	-0.65	0.28	-3.14	-0.28	-0.60	-0.33	0.52	-2.74	-0.28
Central America	0.91	3.15	4.65	-3.90	-0.77	-5.26	-0.96	-1.88	1.03	0.14	-4.77	1.70
Latin America	1.00	2.85	5.05	-2.17	0.02	-4.00	-0.34	-0.56	1.02	1.09	-2.92	2.56
India	-1.47	-1.87	1.38	-0.44	0.06	-2.26	-0.64	-1.21	0.00	2.07	-4.13	1.91
Africa	0.50	2.63	5.40	-0.98	2.17	-1.04	-0.11	1.46	2.34	2.36	-1.63	4.85
Russia	1.46	2.56	5.67	-0.64	0.80	-2.39	0.61	1.37	1.71	2.06	0.06	3.18
MENA	1.45	3.17	6.00	-1.20	1.12	-2.24	0.50	1.28	2.25	2.13	-0.84	3.72
Other countries	-0.97	-0.78	1.93	0.23	1.85	-1.15	-0.09	0.03	0.65	2.91	-2.83	4.23

Source: Authors' calculations.

PE: aggregate price of exports in domestic market

PM: aggregate price of imports in domestic market

PD: producer price index in domestic market

RER: real effective exchange rate. Negative number denotes an appreciation of RER

Table 9: Percent change in real output by sector and scenario in the US

	US protects	Global trade war	Limited trad war (LTW)	LTW and non-US FTA
Agriculture	-4.93	-3.63	-3.74	-4.34
Mining and energy	-1.76	-0.91	-1.11	-0.98
Processed food	-2.45	-3.49	-2.91	-3.53
Textiles	-4.09	-6.23	-5.34	-6.06
Wearing apparel	-1.85	-11.99	-8.26	-9.40
Leather products	-5.33	-15.81	-11.89	-14.02
Wood products	-2.18	-3.75	-3.28	-3.45
Paper products, publishing	-1.72	-0.38	-0.92	-0.78
Petroleum, coal products	-4.64	-9.39	-7.20	-7.37
Mineral products nec	-3.10	-3.12	-3.24	-3.23
Iron and steel (ferrous metals)	-6.62	-2.25	-3.72	-3.49
Chemical, rubber, plastic products	-7.17	-4.57	-5.85	-5.68
Metals nec	-11.24	-4.18	-7.93	-7.46
Metal products	-4.43	-4.08	-4.26	-4.32
Motor vehicles and parts	-6.23	-9.34	-8.29	-9.19
Transport equipment nec	-9.67	-6.67	-8.32	-8.12
Electronic equipment	-5.47	-3.62	-4.34	-3.83
Machinery and equipment nec	-6.96	-4.31	-5.33	-5.20
Manufactures nec	-6.69	-9.72	-8.69	-9.24
Construction	-1.97	-6.39	-4.78	-5.20
Transportation services	-3.19	-3.67	-2.95	-2.73
Other services	0.20	0.83	0.57	0.69

Source: Authors' calculations.

Table A1: Bilateral regional shares of global trade net of intra-ICRE trade

	NAFTA	Europe	E&SE Asia	All Other	Total
NAFTA ICRE		5.4	5.1	4.3	14.8
Europe ICRE	6.0		6.5	10.2	22.7
E&SE Asia ICRE	9.1	8.5		8.2	25.7
All Other	5.7	10.9	9.8	10.3	36.8
Total	20.8	24.7	21.5	33.0	100.0

Entries are percent shares of global real exports from row to column region.
ICRE: Interconnected Regional Economy
Source: GTAP 9 database (2011).

Table A2: Structure of the US economy (percent)

