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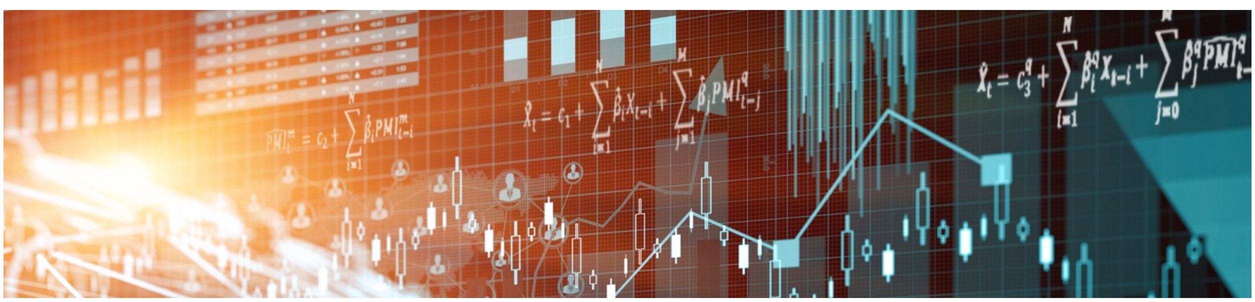
The Trade War in Numbers



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Abstract

We build upon new developments in the international trade literature to isolate and quantify the long-run economic impacts of tariff changes on the United States and the global economy. In particular, we apply the most recent data and trade elasticity estimates to the Ricardian model of Caliendo and Parro (2015) to quantify the long-run impacts of the recently applied and proposed tariff changes, including the U.S. tariffs on steel and aluminum imports and the rounds of additional tariffs between the United States and China. To fit the reality of the current trade policy shift, our analysis also allows for quotas and endogenizes trade balances. Overall, our results suggest that the newly imposed and proposed tariff schemes imply considerable changes in trade flows and sectoral output reallocations, but modest impacts on long-run aggregate prices and output levels.

Bank topics: Recent economic and financial developments; Trade integration
JEL codes: F11, F13, F14, F15, F50, F62, F68

Résumé

Nous nous appuyons sur les travaux récents de la littérature consacrée au commerce international pour isoler et quantifier les effets économiques à long terme des modifications des droits de douane sur les États-Unis et l'économie mondiale. Nous intégrons les données les plus récentes et nos estimations de l'élasticité des échanges commerciaux au modèle ricardien de Caliendo et Parro (2015), afin de calculer l'incidence économique à long terme des droits de douane récemment imposés et proposés, y compris les droits sur les importations d'acier et d'aluminium mis en place par l'administration américaine et les séries de droits de douane supplémentaires appliqués entre les États-Unis et la Chine. Pour rendre compte de l'orientation actuelle de la politique commerciale, notre cadre d'analyse inclut les quotas et endogénéise les balances commerciales. Dans l'ensemble, les résultats obtenus semblent indiquer que les nouveaux droits de douane imposés et proposés ont des répercussions considérables sur les flux commerciaux et la réallocation de la production entre les secteurs. Toutefois, nous estimons que les conséquences à long terme sont modestes sur le niveau général des prix et les niveaux de production.

Sujets : Évolution économique et financière récente; Intégration des échanges
Codes JEL : F11, F13, F14, F15, F50, F62, F68

Non-Technical Summary

Quantifying the impact of tariff changes has become a priority for many policy institutions, given the recent rising trade tensions. In this paper, we build upon new developments in the international trade literature to isolate and quantify the long-run economic impacts of tariff changes on the United States and the global economy. In particular, we apply the most recent data and trade elasticity estimates to the Ricardian model of Caliendo and Parro (2015) to quantify the long-run impacts of the recently applied and proposed tariff changes, including the U.S. tariffs on steel and aluminum imports, the rounds of additional tariffs between the United States and China, and potential U.S tariffs on the imports of automobiles and parts. To fit the reality of the current trade policy shift, our analysis also allows for quotas and endogenizes trade balances.

We use the Caliendo and Parro (2015) model in our benchmark analysis because of its many attractive features that allow us to precisely isolate and quantify the long-run impacts of tariff changes. First, it is a Ricardian model of trade (e.g., Eaton and Kortum (2002)). This implies that differences in technology, across sectors and countries, drive comparative advantage and trade. Second, the model has multiple countries and sectors, with interactions across tradable and non-tradable sectors observed in the input-output tables. Therefore, it allows for trade between countries that are different in terms of resources or technology, including different stages of development. In addition, the model explicitly incorporates trade in intermediate goods, which allows us to capture global value chains and to understand the impact of tariff changes on key systemic sectors of the economy. Third, the model's solution allows us to specifically isolate the long-run impacts of tariff changes from other economic developments. Finally, the multi-sector aspect of the model with input-output linkages allows us to run counterfactual scenarios on tariffs targeted to particular sectors or goods, and to understand how these targeted tariffs ripple through the economy.

We summarize the impact of the recently imposed and planned tariffs on the United States and the global economy by decomposing the events that have happened to date into two layers. First, we look into the recently applied U.S. tariffs on steel and aluminum imports and the following rounds of retaliation by U.S. trading partners. We then look at the impacts of potential U.S tariffs on the imports of automobiles and parts. Overall, our results suggest that the newly imposed and proposed tariff schemes imply considerable changes in trade flows and sectoral output reallocations, but modest impacts on long-run aggregate prices and output levels. The implied large sectoral output reallocations, however, suggest important short-run price movements, as they appear too large to be absorbed given the current industry structure, as many sectors of the U.S. and global economies already face capacity pressures.

1 Introduction

Quantifying the impact of tariff changes has become a priority for many policy institutions, given the recent rising trade tensions. In this paper, we build upon new developments in the international trade literature to isolate and quantify the long-run economic impacts of tariff changes on the United States and the global economy. In particular, we apply the most recent data and trade elasticity estimates to the Ricardian model of Caliendo and Parro (2015) to quantify the long-run impacts of the recently applied and proposed tariff changes, including the U.S. tariffs on steel and aluminum imports, the rounds of additional tariffs between the United States and China, and potential U.S tariffs on the imports of automobiles and parts. To fit the reality of the current trade policy shift, our analysis also allows for quotas and endogenizes trade balances.

We use the Caliendo and Parro (2015) model in our benchmark analysis because of its many attractive features that allow us to precisely isolate and quantify the long-run impacts of tariff changes. First, it is a Ricardian model of trade (e.g., Eaton and Kortum (2002)). This implies that differences in technology, across sectors and countries, drive comparative advantage and trade.[1] Second, the model has multiple countries and sectors, with interactions across tradable and non-tradable sectors observed in the input-output tables. Therefore, it allows for trade between countries that are different in terms of resources or technology, including different stages of development. In addition, the model explicitly incorporates trade in intermediate goods, which allows us to capture global value chains and to understand the impact of tariff changes on key systemic sectors of the economy. Third, the model's solution allows us to specifically isolate the long-run impacts of tariff changes from other economic developments. Finally, the multi-sector aspect of the model with input-output linkages allows us to run counterfactual scenarios on tariffs targeted to particular sectors or goods, and to understand how these targeted tariffs ripple through the economy.

We summarize the impact of the recently imposed and planned tariffs on the United States and the global economy by decomposing the events that have happened to date into two layers. First, we look into the recently applied U.S. tariffs on steel and aluminum imports and the following rounds of retaliation by U.S. trading partners. Our main finding is that Canada, Mexico, and the United States see the largest impacts on their trade flows and real GDP. For example, U.S. real GDP falls by 0.05 percent, while U.S. exports fall by 2.2 percent. In particular, we find that U.S. exports fall in many sectors, reflecting the importance of steel and aluminum as an input in U.S. exports. As such, U.S. exports fall not only because of other countries' retaliatory tariffs on American products, but also because the cost for U.S. firms producing goods for exports rises and makes them less competitive in the global market. Globally, the U.S. tariffs and the following rounds of retaliations represent a world output loss of 0.02 percent or $13.7 billion (in 2018 dollars at market exchange rates) using International Monetary Fund (2018) world output estimates.

We also found that the U.S. administration appeared too optimistic regarding its assessments of the steel and aluminum imports drop and production increase from the newly imposed tariffs. Abstracting from retaliations, the model simulation implies a 34 percent drop in U.S. intermediate metals imports (the sector that includes most steel and aluminum products). This suggests an intermediate metals imports drop almost twice as big as the target identified in Department of Commerce documents (U.S. Department of Commerce (2018a), U.S. Department of Commerce (2018b)). The model simulation also suggests an intermediate metals real GDP increase of only 4.5 percent (7.9 percent without retaliations). This also appears to be far below the implied increase of 10 percent in intermediate metals production targeted by the U.S. administration.

[1] Comparative advantage is a country's ability to produce a good at a lower cost relative to other goods and other countries, based on technology, and taking into account geography, tariffs, quotas, and other trade barriers.

Next, we consider the impacts of the rising tension in the U.S.-China trade relationship. Here, we add the two rounds of U.S. tariffs on Chinese imports with China's retaliations, in addition to the steel and aluminum tariffs discussed above. The model suggests that the proposed January 2019 tariff scheme implies a U.S. real GDP decline of 0.25 percent and a U.S. exports decline of 10.4 percent—with a broad-based decline in exports to China of 52.7 percent. In particular, the newly imposed and proposed tariffs imply important sectoral price adjustments, as well as sectoral export and output reallocations. Globally, the model suggests that the proposed tariff scheme represents a world output loss of 0.1 percent or $81.4 billion (in 2018 dollars at market exchange rates)—which roughly represents the size of the economy of the Dominican Republic. The impacts on global trade, however, are much more pronounced, with a global exports decline of 1.4 percent or $250 billion (in 2018 dollars at market exchange rates)—slightly bigger than the economy of Portugal or Greece.

Our model suggests that U.S.-China trade tensions ripple through the global economy, especially among Canada, Mexico, and other Asian economies that either are part of the global supply chain affected by the tariffs or that offer close substitutes to Chinese and U.S. exports. In particular, Canada and Mexico see sizable output reallocation toward many tradable sectors that provide the U.S. with a close substitute to major Chinese export sectors (e.g., clothing, medical and communication, electrical machinery, machinery, and other manufacturing). These sizable and broad-based sectoral output reallocations for the U.S. and its trading partners suggest important short-run price movements, as they appear too large to be absorbed by the current industry structure given the slow movements of labor and capital across sectors. In fact, some of the sectors with the largest growth rates already face substantial capacity pressure.[2]

As in Caliendo and Parro (2015), the results above assume that trade balances remain fixed following a change in tariff schemes. In the current context, however, this assumption may be misleading as trade rebalancing is at the forefront of the current U.S.-led trade war. As expected, the additional U.S. tariffs reduce the U.S. trade deficit and the Chinese surplus, but the main takeaway is that endogenizing trade balances does not change the qualitative results. As pointed out, the United States depends on imported inputs for many sectors of its economy. As such, U.S. exports fall not only because of other countries' retaliatory tariffs on U.S. exports, but also because the cost for U.S. firms producing goods for exports rises and makes U.S. exports less competitive on the global market. The end results are lower imports, lower exports, and little improvement in the U.S. trade deficit.

This paper is closely related to the trade literature that quantifies the impact of trade integration. For example, the original contribution of Caliendo and Parro (2015) was to estimate the effects of the North American Free Trade Agreement (NAFTA) on consumer welfare and trade. Other notable quantitative studies include Trefler (2004), who studies the impact of the Canada-U.S. free trade agreement on employment and manufacturing plant productivity, Romalis (2007), who identifies NAFTA's effects on trade volumes and prices, and more recently, Auer et al. (2018), who look at the income implications of revoking NAFTA. In contrast, Autor et al. (2013) analyze the effect of rising Chinese import competition on U.S. local labor markets, while Amiti et al. (2017) analyze the effects of China's rapid export expansion on U.S. prices.[3] In this paper, we look at the price, trade, and output implications of the current shift in global tariff schemes initiated by the United States in 2018.

[2]For example, Canadian and U.S. capacity utilization rates in many manufacturing sectors are currently close to historical highs.

[3]See Costinot and Rodríguez-Clare (2014) and Maggi (2014) for an excellent review of recent theoretical and quantitative works on trade integration.

Our analysis also offers several advantages over many policy models that have been used to estimate the impact of the current trade policy shift, such as the Global Trade Analysis Project (GTAP) (Corong et al. (2017)) or the Global Integrated Monetary and Fiscal Model (GIMF) (Anderson et al. (2013) and International Monetary Fund (2018)). For example, these models use Armington aggregates to bundle imports, while we allow consumers and producers to search for the lowest-cost supplier. In addition, our model is highly disaggregated and uses input-output linkages, allowing us to run counterfactual scenarios on tariffs targeted to particular sectors or countries, and to understand how these targeted tariffs ripple to other sectoral and aggregate variables such as prices, trade flows, and production.

Overall, our results suggest that the newly imposed and proposed tariff schemes imply considerable changes in trade flows and sectoral output reallocations, but modest impacts on long-run aggregate prices and output levels. The implied large sectoral output reallocations, however, suggest important short-run price movements, as they appear too large to be absorbed given the current industry structure, as many sectors of the U.S. and global economies already face capacity pressures. The rest of the paper proceeds as follows. In section 2, we present the main equations of the Caliendo and Parro (2015) model, which we use as the backbone to run our tariff change scenarios. In section 3, we describe the data, show our recent sectoral trade elasticity estimates, and explain how we incorporate the newly imposed and proposed tariffs and quotas. In section 4, we present the estimated impacts of recently imposed and proposed tariffs on the United States and the global economy. In addition to the scenarios discussed above, section 4 also looks at the impact of potential U.S tariffs on the imports of automobiles and parts. Finally, section 5 concludes.

2 The Economic Environment

Our economic environment builds on the Eaton and Kortum (2002) Ricardian model of trade and is similar to Caliendo and Parro (2015). The model features multiple regions, sectoral linkages and heterogeneity in production structures. Households receive income from labor income and tariff revenues. Labor is the only factor of production, which is perfectly mobile across sectors but not across countries. The production technology displays constant returns to scale, and all markets are perfectly competitive. Finally, international trade in goods is costly because of transportation costs and tariffs. Below, we present the main equations of the Caliendo and Parro (2015) model, which we use as the backbone to run our tariff change scenarios, and discuss its equilibrium equations.[4]

The Caliendo-Parro model

Households

In each country, representative households maximize utility by consuming a plethora of final goods C_n^j according to Cobb-Douglas preferences:

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

Households receive income I_n from tariff revenues and labor income $w_n L_n$, where w_n represents country n's wage and L_n represents country n's labor supply.

[4] A more detailed version of the model and its solution are available in Caliendo and Parro (2015).

Intermediate goods

A continuum of intermediate goods ω^j is produced in each sector j. To capture the sectoral linkages, intermediate goods ω^j are produced from labor and a composite of intermediate goods from all other sectors—thereafter materials. To capture heterogeneity in production structures, we assume that producers of intermediate goods differ in production efficiency $z_n^j(\omega^j)$ and in their materials input. The production technology of an intermediate good ω^j in country n is

$$q_n^j(\omega^j) = z_n^j(\omega^j) \cdot l_n^j(\omega^j)^{\gamma_n^j} \cdot \prod_{k=1}^{J} m_n^{k,j}(\omega^j)^{\gamma_n^{k,j}} \text{ , where } \omega^j \in [0,1], \gamma_n^{k,j} \geq 0. \tag{2}$$

In equation (2), $l_n^j(\omega^j)$ represents labor, while $m_n^{k,j}(\omega^j)$ represents materials from sector k used in the production of intermediate goods ω^j. The parameter $\gamma_n^{k,j}$ is the share of materials from sector k used in the production of intermediate goods ω^j, with $\sum_{k=1}^{J} \gamma_n^{k,j} = 1 - \gamma_n^j$ and where $\gamma_n^j \geq 0$ is the share of value added. Constant returns to scale in the production of intermediate goods imply that existing technology can be scaled to meet changing demand (e.g., following a change in trade flows).

Since production of intermediate goods is constant returns to scale and markets are perfectly competitive, firms price at unit cost, $c_n^j / z_n^j(\omega^j)$, where the cost c_n^j of an input bundle is

$$c_n^j = \Psi_n^j \cdot w_n^{\gamma_n^j} \cdot \prod_{k=1}^{J} P_n^{k\gamma_n^{k,j}} \text{, where } \Psi_n^j = \prod_{k=1}^{J} (\gamma_n^{k,j})^{-\gamma_n^{k,j}} (\gamma_n^j)^{-\gamma_n^j}. \tag{3}$$

In equation (3), P_n^k is the cost of materials from sector k, and Ψ_n^j is a constant, reflecting sectoral productivity differences across countries. Equation (3) captures a key difference relative to the one-sector model, as the cost of the input bundle depends on wages and on the price of all the composite intermediate goods in the economy. A change in policy that affects the price in any single sector will indirectly affect all the sectors in the economy via the wage and materials input.

Retailers

Retailers supply composite intermediate goods to households and firms. They supply Q_n^j at minimum cost by purchasing intermediate goods ω^j from the lowest-cost suppliers across countries.[5] The quantity of materials Q_n^j follows a Dixit and Stiglitz (1977) aggregate such that

$$Q_n^j = \left(\int r_n^j(\omega^j)^{1-1/\sigma^j} d\omega^j \right)^{\sigma^j/(\sigma^j-1)}, \tag{4}$$

where $\sigma_j > 0$ is the elasticity of substitution across intermediate goods within sector j, and $r_n^j(\omega^j)$ is the demand of intermediate goods ω^j from the lowest-cost supplier. The solution to the problem of the composite intermediate good producer gives the following demand for good ω^j:

[5]Allowing for producers of composite intermediate goods to search for the lowest-cost supplier is a key distinction from models with Armington-type assumptions such as the Global Trade Analysis Project (Corong et al. (2017)) or the Global Integrated Monetary and Fiscal Model (GIMF) used in simulation by the International Monetary Fund (2018). In Ricardian models based on Eaton and Kortum (2002), the source from which goods are purchased is endogenously determined and can change as a consequence of tariff reductions. This is an adjustment along the extensive margin of trade.

$$r_n^j(\omega^j) = \left(\frac{p_n^j(\omega^j)}{P_n^j}\right)^{-\sigma^j} Q_n^j, \tag{5}$$

where P_n^j is the unit price of materials such that

$$P_n^j = \left(\int p_n^j(\omega^j)^{1-\sigma^j} d\omega^j\right)^{1/(1-\sigma^j)}, \tag{6}$$

and where $p_n^j(\omega^j)$ denotes the lowest price of intermediate good ω^j across all locations n where it can be delivered. In turn, composite intermediate goods from sector j are used as materials for the production of intermediate good ω^k in the amount $m_n^{j,k}(\omega^k)$ in all sectors k, and as final goods in consumption C_n^j. As such, the market clearing condition for the intermediate and final goods sector j is

$$Q_n^j = C_n^j + \sum_{k=1}^{J} \int m_n^{j,k}(\omega^k) d\omega^k. \tag{7}$$

Trade costs and prices

We consider two types of trade costs. First, a transportation cost or iceberg cost is defined in physical units as in Samuelson (1954), where one unit of a tradable intermediate good in sector j shipped from country i to country n requires producing $d_{ni}^j \geq 1$ units in i, with $d_{nn}^j = 1$. Second, an *ad-valorem* flat-rate tariff τ_{ni}^j applicable over unit prices. Combining both trade costs leads to the following:

$$\kappa_{ni}^j = (1 + \tau_{ni}^j) \cdot d_{ni}^j. \tag{8}$$

After taking into account trade costs, a unit of a tradable intermediate good ω^k produced in country i is available in country n at unit prices $c_i^j \kappa_{ni}^j / z_i^j(\omega^j)$. Therefore, the price of intermediate good ω^k in country n is given by

$$p_n^j(\omega^j) = \min_i \left(\frac{c_i^j \kappa_{ni}^j}{z_i^j(\omega^j)}\right). \tag{9}$$

The tradable and the non-tradable sectors are identical, except that $\kappa_{ni}^j = \infty$ in the non-tradable sector. Thus, it is always cheaper to buy goods from local suppliers in the non-tradable sector.