	Sector share of total:						Within sector:	
	Value added	Produc-tion	Employ-ment	Consump-tion	Exports	Imports	Export share of production	Import share of consumption
Agriculture	1.18	1.46	1.26	1.28	4.63	1.79	21.12	12.96
Mining and energy	3.07	3.06	1.27	4.10	1.62	13.38	3.51	29.77
Processed food	1.89	3.22	1.41	3.20	3.89	3.43	8.04	10.26
Textiles	0.41	0.60	0.38	0.74	0.87	2.10	9.53	27.79
Wearing apparel	0.22	0.43	0.23	0.68	0.18	2.65	2.81	39.89
Leather products	0.04	0.06	0.04	0.19	0.14	1.37	15.23	74.04
Wood products	0.81	1.04	0.80	1.15	0.61	1.94	3.89	15.50
Paper products, publishing	1.64	1.85	1.42	1.77	1.95	1.11	7.02	5.76
Petroleum, coal products	0.10	2.58	0.06	2.38	6.81	3.37	17.52	12.12
Mineral products nec	0.51	0.57	0.45	0.59	0.69	0.82	7.99	13.14
Iron and steel (ferrous metals)	0.48	0.75	0.46	0.77	1.50	1.54	13.28	18.30
Chemical, rubber, plastic products	2.75	3.86	1.98	3.78	14.28	10.18	24.50	25.12
Metals nec	0.29	0.63	0.26	0.66	2.74	2.45	28.75	34.13
Metal products	1.11	1.38	1.11	1.39	1.70	1.70	8.19	11.42
Motor vehicles and parts	0.94	2.18	0.89	2.49	6.14	8.35	18.76	30.24
Transport equipment nec	0.78	0.97	0.79	0.81	4.92	1.98	33.57	22.51
Electronic equipment	0.51	1.99	0.43	2.60	5.10	10.77	16.92	38.03
Machinery and equipment nec	3.62	4.09	3.45	4.19	16.22	13.59	26.29	29.98
Manufactures nec	0.34	0.43	0.34	0.62	1.28	3.12	19.78	46.19
Construction	6.26	6.36	8.84	6.16	0.41	0.13	0.43	0.20
Transportation services	2.79	3.68	3.83	3.50	6.13	3.55	11.10	9.34
Other services	70.26	58.81	70.27	56.94	18.19	10.66	2.06	1.72
Total/Average	100.00	100.00	100.00	100.00	100.00	100.00	6.64	9.27

Source: GTAP 9 data (2011).

Table A3: GLOBE Model Region aggregation

Code	GTAP region	GLOBE model region
usa	United States of America	United States
pri	Puerto Rico	
can	Canada	Canada
mex	Mexico	Mexico
aut	Austria	
bel	Belgium	
cyp	Cyprus	
cze	Czech Republic	
dnk	Denmark	
est	Estonia	
fin	Finland	
fra	France	
deu	Germany	
grc	Greece	
hun	Hungary	Europe
irl	Ireland	
ita	Italy	
lva	Latvia	
ltu	Lithuania	
lux	Luxembourg	
mlt	Malta	
nld	Netherlands	
pol	Poland	
prt	Portugal	
svk	Slovakia	
svn	Slovenia	
esp	Spain	
swe	Sweden	
gbr	United Kingdom	
che	Switzerland	
nor	Norway	
bgr	Bulgaria	
hrv	Croatia	
rou	Romania	
chn	China	China & HK
hkg	Hong Kong	

Table A3, cont.

Code	GTAP region	GLOBE model region
jpn	Japan	Japan
kor	Korea	Korea
aus	Australia	
nzl	New Zealand	
xoc	Rest of Oceania	High-income Asia
twn	Taiwan	
sgp	Singapore	
xea	Rest of East Asia	
brn	Brunei	
khm	Cambodia	
idn	Indonesia	
lao	Lao People's Democratic Republ	Low-income Asia
mys	Malaysia	
phl	Philippines	
tha	Thailand	
vnm	Viet Nam	
xse	Rest of Southeast Asia	
cri	Costa Rica	
gtm	Guatemala	
hnd	Honduras	
nic	Nicaragua	
pan	Panama	
slv	El Salvador	Central America
xca	Rest of Central America	
dom	Dominican Republic	
jam	Jamaica	
tto	Trinidad and Tobago	
xcb	Caribbean	
arg	Argentina	
bol	Bolivia	
bra	Brazil	
chl	Chile	
col	Colombia	
ecu	Ecuador	Latin America
pry	Paraguay	
per	Peru	
ury	Uruguay	
ven	Venezuela	
xsm	Rest of South America	
ind	India	India

Table A3 cont.

Code	GTAP region	GLOBE model region
ben	Benin	
bfa	Burkina Faso	
cmr	Cameroon	
civ	Cote d'Ivoire	
gha	Ghana	
gin	Guinea	
nga	Nigeria	
sen	Senegal	
tgo	Togo	
xwf	Rest of Western Africa	
xcf	Central Africa	
xac	South Central Africa	
eth	Ethiopia	
ken	Kenya	
mdg	Madagascar	Africa
mwi	Malawi	
mus	Mauritius	
moz	Mozambique	
rwa	Rwanda	
tza	Tanzania	
uga	Uganda	
zmb	Zambia	
zwe	Zimbabwe	
xec	Rest of Eastern Africa	
bwa	Botswana	
nam	Namibia	
zaf	South Africa	
xsc	Rest of South African Customs	
alb	Albania	
blr	Belarus	
rus	Russian Federation	
ukr	Ukraine	
xee	Rest of Eastern Europe	
xer	Rest of Europe	Russia
kaz	Kazakhstan	
kgz	Kyrgyztan	
xsu	Rest of Former Soviet Union	
arm	Armenia	
aze	Azerbaijan	
geo	Georgia	

Table A3 cont.