Ricardian motives to trade are introduced following the Eaton and Kortum (2002) probabilistic representation of technologies allowing productivities to differ by country and sector. As such, we assume that the efficiency of producing a good ω^j in country n is the realization of a Fréchet distribution with a location parameter that varies by country and sector $\lambda_n^j \geq 0$ and shape parameter that varies by sector θ^j. In the context of this model, a higher $\lambda_n^j \geq 0$ implies higher average sectoral productivity—a notion of absolute advantage—whereas a smaller value of θ^j implies higher dispersion of productivity across goods ω^j—a notion of comparative advantage. We assume that the distributions of productivities are independent across goods, sectors, and countries, and that $1 + \theta^j > \sigma^j$. With these assumptions, the price of the composite intermediate good is given by

$$P_n^j = A^j \left(\sum_{i=1}^{N} \lambda_i^j (c_i^j \kappa_{ni}^j)^{-\theta^j}\right)^{-1/\theta^j}, \tag{10}$$

for all sectors j and countries n.

Finally, with Cobb-Douglas preferences, the consumption price index is given by

$$P_n = \prod_{j=1}^{J} \left(\frac{P_n^j}{\alpha_n^j} \right)^{\alpha_n^j}. \tag{11}$$

Expenditure shares

Total expenditure on sector j goods in country n is given by

$$X_n^j = P_n^j Q_n^j. \tag{12}$$

Denote X_{ni}^j to be the expenditure in country n of sector j goods from country i. It follows that country n's share of expenditure on goods j from i is given by

$$\pi_{ni}^j = \frac{X_{ni}^j}{X_n^j}, \tag{13}$$

which is also the probability that country i provides goods at the lowest cost to country n. Using the properties of the Fréchet distribution, we can derive expenditure shares as a function of technologies, prices and trade costs:

$$\pi_{ni}^j = \frac{\lambda_i^j (c_i^j \kappa_{ni}^j)^{-\theta^j}}{\sum_{h=1}^{N} \lambda_h^j (c_h^j \kappa_{nh}^j)^{-\theta^j}}. \tag{14}$$

Notice that changes in tariffs have a direct effect on trade shares via the trade cost κ_{ni}^j, and an indirect effect through the input bundles cost c_n^j—since it incorporates all the information contained in input-output linkages.

Total expenditure and trade balance

Total expenditure on sector j is the sum of the expenditure on composite intermediate goods by firms and expenditure by households. Then, X_n^j is given by

$$X_n^j = \sum_{k=1}^{J} \gamma_n^{jk} \cdot \sum_{i=1}^{N} \frac{\pi_{in}^k}{1+\tau_{in}^k} X_i^k + \alpha_n^j I_n, \tag{15}$$

where

$$I_n = w_n L_n + R_n + D_n. \tag{16}$$

In this equation, I_n represents final absorption as the sum of labor income $w_n L_n$, tariff revenues R_n, and the trade deficit D_n. Specifically,

$$R_n = \sum_{j=1}^{J} \sum_{i=1}^{N} \tau_{ni}^j M_{ni}^j, \text{ where } M_{ni}^j = X_n^j \frac{\pi_{ni}^j}{1+\tau_{ni}^j} \text{ represents imports,} \tag{17}$$

and

$$D_n = \sum_{k=1}^{J} D_n^k, \text{ and } D_n^j = \sum_{i=1}^{N} M_{ni}^j - \sum_{i=1}^{N} E_{ni}^j, \text{ where} E_{ni}^j = X_i^j \frac{\pi_{in}^j}{1+\tau_{in}^j} \text{ represents exports.} \quad (18)$$

Aggregate trade deficits in each country are exogenous in the model, while sectoral trade deficits are endogenously determined.[6]

Finally, using the definition of expenditure and trade deficit we have that

$$\sum_{j=1}^{J}\sum_{i=1}^{N} \frac{\pi_{ni}^j}{1+\tau_{ni}^j} X_n^j - D_n = \sum_{j=1}^{J}\sum_{i=1}^{N} \frac{\pi_{in}^j}{1+\tau_{in}^j} X_i^j. \quad (19)$$

This condition reflects the fact that total expenditure, excluding tariff payments, in country n minus trade deficits equals the sum of each country's total expenditure, excluding tariff payments, on tradable goods from country n. In this environment, the equilibrium of the model can be described as follows:

Model's equilibrium: Given L_n, D_n, λ_n^j and d_{ni}^j, an equilibrium under policy τ is a wage vector $w \in R_{++}^N$ and prices $\{P_n^j\}_{j=1,n=1}^{J,N}$ that satisfy equilibrium condition (3), (10), (14), (15), and (19) for all j, n.

Equilibrium in relative changes

As in Caliendo and Parro (2015), we solve for changes in prices and wages after changing from tariff schedules τ to τ', instead of solving for an equilibrium under tariff schedule τ. First, this allows us to condition the model on the state of the world in a base year. Second, this allows us to identify the effect on equilibrium outcomes from a pure change in tariff schedules—which is what we are after in this paper. Finally, we can solve for the general equilibrium of the model without needing to estimate parameters that are difficult to identify in the data, as productivity parameters and iceberg cost vanish in differences. The equilibrium of the model in relative changes, that is, under tariff schedule τ' relative to a tariff schedule τ, can be described as follows:

Equilibrium in relative changes: Let (w, P) be an equilibrium under policy τ and let (w', P') be an equilibrium under tariff schedule τ'. Define $(\hat{w}, \hat{P})$ as an equilibrium under τ' relative to τ, where a variable with a hat "$\hat{x}$" represents the relative change of the variable, namely $\hat{x} = x'/x$. Using equations (3), (10), (14), (15), and (19), the equilibrium conditions in relative changes satisfy the following conditions:

1. Cost of the input bundles:

$$\hat{c}_n^j = \hat{w}_n^{\gamma_n^j} \cdot \prod_{k=1}^{J} \hat{P}_n^{k\gamma_n^{k,j}}. \quad (20)$$

2. Price index:

$$\hat{P}_n^j = \left(\sum_{i=1}^{N} \pi_{ni}^j (\hat{c}_i^j \hat{\kappa}_{ni}^j)^{-\theta^j} \right)^{-1/\theta^j}. \quad (21)$$

[6] The quantitative results are robust to whether we exogenously impose current aggregate trade surplus/deficits or aggregate balanced trade for each region.

3. Bilateral trade shares:

$$\hat{\pi}_{ni}^{j} = \left(\frac{\hat{c}_{i}^{j} \hat{\kappa}_{ni}^{j}}{\hat{P}_{n}^{j}} \right)^{-\theta^{j}}. \tag{22}$$

4. Total expenditure in each country n and sector j:

$$X_{n}^{j\prime} = \sum_{k=1}^{J} \gamma_{n}^{jk} \cdot \sum_{i=1}^{N} \frac{\pi_{in}^{k\ \prime}}{1+\tau_{in^{\prime}}^{k}} X_{i}^{k\prime} + \alpha_{n}^{j} I_{n}^{\prime}. \tag{23}$$

5. Trade balance:

$$\sum_{j=1}^{J} \sum_{i=1}^{N} \frac{\pi_{ni}^{j\ \prime}}{1+\tau_{ni}^{j\ \prime}} X_{n}^{j\prime} - D_{n} = \sum_{j=1}^{J} \sum_{i=1}^{N} \frac{\pi_{in}^{j\ \prime}}{1+\tau_{in}^{j\ \prime}} X_{i}^{j\prime}, \tag{24}$$

where

$$\hat{\kappa}_{ni}^{j} = \frac{1+\tau_{ni}^{j\ \prime}}{1+\tau_{ni}^{j}}, \text{ and } I_{n}^{\prime} = w_{n}^{\prime} L_{n} + \sum_{j=1}^{J} \sum_{i=1}^{N} \tau_{ni}^{j\ \prime} \frac{\pi_{ni}^{j\ \prime}}{1+\tau_{ni}^{j\ \prime}} X_{n}^{j\prime} + D_{n}. \tag{25}$$

From inspecting equilibrium conditions 20-23, we can observe that the focus on relative changes allows us to perform policy experiments without relying on estimates of total factor productivity or transport costs. We need only two sets of tariff structures (τ and τ'), data on bilateral trade shares (π_{ni}^{j}), the share of value added in production (γ_{n}^{j}), value added ($w_n L_n$), the share of intermediate consumption ($\gamma_{n}^{k,j}$), and sectoral dispersion of productivity (θ^{j}). The share of each sector in final demand (α_{n}^{j}) is obtained from these data. In the next section, we briefly describe the data and the estimation of sectoral productivity dispersion (θ^{j})—which is the only set of parameters to estimate.

3 Data and Estimation

3.1 Matching the model with the data

Our quantitative analysis includes 44 sectors and 16 regions. The sectors are divided into 24 tradable and 20 non-tradable sectors, which are enumerated in Appendix A. We group sectors by commodities defined using the Harmonized Commodity Description and Coding System (HS) 2012 at the six-digit level of aggregation and concorded to two digits ISIC Revision 3. The regions include Australia, Brazil, Canada, China, the European Union, India, Japan, Malaysia, Mexico, Norway, Peru, South Korea, Switzerland, Thailand, the United States, and a catch-all region named rest of world.

We use the most recent available data to get an up-to-date picture of the global economy. Data on bilateral trade flows are from the United Nations Statistical Division (UNSD) Commodity Trade (COMTRADE) database. We use an average of 2014 and 2015 bilateral trade flow data because some sectoral trade flows are lumpy even at annual frequency (e.g., aircraft).[7] Data on sectoral value added, gross production and input-output tables are from the 2011 OECD Input-Output Database.[8] We obtain measures of bilateral trade

[7] We choose to not incorporate the 2016 bilateral trade flow data because the recent oil price shock affected trade flows significantly in 2016.

[8] At the time of publication, the 2011 OECD Input-Output Database was the most up-to-date database that ensured consistency across countries.

shares π_{ni}^j, share of value added γ_n^j, share of intermediate inputs $\gamma_n^{j,k}$ and share of final demand α_n^j using data on bilateral trade flows, value added, gross production, and input-output tables.

Finally, bilateral tariff data are from the WTO Tariff Database for the year 2016 at the HS 2012 six-digit level. They are aggregated into our 24 tradable sectors using the average of 2014 and 2015 bilateral trade flow data. We use trade agreement tariffs (e.g., NAFTA) when lower than most-favored-nation (MFN) tariffs, and apply symmetric tariff schedules in cases where a trade agreement between two countries was not available for one of the countries in the WTO Tariff Database. Appendix B offers a detailed description of the data.

3.2 Trade elasticity estimates

The remaining parameters to measure are the trade elasticities. In the model, trade elasticities govern the extent of comparative advantage and are key parameters for our quantitative scenario analysis. For example, a low trade elasticity implies a high productivity dispersion across countries. This means that a retailer's current supplier is likely to remain its lowest-cost supplier when trade costs increase. As such, an increase in tariffs or other trade costs has a small impact on trade flows.

We estimate trade elasticities using tariff schedules and bilateral trade flow data following Caliendo and Parro (2015). Specifically, our estimating equation is

$$\ln\left(\frac{X_{ni}^j X_{ih}^j X_{hn}^j}{X_{in}^j X_{hi}^j X_{nh}^j}\right) = -\theta^j \ln\left(\frac{\tilde{\tau}_{ni}^j \tilde{\tau}_{ih}^j \tilde{\tau}_{hn}^j}{\tilde{\tau}_{in}^j \tilde{\tau}_{hi}^j \tilde{\tau}_{nh}^j}\right) + \epsilon^j, \tag{26}$$

where $\tilde{\tau}_{ni} = (1 + \tau_{ni})$ for all n, h, i.

Our trade elasticity estimates and their standard errors are presented in **Table 1**. The elasticity estimates range from a high degree of substitutability of 69.1 in the other energy sector (e.g., coal) to a low of 1.1 in the farm sector. For example, the intermediate metals sector (e.g., steel and aluminum) elasticity estimate is in the mid-range of 6.2. From (22), this implies that a 10 percent increase in tariffs reduces the sectoral import shares by 45 percent—keeping everything else constant. These estimates are in the range of the trade elasticity estimates in the literature.[9]

The dispersion in trade elasticity shown in **Table 1** highlights differences in sectoral sensitivity to tariff changes. The equality of parameter estimates across sectors is strongly rejected by an F-test. Although the focus of this paper is on sectoral trade elasticities and input-output linkages, we nevertheless estimate an aggregate trade elasticity by running (26) on all sectoral data. For example, this is the trade elasticity that would be used in a one-sector model such as Eaton and Kortum (2002). On aggregate, our trade elasticity estimate is 2.7, which is in the range of the estimates in the literature. Notice, however, that this aggregate elasticity estimate is much lower than the sectoral average of 12.0. See Imbs and Mejean (2015) and Simonovska and Waugh (2014) for a discussion on this issue and other recent advances.

Table 1 also shows the trade elasticities reported in Caliendo and Parro (2015). These are based on 1993 data, the year before NAFTA came into force. Elasticities computed using 1996 tariffs and trade data show that the difference between our estimates and those of Caliendo and Parro (2015) are due to a change in

[9] These estimates are robust to the removal of different types of outliers. In the esimates presented in **Table 1**, we take out countries that have less than 0.1 percent of world trade. We also remove Switzerland.

Table 1: Trade elasticity estimates

Sector	θ_{2016}	s.e.	θ_{1993}	s.e.
Other energy	69.07	(5.6)	51.1	(18.1)
Ores	43	(9.4)	15.8	(2.8)
Pharmacy	29.35	(4.4)	4.8	(1.8)
Oil and gas	18.21	(2.1)	51.1	(18.1)
Wood	15.77	(1.0)	10.8	(2.5)
Machinery, n.e.c.	13.01	(2.5)	1.5	(1.8)
Electrical machinery	12.26	(3.5)	10.6	(1.4)
Medical and communication	9.75	(4.4)	7.1	(1.7)
Metals (fabricated)	9.58	(2.2)	4.3	(2.2)
Paper	9.1	(1.8)	9.1	(1.7)
Other transportation	8.68	(0.6)	0.4	(1.1)
Printing	8.32	(2.2)	9.1	(1.7)
Recyclable	7.59	(1.4)	5	(0.9)
Metals (intermediate)	6.16	(1.9)	8	(2.5)
Rubber	4.97	(2.2)	1.7	(1.4)
Auto	4.5	(2.3)	1	(0.8)
Aircraft	3.45	(3.1)	0.4	(1.1)
Non-metal products	2.97	(1.4)	2.8	(1.4)
Other manufacturing, n.e.c.	2.89	(1.9)	5	(0.9)
Chemicals	2.17	(1.8)	4.8	(1.8)
Non-metals	1.93	(1.7)	15.7	(2.8)
Clothing	1.7	(1.0)	5.6	(1.1)
Food	1.53	(0.4)	2.6	(0.6)
Farm	1.1	(0.2)	8.1	(1.9)
Aggregate	2.7	(0.1)	4.5	(0.4)

Note: The 1993 elasticity estimates (θ_{1993}) are from Caliendo and Parro (2015). Some of these estimates have been split across sectors due to the smaller number of sectors in Caliendo and Parro (2015).

the structure of the economy over time and not to a difference in the aggregation of sectors.[10] These trade elasticity movements highlight the importance of using recent estimates when quantifying the impact of tariff changes on the global economy. For example, the intermediate metals sector elasticity estimate based on 1993 data implies that a 10 percent increase in tariffs reduces the sectoral import shares by 53 percent instead of the 45 percent previously discussed—keeping everything else constant.

3.3 Dealing with additional tariffs and quotas

The model uses aggregate sectors and as such, tariffs cannot be applied on individual goods. Therefore, we build on our existing tariff schedules by taking a weighted average of the newly imposed or proposed tariffs from the Office of the United States Trade Representative (USTR) official releases, and other nation counterparties in case of retaliation. More precisely, we first compute newly imposed or proposed tariffs by taking a trade-weighted average of the HS eight-digit level tariff lines within our existing HS six-digit level bilateral tariff data described in section 3.1. This is necessary as goods subject to newly imposed or

[10]These estimates are available on demand.

proposed tariffs are often described at the HS eight-digit level.[11] Then, we update our tariff schedules by adding these additional tariffs to our existing tariff schedule. A broader description of the tariff data and a detailed timeline of additional tariff events are available in Appendix C.

Some of the new trade barriers also involve quotas. For example, the U.S. imposed absolute quotas on steel from Brazil and South Korea. To reflect such measures in our counterfactual analysis, we impose a quota on an entire sector when the majority of that sector is affected by the quota. For example, 65 percent of Brazilian nominal exports of intermediate metals is affected by the steel quotas, while this number is 77 percent for South Korea. Therefore, we impose a quota on U.S. imports of intermediate metals from Brazil and South Korea. In contrast, washing machines and solar panels, for which quotas were also imposed, represent only an average of 9 percent of the electrical machinery sector.[12] Since they represent such a small fraction, these quotas are not taken into account in our counterfactual analysis. We choose to impose quotas rather than tariff equivalents in order to maintain an accurate redistribution of wealth (i.e., no collection of tariffs by the U.S.). As mentioned above, quotas are applied on the entirety of a sector as a percentage of our nominal baseline trade data affected by the quota. This has the caveat of not allowing other parts of the sector to respond to changes in the economic environment. We further assume the quotas to always be binding.[13]

Note that throughout the paper, the baseline is the 2016 tariff schedule, and therefore abstracts from trade actions taken between 2016 and early 2018. More specifically, our baseline abstracts from two sets of tariffs imposed prior to the steel and aluminum tariffs. The first concerns the softwood lumber dispute between Canada and the U.S. The tariffs imposed in this context are anti-dumping and countervailing duties and are temporary in nature. We therefore do not include them. The second are the early 2018 tariffs and quotas on solar panels and washing machines. As explained above, we do not include these measures due to their large quota component on a small fraction of goods in the electrical machinery sector.

4 The Trade War in Numbers

In this section, we present the estimated impacts of recently imposed and proposed tariffs on the United States and the global economy. In particular, we present the impact on prices, trade flows, and real GDP. Since this is a one-factor model, the latter correspond to the real wage impacts.[14] Below, we first estimate

[11]HS codes are not harmonized across countries at a more detailed level than six digits. Therefore, we can only get this level of detail in our analysis for U.S. imposed tariffs. For all other countries, we impose the tariff on the six-digit good associated with the eight-digit good(s) targeted. A caveat of this limitation is that it may lead to an overstatement of the trade amount affected by the tariffs. In fact, the U.S. data suggest that there could be a sizable difference. However, the trade values affected by tariffs found using this method are in line with the numbers announced by the respective governments.

[12]The only country where it represents a significant share is Malaysia, with 49 percent of electrical machinery exports to the U.S.

[13]This assumption is supported by the model: given the steel and aluminum tariffs, if no tariffs were applied to imports of intermediate metals from Brazil and South Korea, the model would suggest a large increase in those imports.

[14]We do not report welfare effects as in Caliendo and Parro (2015) as we want to abstract from questions or redistribution of tariff revenues. In that sense our estimates compare to studies that evaluate the effects of trade openness when there are no tariffs, such as Arkolakis et al. (2012).

the impacts of the trade war saga to date. Then, we look at the implications of endogenizing trade balances. Finally, we consider the effects of potential tariffs on automobiles and automobile parts.[15]

4.1 The trade war saga

We summarize the impact of the recently imposed and planned tariffs on the United States and the global economy by decomposing the events that have happened so far in two parts: the recently applied U.S. tariffs on steel and aluminum imports and the following rounds of retaliation by U.S. trading partners, and the recently applied and proposed U.S. tariffs on Chinese goods imports and the following rounds of Chinese retaliation. We dig into the steel and aluminum tariffs saga first because it allows us to more easily develop a story and to gain economic intuitions, as the U.S. import tariffs are mostly concentrated in one tradable sector of the economy: intermediate metals. Our baseline for this exercise is the 2016 global tariff schedule described in the previous section.

Part 1: Steel and aluminum tariffs

On March 1, 2018, President Trump announced his intention to impose a 25 percent tariff on steel and a 10 percent tariff on aluminum imports.[16] A number of countries have retaliated following the imposition of U.S. tariffs on steel and aluminum imports. In particular, Canada, China, and the European Union imposed retaliatory tariffs on a number of products, ranging from U.S. steel and aluminum products to iconic American products such as Jack Daniel's and Harley-Davidson motorcycles. The distribution of U.S. and retaliatory tariffs across sectors are displayed in **Figure 1**. The U.S. tariffs on steel and aluminum imports are concentrated in the intermediate metals sector, while the retaliatory tariffs on U.S. exports are more broadly distributed across sectors.