Code	GTAP region	GLOBE model region
bhr	Bahrain	
irn	Iran Islamic Republic of	
isr	Israel	
jor	Jordan	
kwt	Kuwait	
omn	Oman	
qat	Qatar	
sau	Saudi Arabia	Mid East and North Africa
tur	Turkey	
are	United Arab Emirates	
xws	Rest of Western Asia	
egy	Egypt	
mar	Morocco	
tun	Tunisia	
xnf	Rest of North Africa	
mng	Mongolia	
bgd	Bangladesh	
npl	Nepal	
pak	Pakistan	
lka	Sri Lanka	Rest of World
xsa	Rest of South Asia	
xna	Rest of North America	
xef	Rest of EFTA	
xtw	Rest of the World	

Table A4a: GLOBE Model Sector Aggregation

Code	GTAP	GLOBE model sector
gro	Cereal grains nec	Other cereal grains
v_f	Vegetables fruit nuts	Vegetables and fruit
wht	Wheat	Wheat
pdr	Paddy rice	Other crops
osd	Oil seeds	
c_b	Sugar cane sugar beet	
pfb	Plant-based fibers	
ocr	Crops nec	
ctl	Cattle sheep goats horses	Livestock
oap	Animal products nec	
rmk	Raw milk	
wol	Wool silk-worm cocoons	
frs	Forestry	Forestry
fsh	Fishing	Fishing
coa	Coal	Extraction industries
oil	Oil	
gas	Gas	
omn	Minerals nec	
cmt	Meat cattle sheep goats horse	Meat
omt	Meat products nec	
vol	Vegetable oils and fats	Vegetable oils and fats
mil	Dairy products	Dairy products
sgr	Sugar	Processed sugar
pcr	Processed rice	Food products nec
ofd	Food products nec	
b_t	Beverages and tobacco product	Beverges and tobacco
tex	Textiles	Textiles
wap	Wearing apparel	Wearing apparel
lea	Leather products	Leather products
lum	Wood products	Wood Products
ppp	Paper products publishing	Paper products publishing
p_c	Petroleum coal products	Petroluem and coke products
nmm	Mineral products nec	Mineral products nonmetallic minerals
i_s	Ferrous metals	Ferrous metals iron and steel
crp	Chemical rubber plastic prods	chemicals rubber plastic
nfm	Metals nec	non ferrous metals copper aluminum etc.
fmp	Metal products	fabricated metal products

Table A4a, cont.

Code	GTAP	GLOBE model sector
mvh	Motor vehicles and parts	Motor vehicles and parts
otn	Transport equipment nec	Other transport equipment
ele	Electronic equipment	Electronic equipment
ome	Machinery and equipment nec	Other machinery and equipment
omf	Manufactures nec	Other manufacturing
ely	Electricity	Electricity
gdt	Gas manufacture distribution	Gas distribution
wtr	Water	Water collection purification and distribution
cns	Construction	Construction
trd	Trade	Retail sales wholesale tradecommission sales
otp	Transport nec	Air sea and other transport
wtp	Sea transport	
atp	Air transport	
cmn	Communication	Communication
ofi	Financial services nec	Other financial services
isu	Insurance	Insurance
obs	Business services nec	Other business services and dwellings
dwe	Dwellings	
ros	Recreation and other services	Recreation and other services
osg	PubAdmin Defence Health Edu	Public adminisration defense health

Table A4b: Sector Aggregation for Reports (Table 9)

Reported sector	GLOBE model sector
Agriculture	Other cereal grains
	Vegetables and fruit
	Wheat
	Oher crops
	Livestock
	Forestry
	Fishing
Mining and energy	Extraction industries
	Electricity
	Gas distribution
Processed food	Meat
	Vegetable oils and fats
	Dairy products
	Processed sugar
	Food products nec
	Beverges and tobacco
Textiles	Textiles
Wearing apparel	Wearing apparel
Leather products	Leather products
Wood products	Wood Products
Paper products, publishing	Paper products publishing
Petroleum, coal products	Petroluem and coke products
Mineral products nec	Mineral products nonmetallic minerals
Iron and steel (ferrous metals)	Ferrous metals iron and steel
Chemical, rubber, plastic products	chemicals rubber plastic
Metals nec	non ferrous metals copper aluminum etc.
Metal products	fabricated metal products
Motor vehicles and parts	Motor vehicles and parts
Transport equipment nec	Other transport equipment
Electronic equipment	Electronic equipment
Machinery and equipment nec	Other machinery and equipment
Manufactures nec	Other manufacturing
Transportation services	Air sea and other transport
Construction	Construction
Other services	Water collection purification and distribution
	Retail sales wholesale trade commission sales
	Communication
	Other financial services
	Insurance
	Other business services and dwellings
	Recreation and other services
	Public administration defense health