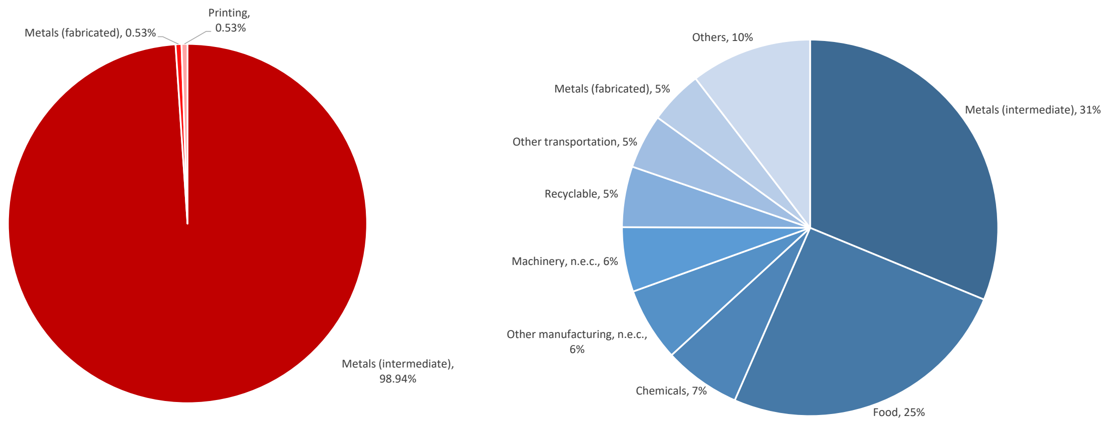
First, we consider the macroeconomic impacts of the steel and aluminum tariffs on the United States and its trading partners, without retaliations. This will allow us to get a clear picture of the mechanisms underlying the impacts of U.S. tariffs on steel and aluminum on the global economy. Then, we look at the impacts of the steel and aluminum tariffs with trading partner retaliation. Finally, we look into sectoral exports, prices, and output reallocation implications of these additional tariffs for the global economy.

Panel A of **Table 2** displays the global impacts from the U.S. tariffs on steel and aluminum imports on trade flows, terms of trade, GDP deflators, and real GDP across countries without retaliation. Overall, the main takeaway is that the countries that see the largest impacts on their trade flows, terms of trade, and real GDP are Canada, Mexico, and the United States. For example, Canada experiences the largest decrease in exports among U.S. trading partners because it has the largest share of exports exposed to the U.S. steel and

[15] The results presented below are qualitatively robust to the trade elasticity estimates.

[16] U.S. steel and aluminum tariffs are applied to all countries except Australia. Absolute quotas on steel from Brazil and South Korea are set to 70 percent of the average steel volume of exports to the United States (100 percent for Brazil semi-finished steel products) from these countries between 2015 and 2017. Here, we treat U.S. steel and aluminum quotas as binding for Brazil and South Korea and set an effective quota on intermediate metals sector exports of both countries to the U.S. These quotas are set at 94 percent and 77 percent of the baseline nominal trade data, for Brazil and South Korea respectively, to reflect the share of steel in each country's exports of intermediate metals. If Brazil and South Korea had chosen to have their steel exports submitted to the tariffs rather than take a quota restriction, their exports would have fallen much more. The model suggests that they are better off with the quota. We do not include the U.S. steel and aluminum tariffs exemption of Argentina and the Turkish retaliation because they are part of the rest of the world region.

Figure 1: Bilateral trade-weighted tariffs on U.S. imports and exports, by sector



aluminum tariffs.[17] In turn, this decrease in exports has a negative impact on Canada's aggregate demand and its terms of trade, GDP deflator, and real GDP.[18] Interestingly, U.S. exports and real GDP also drop following the unilateral imposition of steel and aluminum tariffs. In particular, U.S. exports drop because the steel and aluminum tariffs lead to an increase in U.S. terms of trade, as the increase in the price of U.S. exports dominates that of U.S. imports. This is because steel and aluminum are important intermediate goods used in many sectors of the U.S. economy. Therefore, a steel and aluminum price increase ripples through the U.S. manufacturing industry due to the importance this sector holds in U.S. input-output linkages. The steel and aluminum price increase also implies a drop in exports in many tradable sectors of the U.S. economy, partly reflecting the importance of these metals as an input in U.S. exports, and further contributing to the fall in real GDP.

The intermediate-goods nature of steel and aluminum has distinct economic implications relative to final goods, notably on U.S. exports, the GDP deflator, and real GDP. To illustrate these distinctions, we conduct the following exercise: We modify the input-output tables for all countries such that intermediate metals are used only as final consumption—and not used by any other sectors of the economy. Using intermediate metals as final goods increases the GDP deflator by ten-fold, but reduces the impact on U.S. exports by seven-fold and real GDP by three-fold. In other words, using intermediate metals as final goods implies that the impact of the U.S. steel and aluminum tariffs moves into prices—away from exports and production. This exemplifies the importance of steel and aluminum in U.S. exports and real GDP.

As mentioned in section 3, the intermediate metals sector has a large trade elasticity and is therefore quite sensitive to tariff changes. Consequently, U.S. imports of intermediate metals fall considerably following the imposition of U.S. tariffs on steel and aluminum imports. In fact, the model's simulation without retaliation implies a 34 percent drop in U.S. intermediate-metals imports. This suggests a drop in intermediate-metals imports almost twice as big as the target identified in Department of Commerce documents (U.S. Depart-

[17] Steel and aluminum are important export industries for Canada, and the majority of these exports are headed to the United States.

[18] Canadian import prices don't move, but export prices go down.

Table 2: Global impacts from U.S. tariffs on steel and aluminum
(in percent change)

Panel A: No retaliation

	Exposure		Change in Trade Flows			Terms of	GDP	Real
	Tariffs	X to U.S.	X to U.S.	Total X	Total M	Trade	Deflator	GDP
Australia	0.12	4.34	2.52	-0.05	-0.05	0.00	0.01	0.00
Brazil	1.38	12.44	-0.48	-0.11	-0.12	0.00	0.01	0.00
Canada	2.81	76.09	-1.50	-0.81	-0.80	-0.05	-0.08	-0.05
China	0.19	17.53	-0.16	0.02	0.03	0.00	0.02	0.00
EU	0.17	7.38	-1.53	-0.02	-0.02	0.00	0.00	0.00
India	0.40	14.30	-1.88	-0.19	-0.14	0.00	-0.01	-0.01
Japan	0.42	19.65	-1.05	-0.08	-0.08	0.00	0.01	0.00
Korea	0.73	12.80	-1.13	-0.06	-0.08	0.00	0.01	0.00
Malaysia	0.04	8.80	0.42	0.05	0.06	0.00	0.01	0.00
Mexico	0.82	80.75	-0.43	-0.21	-0.21	-0.04	-0.02	-0.04
Norway	0.03	3.92	1.94	0.00	0.00	0.00	0.00	0.00
Peru	0.06	15.72	4.98	0.12	0.11	0.00	0.03	0.00
Switzerland	0.03	10.30	0.37	0.01	0.01	-0.01	0.02	-0.01
Thailand	0.06	10.81	0.02	0.02	0.03	0.00	0.02	0.00
U.S.	·	·	·	-1.55	-0.95	0.02	0.04	-0.03
ROW	0.15	6.04	-1.59	-0.02	-0.02	-0.01	0.00	-0.01

Panel B: Trading partners retaliate

	Exposure		Change in Trade Flows			Terms of	GDP	Real
	Tariffs	X to U.S.	X to U.S.	Total X	Total M	Trade	Deflator	GDP
Australia	0.12	4.34	1.86	-0.01	-0.02	0.00	0.03	0.00
Brazil	1.38	12.44	-0.73	-0.05	-0.05	0.00	0.03	0.00
Canada	2.81	76.09	-2.66	-1.96	-1.94	-0.05	-0.01	-0.11
China	0.19	17.53	-0.45	-0.03	-0.04	0.00	0.05	-0.01
EU	0.17	7.38	-1.73	-0.04	-0.04	0.00	0.03	0.00
India	0.4	14.30	-2.01	-0.16	-0.12	0.00	0.02	-0.01
Japan	0.42	19.65	-1.19	-0.04	-0.04	0.00	0.03	0.00
Korea	0.73	12.80	-1.27	-0.04	-0.04	0.00	0.03	0.00
Malaysia	0.04	8.80	0.21	0.05	0.07	0.00	0.03	0.00
Mexico	0.82	80.75	-1.15	-0.84	-0.84	-0.04	0.08	-0.08
Norway	0.03	3.92	1.66	0.01	0.01	0.00	0.03	0.00
Peru	0.06	15.72	4.25	0.35	0.34	0.00	0.06	0.00
Switzerland	0.03	10.30	0.26	0.03	0.03	-0.01	0.04	-0.01
Thailand	0.06	10.81	-0.22	0.04	0.04	0.00	0.04	0.00
U.S.	1.96	·	·	-2.24	-1.36	0.02	-0.03	-0.05
ROW	0.15	6.04	-1.79	0.01	0.01	-0.01	0.02	-0.01

Note: X represents exports and M represents imports. The "Tariffs" column displays the share of total exports that are subject to additional tariffs or quotas, while the "X to U.S." exposure column displays U.S. export shares in total exports. We do not include the U.S. steel and aluminum tariffs exemption for Argentina and the Turkish retaliation because they are part of the rest of the world region. The "Change in Trade Flows," "Terms of Trade," "GDP deflator," and "Real GDP" columns are in percentage change from the baseline.

ment of Commerce (2018a), U.S. Department of Commerce (2018b)).[19]

Panel B of **Table 2** displays the global impacts from the U.S. tariffs on steel and aluminum imports on trade flows, terms of trade, GDP deflators, and real GDP across countries with trading partner retaliation. First, we observe that each country that retaliates (e.g., Canada, the European Union, Mexico, and China) experiences lower imports, higher GDP deflator, and lower real GDP than that of the no-retaliation case. Second, the retaliations affect the United States through a decrease in the demand for American products. In turn, this lowers U.S. exports, aggregate demand, and real GDP. With retaliations, however, lower demand for U.S. products drives down the U.S. GDP deflator. Collectively, this represents a global output loss of $13.7 billion (in 2018 dollars at market exchange rates) using International Monetary Fund (2018) world output estimates. Next, we turn to the sectoral prices adjustment, and exports and output reallocation.

Table 3 displays current export shares and export reallocation for the NAFTA partners, which are the countries that experience that largest drop in real GDP from the steel and aluminum tariffs and the following rounds of retaliations. At the sectoral export level, all three NAFTA partners experience an intermediate-metals exports decline of about 20 percent, which is the sector most affected by the steel and aluminum tariffs and their aftermath. As mentioned above, the steel and aluminum and retaliatory tariffs mostly impact the intermediate metals sector, but ripple through other important export manufacturing sectors of these economies (e.g., machinery, n.e.c.) as the higher production costs in these sectors make them less competitive in global markets. The impact on Canadian exports is mitigated, however, by a change in export composition. Notably, Canadian exports in the oil and gas, other energy, ores, and pharmacy sectors increase following these additional tariffs. For the U.S., however, the drop in exports is more broad-based. In addition to manufacturing sectors depending on intermediate metals, we observe a decline in the U.S. food sectors and a noticeable decline in other transportation following targeted U.S. export sectors in trading partner retaliations (e.g., European Union retaliatory tariffs on Jack Daniel's whiskey and Harley Davidson's motorcycles).

Table 4 displays sectoral value added shares, sectoral price adjustments, and changes in sectoral real GDP for the NAFTA partners.[20] Once again, the intermediate metals sector is directly impacted by the tariffs and the price deflator in this sector increases by almost 3 percent for the U.S. economy. Interestingly, intermediate metals real output increases by only 4.5 percent. This is significantly below the implied 10 percent target called for by the U.S. administration.[21] In fact, without retaliatory actions, the model suggests that intermediate metals real output would have gone up 7.9 percent, which is still short of the U.S. administration's target.

Part 2: U.S.-China trade tensions

Next, we consider the impacts of the rising tension in the U.S.-China trade relationship. First, we look at the impact of the current tariff structure. This includes the steel and aluminum tariffs, and two rounds of U.S.

[19] Intermediate-metals imports should decrease by approximately 19 percent, with the steel imports target reduction of 37 percent and the aluminum imports target reduction of 13 percent announced in the U.S. Department of Commerce documents (U.S. Department of Commerce (2018a), U.S. Department of Commerce (2018b)).

[20] Share differences between gross output and value added are displayed in Appendix A. In contrast to value added, gross output is a measure of economic activity (i.e., sales or revenues) that accounts for the use of intermediate inputs. Sectoral and aggregate real gross output results are displayed in Appendix A.

[21] In fact, the U.S. administration called for a target steel production increase of 11 percent and a target aluminum production increase of 85 percent, which implies an intermediate metals production increase of about 10 percent.

Table 3: Sectoral export reallocation from U.S. tariffs on steel and aluminum

	Current exports from (as a share of total exports)			**Change in exports from** (in percent)		
Sector	Canada	Mexico	U.S.	Canada	Mexico	U.S.
Farm	5.4	3.7	5.2	0.02	-0.26	-0.28
Wood	2.9	0.1	0.6	0.61	-1.20	-0.83
Other energy	1.8	0.0	0.7	4.09	0.24	2.09
Oil and gas	22.5	8.6	8.9	1.10	0.00	0.01
Ores	1.9	1.2	0.5	3.06	0.38	0.31
Non-metals	2.2	0.2	0.2	0.20	-0.04	-0.15
Food	6.9	4.2	6.1	-0.01	-0.15	-3.22
Clothing	0.7	2.0	1.4	0.07	-0.06	-0.57
Paper	3.6	0.5	1.8	0.21	-0.11	-2.03
Printing	0.3	0.3	0.8	-5.73	-0.20	0.01
Chemicals	3.5	2.1	7.3	-0.04	0.00	-0.47
Pharmacy	2.1	0.7	5.7	0.96	0.28	1.40
Rubber	3.9	2.6	5.5	-0.22	-0.16	-0.18
Non-metal products	0.7	1.0	1.0	0.21	0.03	-0.01
Metals (intermediate)	9.5	3.4	4.4	-21.97	-20.51	-19.95
Metals (fabricated)	1.2	1.7	1.9	-3.14	-1.72	-12.59
Machinery, n.e.c.	5.3	7.9	11.1	-3.03	-0.85	-3.63
Medical and communication	2.8	19.0	12.0	-0.11	-0.31	0.13
Electrical machinery	1.4	7.3	4.2	-3.34	-0.16	-4.76
Auto	14.8	28.4	9.4	-0.13	0.14	-0.80
Other transportation	0.4	0.3	0.7	-0.16	0.35	-12.00
Aircraft	3.6	0.6	6.0	-0.38	-0.35	-0.30
Other manufacturing, n.e.c.	1.8	3.8	3.4	0.08	0.20	-1.21
Recyclable	1.1	0.4	1.4	0.45	0.55	-10.12
Total	100	100	100	-1.96	-0.84	-2.24

tariffs on Chinese imports with and without retaliations. In the first round, the U.S. government released a list of approximately $50 billion of imports from China to be subjected to 25 percent tariffs. These tariffs and the Chinese retaliation went into effect in the summer of 2018. In the second round, the U.S. government released an additional list of products of approximately $200 billion of imports from China to be subjected to 10 percent tariffs on September 24, 2018. In turn, China retaliated with a list of approximately $60 billion of imports from the United States. We then look at the impact of an escalation in U.S. tariffs on Chinese imports, increasing tariffs on the list of products on $200 billion of imports from China from 10 to 25 percent starting in January 2019, with and without retaliation.

The distribution of U.S. tariffs on Chinese goods imports and of Chinese retaliatory tariffs on U.S. goods imports across sectors is displayed in **Figure 2**. First, this figure shows that the two rounds of additional tariffs have significantly increased tariffs on trade between the U.S. and China: U.S. tariffs on Chinese goods imports went from a weighted average across sectors of 2.7 percent in the baseline to 10.6 as of October 2018, and are projected to reach 16.3 in January 2019. In contrast, Chinese tariffs on U.S. goods went from 6.2 percent in the baseline to 17.2 as of October 2018, and are projected to reach 20.6 in January 2019. Second, in contrast to steel and aluminum tariff scenario, the two rounds of additional U.S tariffs on Chinese goods imports are broad-based across sectors. Adding all the U.S. and trading partner retaliatory tariffs, the

Table 4: Sectoral price changes and output reallocation from U.S. tariffs on steel and aluminum

	Share of gross value added			**Percentage change in deflator**			**Percentage change in gross value added**		
Sector	Canada	Mexico	U.S.	Canada	Mexico	U.S	Canada	Mexico	U.S.
Farm	1.5	2.3	0.8	-0.04	0.16	-0.03	0.26	0.08	-0.24
Wood	1.1	1.3	0.5	-0.03	0.04	-0.03	0.70	0.16	-0.19
Other energy	3.8	4.5	1.9	-0.05	0.01	-0.02	-0.31	-0.15	0.20
Oil and gas	3.8	2.3	0.5	0.01	0.00	0.00	1.09	-0.01	0.02
Ores	1.8	2.3	0.6	-0.04	0.01	0.00	0.20	-0.09	0.53
Non-metals	2.1	2.3	0.6	-0.05	0.01	0.00	-0.62	-0.20	0.51
Food	1.7	4.7	1.5	0.35	0.37	-0.01	0.06	0.12	-0.40
Clothing	0.2	0.7	0.2	0.05	0.02	0.02	0.06	0.00	-0.17
Paper	0.8	0.4	0.8	0.38	0.00	-0.03	1.66	-0.08	-0.20
Printing	0.8	0.4	0.8	-0.02	0.01	-0.02	0.05	-0.04	0.04
Chemicals	1.0	1.4	1.6	0.21	0.01	-0.02	0.15	-0.02	-0.09
Pharmacy	0.2	0.1	0.2	0.00	0.01	0.02	0.95	0.17	1.38
Rubber	0.5	0.4	0.5	0.23	0.02	0.02	-0.04	-0.10	-0.23
Non-metal products	0.4	0.9	0.2	-0.02	0.01	0.01	-0.02	0.05	0.03
Metals (intermediate)	0.8	1.6	0.4	2.23	0.86	2.80	-12.23	-3.35	4.47
Metals (fabricated)	0.9	0.5	0.8	0.65	0.32	0.64	-0.37	-0.54	-2.45
Machinery, n.e.c.	0.8	0.9	0.9	0.36	0.21	0.18	-2.27	-1.05	-2.97
Medical and communication	0.4	0.8	1.5	0.03	0.03	0.03	-0.14	-0.34	0.03
Electrical machinery	0.2	0.7	0.3	0.29	0.19	0.22	-3.20	-0.35	-4.52
Auto	0.6	3.1	0.5	0.23	0.19	0.21	-0.33	-0.05	-0.97
Other transportation	0.4	0.1	0.5	0.38	0.17	0.18	1.78	0.06	-1.03
Aircraft	0.3	0.1	0.2	0.13	0.15	0.07	-0.51	-0.50	-0.37
Other manufacturing, n.e.c.	0.3	0.5	0.4	0.68	0.25	0.07	-0.03	-0.05	-0.70
Recyclable	0.3	0.2	0.4	0.08	0.08	0.14	0.08	0.12	-1.84
Non-tradable	75.6	67.5	83.5	-0.06	0.01	-0.04	-0.04	0.03	0.02
Total	100	100	100	-0.01	0.08	-0.03	-0.11	-0.08	-0.05

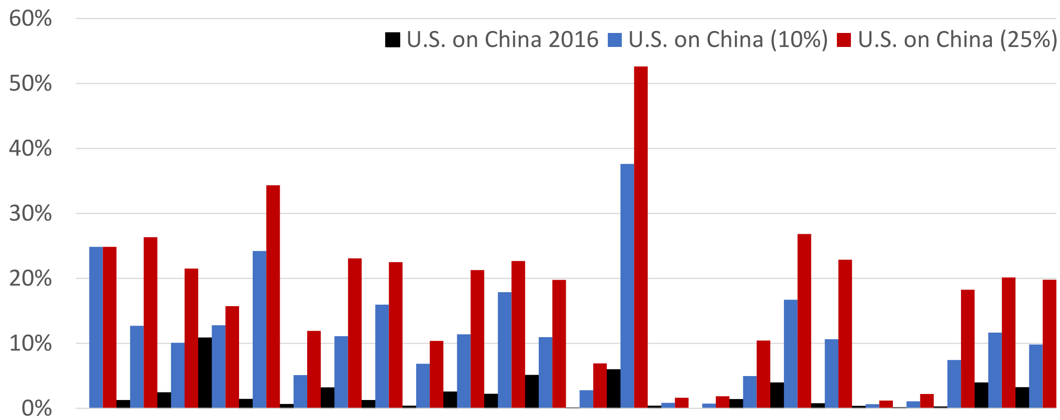
Note: The sum of value added across all sectors is equal to real GDP.

U.S. had tariffs on 12 percent of its total imports, while the combined trading partner retaliation covers 8 percent of total U.S. exports as of October 2018.

Panel A of **Table 5** displays the global impacts from the U.S. tariffs on Chinese imports with China's retaliation as of October 2018 on trade flows, terms of trade, GDP deflators, and real GDP across countries, while **Panel B** displays the global impacts from the proposed tariffs starting in January 2019. Below, we focus on Panel B's results, as the stories of the tariff schedules effective October 2018 and the proposed tariffs for January 2019 are relatively similar. As expected, the biggest impacts are on the United States and China. For example, China's exports to the U.S. fall by 50.3 percent, while those of the U.S. to China fall by 53.3 percent. On aggregate, China's exports fall by 6.8 percent, as global demand for its products declines, while U.S. exports fall by 10.5 percent. U.S. exports fall by more than Chinese exports because the U.S. terms of trade increase, while those of China decrease following the imposition of the bilateral tariffs. In turn, the Chinese GDP deflator decreases by 0.52 percent, while that of the U.S. increases by 0.42 percent. The magnitude of these aggregate price movements is 10 times larger than under the steel and aluminum scenario. Finally, real GDP drops by 0.33 percentage points in China and 0.25 percentage points in the U.S.

Figure 2: Bilateral trade-weighted tariffs between the United States and China, by sector

Panel A: U.S. tariffs on Chinese goods imports



Panel B: Chinese tariffs on U.S. goods imports

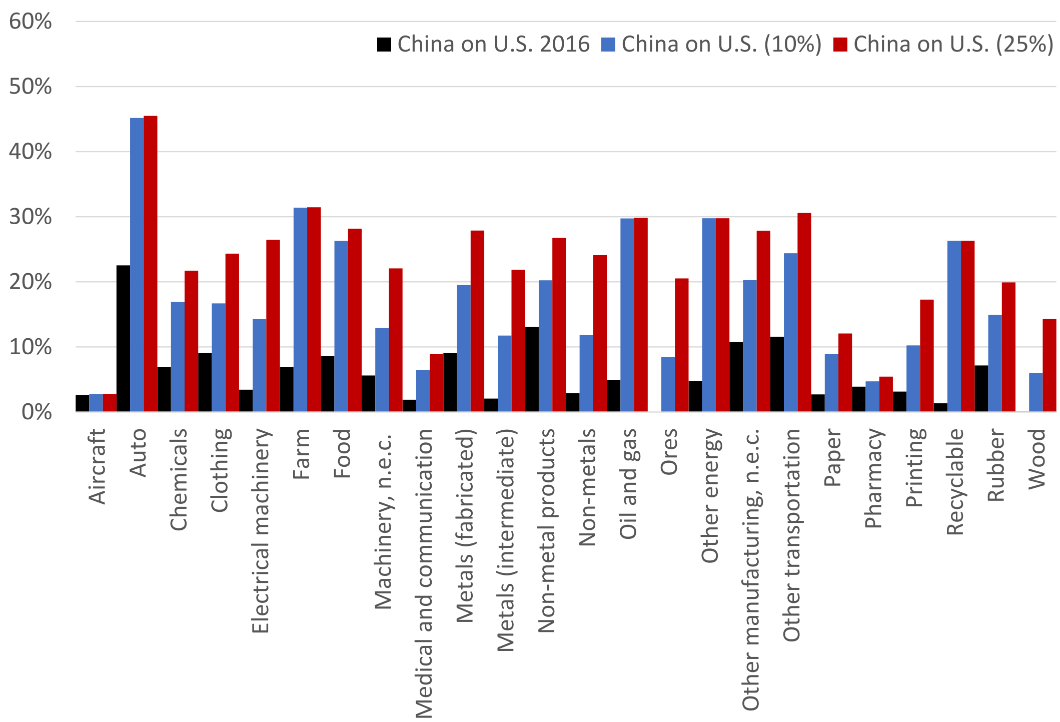


Table 5: Global impacts from U.S. tariffs on $250 billion of Chinese goods imports
(in percentage change)

Panel A: Tariffs effective October 2018

	Change in Trade Flows				Terms of	GDP	Real
	Exports to U.S.	Exports to China	Total Exports	Total Imports	Trade	Deflator	GDP
Australia	7.20	-7.96	-0.24	-0.29	-0.02	-0.08	-0.02
Brazil	2.57	-4.71	-0.24	-0.26	0.00	0.01	0.00
Canada	-1.04	-6.07	-1.44	-1.43	0.00	0.16	-0.11
China	-36.99	·	-5.16	-6.99	-0.14	-0.32	-0.26
EU	4.30	-2.92	0.14	0.15	0.02	0.07	0.01
India	1.42	-2.08	0.27	0.20	0.00	0.04	0.00
Japan	7.15	-3.37	0.65	0.64	0.01	0.10	0.01
Korea	7.28	-2.75	0.17	0.21	0.02	0.05	0.02
Malaysia	15.91	-3.58	0.94	1.30	0.08	0.09	0.05
Mexico	4.09	-9.18	1.76	1.76	0.09	0.54	0.02
Norway	6.05	-2.83	0.05	0.06	0.00	0.06	0.00
Peru	6.15	-9.19	0.15	0.15	-0.01	0.02	-0.01
Switzerland	7.39	-4.04	0.18	0.18	0.00	0.10	0.00
Thailand	10.78	-2.73	0.75	0.85	0.06	0.11	0.06
U.S.	·	-43.73	-8.37	-5.08	0.04	0.25	-0.18
ROW	2.91	-3.53	0.08	0.08	-0.01	0.02	0.00

Panel B: Proposed tariffs for January 2019

	Change in Trade Flows				Terms of	GDP	Real
	Exports to U.S.	Exports to China	Total Exports	Total Imports	Trade	Deflator	GDP
Australia	9.87	-11.52	-0.34	-0.40	-0.03	-0.13	-0.02
Brazil	3.97	-6.95	-0.35	-0.39	-0.01	-0.01	-0.01
Canada	-0.36	-8.54	-1.25	-1.23	0.00	0.23	-0.11
China	-50.26	·	-6.82	-9.24	-0.21	-0.52	-0.33
EU	6.46	-4.30	0.19	0.19	0.02	0.08	0.02
India	3.54	-3.06	0.50	0.36	0.01	0.04	0.01
Japan	9.76	-4.69	0.85	0.83	0.02	0.11	0.02
Korea	10.45	-3.82	0.24	0.29	0.03	0.05	0.02
Malaysia	21.76	-4.99	1.27	1.75	0.11	0.10	0.07
Mexico	5.86	-12.44	2.64	2.65	0.12	0.71	0.05
Norway	7.65	-4.04	0.06	0.08	0.00	0.06	0.00
Peru	7.37	-12.88	0.06	0.06	-0.02	0.00	-0.02
Switzerland	10.12	-5.44	0.24	0.24	0.00	0.11	0.00
Thailand	15.38	-3.88	1.03	1.17	0.09	0.14	0.08
U.S.	·	-53.35	-10.45	-6.34	0.05	0.42	-0.25
ROW	5.10	-5.10	0.11	0.11	0.00	0.01	0.00

Table 6 displays sectoral changes in U.S. exports to China and in Chinese exports to the U.S., together with their current export shares. As the tariffs are broad-based across sectors, exports massively drop in almost every sector except the ones for which there are no close import substitutes. This is clothing (and a couple of other smaller sectors) for Chinese exports to the U.S., and aircraft for U.S. exports to China.

The U.S.-China trade tensions also ripple through the global economy, especially among Canada, Mexico, and other Asian economies that either are part of the global supply chain affected by the tariffs or that

Table 6: Bilateral export reallocation from U.S. tariffs on $250 billion of Chinese goods imports (proposed tariff schedules starting in January 2019, with China's retaliation)

	Current exports from (as a share of exports)		**Change in exports from** (in percent)	
Sector	China to U.S.	U.S. to China	China to U.S.	U.S. to China
Medical and communication	34.0	16.3	-53.2	-55.2
Clothing	15.1	0.7	-7.7	-31.3
Other manufacturing, n.e.c.	12.7	1.8	-21.3	-43.8
Machinery, n.e.c.	10.7	8.0	-91.0	-89.0
Electrical machinery	6.5	4.5	-96.5	-94.0
Rubber	4.1	4.9	-53.8	-63.2
Metals (fabricated)	3.6	1.1	-79.3	-81.6
Auto	2.9	9.3	-68.5	-63.0
Chemicals	2.3	6.2	-40.6	-36.3
Non-metal products	1.5	1.0	-37.0	-37.7
Metals (intermediate)	1.4	3.1	-65.0	-75.3
Food	1.2	4.7	-34.9	-35.5
Wood	0.9	1.6	-90.3	-90.8
Paper	0.7	1.9	-85.3	-61.4
Other transportation	0.7	0.1	-83.5	-66.1
Pharmacy	0.5	2.3	-7.9	-80.8
Printing	0.5	1.2	-11.2	-71.9
Farm	0.2	12.5	-19.7	-36.3
Aircraft	0.2	11.9	-61.5	-4.6
Oil and gas	0.1	1.4	-99.9	-98.5
Non-metals	0.1	0.2	-15.8	-43.4
Other energy	0.0	0.1	-47.9	-100.0
Recyclable	0.0	3.9	-73.4	-37.0
Ores	0.0	1.2	-12.0	-100.0
Total	100	100	-50.3	-53.3

offer close substitutes to Chinese and U.S. exports. **Table 7** displays percentage changes in Canada, Mexico, U.S., and China sectoral exports, together with their current sectoral export shares. The table shows important export reallocations across these countries. For example, Canadian and Mexican exports go up in many export sectors that provide the U.S. with a close substitute to major Chinese export sectors (e.g., clothing, medical and communication, electrical machinery, machinery, and other manufacturing constitute about 80 percent of Chinese exports to the U.S.). In turn, these massive sectoral export reallocations have important implications on prices and real economic activity.

Table 8 displays sectoral value added shares, sectoral price adjustments, and changes in sectoral real value added for the U.S., China, and the two other NAFTA partners. In the U.S., the sectors that experience the largest drop in Chinese imports see more noticeable increases in prices (e.g., clothing, medical and communication, electrical machinery, machinery, and other manufacturing), reflecting the lack of cheap inputs from China. In contrast, China's output prices decline in almost every sector, reflecting the drop in aggregate demand for Chinese products—as the Chinese economy relies heavily on its tradable sectors relative to the U.S. Overall, however, changes in sectoral prices remain relatively small, calling for a U.S. GDP deflator increase of 0.4 percentage point and Chinese GDP deflator decline of 0.5 percentage point. The sectoral out-

Table 7: Sectoral export reallocation from U.S. tariffs on $250 billion of Chinese goods imports (proposed tariff schedules starting in January 2019, with China's retaliation)

	Current exports from (as a share of total exports)				**Change in exports from** (in percent)			
Sector	Canada	Mexico	U.S.	China	Canada	Mexico	U.S.	China
Farm	5.4	3.7	5.2	0.6	-0.28	-0.88	-9.86	-0.43
Wood	2.9	0.1	0.6	0.7	0.74	-6.37	-28.85	-14.90
Other energy	1.8	0.0	0.7	0.1	-7.63	-37.94	-12.49	57.42
Oil and gas	22.5	8.6	8.9	1.0	-0.87	-10.89	-5.46	12.54
Ores	1.9	1.2	0.5	0.0	-8.62	-25.45	-22.49	32.71
Non-metals	2.2	0.2	0.2	0.1	-0.40	-1.69	-2.43	0.48
Food	6.9	4.2	6.1	2.0	0.22	-0.46	-5.94	-3.58
Clothing	0.7	2.0	1.4	16.0	1.75	1.04	-2.86	-0.83
Paper	3.6	0.5	1.8	0.9	0.35	-2.75	-10.22	-8.69
Printing	0.3	0.3	0.8	0.4	-5.21	-2.98	-12.63	0.88
Chemicals	3.5	2.1	7.3	3.8	0.22	-0.86	-4.04	-3.61
Pharmacy	2.1	0.7	5.7	0.6	-4.38	-15.42	-9.79	15.24
Rubber	3.9	2.6	5.5	4.0	5.05	1.87	-6.02	-8.42
Non-metal products	0.7	1.0	1.0	2.2	3.12	0.96	-4.49	-3.58
Metals (intermediate)	9.5	3.4	4.4	4.1	-22.16	-21.95	-25.98	-0.61
Metals (fabricated)	1.2	1.7	1.9	3.8	2.01	-0.51	-19.26	-9.81
Machinery, n.e.c.	5.3	7.9	11.1	9.2	7.20	7.66	-16.02	-14.87
Medical and communication	2.8	19.0	12.0	27.8	12.43	15.30	-11.94	-10.33
Electrical machinery	1.4	7.3	4.2	9.2	15.12	18.27	-20.19	-8.20
Auto	14.8	28.4	9.4	2.6	1.60	0.93	-8.53	-13.88
Other transportation	0.4	0.3	0.7	1.8	2.26	0.10	-17.23	-1.69
Aircraft	3.6	0.6	6.0	0.2	-0.16	-0.97	-2.27	-9.88
Other manufacturing, n.e.c.	1.8	3.8	3.4	8.7	5.81	4.75	-4.80	-5.06
Recyclable	1.1	0.4	1.4	0.0	0.33	-2.65	-28.73	-7.74
Total	100	100	100	100	-1.25	2.64	-10.45	-6.82

put reallocation effects, however, are very large in some sectors. This is especially true for the economies of Canada and Mexico, which experience large real output gains in many tradable sectors of their economies (e.g., medical and communication, and electrical machinery in Mexico). These sizable and broad sectoral output reallocations for the U.S. and its trading partners suggest important short-run price movements, as they appear too large to be absorbed by the current industry structure due to the slow movements of labor and capital across sectors.

4.2 Endogenizing trade balances

As in Caliendo and Parro (2015), the results in the previous subsection assumed that trade balances remain fixed following tariff changes. In the current context, however, this assumption may be misleading as the trade rebalancing is at the root of the U.S.-led trade war. In this subsection, we endogenize trade balances D_n, by fixing income I_n in (27). That is,

Table 8: Sectoral price changes and output reallocation from U.S. tariffs on $250 billion of Chinese goods imports (proposed tariff schedules starting in January 2019, with China retaliation)

	Share of gross value added				**Percent change in deflator**				**Percent change in gross value added**			
Sector	Canada	Mexico	U.S.	China	Canada	Mexico	U.S	China	Canada	Mexico	U.S.	China
Farm	1.5	2.3	0.8	6.6	0.21	0.78	0.33	-0.19	-0.04	-0.43	-3.30	-0.07
Wood	1.1	1.3	0.5	4.4	0.21	0.71	0.45	-0.61	0.51	-0.36	-0.25	0.02
Other energy	3.8	4.5	1.9	4.1	0.20	0.71	0.28	-0.61	-0.93	-1.12	-0.32	1.02
Oil and gas	3.8	2.3	0.5	1.2	0.26	0.30	0.14	-0.26	-1.12	-11.16	-5.59	8.24
Ores	1.8	2.3	0.6	1.3	0.21	0.73	0.35	-0.46	-3.09	-8.81	-2.30	9.77
Non-metals	2.1	2.3	0.6	1.5	0.20	0.74	0.36	-0.61	-1.14	-0.87	-0.37	0.61
Food	1.7	4.7	1.5	3.2	0.60	1.01	0.48	-0.37	0.05	0.04	-0.81	-0.40
Clothing	0.2	0.7	0.2	2.5	-0.10	0.32	1.45	-0.51	0.83	0.30	-0.77	-0.33
Paper	0.8	0.4	0.8	0.4	0.64	0.48	0.47	-0.30	1.72	-1.10	-0.38	-0.39
Printing	0.8	0.4	0.8	0.4	0.24	0.60	0.38	-0.38	0.19	0.28	-0.61	0.42
Chemicals	1.0	1.4	1.6	2.4	0.47	0.52	0.59	-0.37	0.35	-0.27	-1.08	-0.71
Pharmacy	0.2	0.1	0.2	0.2	0.18	0.20	0.09	-0.32	-4.55	-14.40	-9.87	8.39
Rubber	0.5	0.4	0.5	1.4	0.51	0.37	1.52	-0.28	3.45	1.07	-1.14	-1.84
Non-metal products	0.4	0.9	0.2	2.0	0.20	0.61	1.24	-0.56	0.66	0.40	0.27	-0.65
Metals (intermediate)	0.8	1.6	0.4	3.8	2.40	1.37	3.26	-0.48	-11.98	-2.58	3.29	-0.48
Metals (fabricated)	0.9	0.5	0.8	1.1	0.84	0.65	1.56	-0.50	0.32	-0.10	0.42	-2.19
Machinery, n.e.c.	0.8	0.9	0.9	3.4	0.63	0.43	1.62	-0.38	4.01	7.20	-4.53	-1.97
Medical and communication	0.4	0.8	1.5	2.0	0.10	-0.01	2.40	0.05	7.43	15.31	1.41	-7.34
Electrical machinery	0.2	0.7	0.3	1.7	0.49	0.20	2.50	-0.32	8.13	16.62	-4.55	-1.65
Auto	0.6	3.1	0.5	1.8	0.76	0.57	1.04	-0.07	0.86	0.36	-3.85	-0.51
Other transportation	0.4	0.1	0.5	0.5	0.64	0.54	0.96	-0.48	2.10	-0.81	-0.45	-0.49
Aircraft	0.3	0.1	0.2	0.2	0.50	0.62	0.40	-0.06	-0.66	-1.58	-2.66	-0.23
Other manufacturing, n.e.c.	0.3	0.5	0.4	1.3	0.70	0.18	2.56	0.46	3.53	4.56	-1.41	-5.49
Recyclable	0.3	0.2	0.4	1.0	0.37	0.66	0.60	-0.17	0.27	1.19	-5.48	2.36
Non-tradable	75.6	67.5	83.5	51.5	0.13	0.47	0.22	-0.42	0.01	0.46	0.00	-0.35
Total	100	100	100	100	0.23	0.71	0.42	-0.52	-0.11	0.05	-0.25	-0.33

Note: The sum of value added across all sectors is equal to real GDP.

$$\hat{\kappa}^j_{ni} = \frac{1+\tau^{j\,\prime}_{ni}}{1+\tau^j_{ni}}, \text{ and } I_n = w'_n L_n + \sum_{j=1}^{J}\sum_{i=1}^{N} \tau^{j\,\prime}_{ni} \frac{\pi^{j\,\prime}_{ni}}{1+\tau^{j\,\prime}_{ni}} X^{j\,\prime}_n + D'_n. \tag{27}$$

In line with Caliendo and Parro (2015)'s partial results, endogenizing trade balances does not change the qualitative results.[22] **Table 9** displays the global impacts from the U.S. tariffs on Chinese imports with China's retaliation starting in January 2019 on trade flows, terms of trade, GDP deflators, real GDP, and trade balances across countries. Indeed, the additional U.S. tariffs reduce the U.S. trade deficits and the Chinese surplus, but the main takeaway is that endogenizing trade balances does not change the qualitative results displayed in section 4.1. Interestingly, the model suggests that Mexico (followed by Canada and Japan) experiences a relatively large improvement in its trade balance.

As we can see from **Table 9**, additional tariffs reduce both U.S. imports and U.S. exports, with little improvement in the U.S. trade deficit. As we pointed out earlier, the U.S. depends on imported inputs for

[22] Caliendo and Parro (2015) do not endogenize trade deficits, but instead compare results between fixed trade deficits and balanced trade. Their results show little quantitative differences between the two. In later papers, Caliendo et al. (2017), Caliendo et al. (2018a), and Caliendo et al. (2018b) propose a way to endogenize trade balances. In this paper, we use a simpler framework to endogenize trade balances at the cost of fixing income.

Table 9: Global impacts from U.S. tariffs on $250 billion of Chinese goods imports (proposed tariff schedules starting in January 2019, endogenizing trade balances)

	Change in Trade Flows				Terms of	GDP	Real	Trade Balance (in billions of $)		
	X to U.S.	X to China	Total X	Total M	Trade	Deflator	GDP	Current	Endogenous	Difference
Australia	8.07	-9.17	-0.82	-0.25	-0.02	-0.09	-0.02	39.4	37.9	-1.6
Brazil	2.91	-5.13	-0.36	-0.22	0.00	-0.01	0.00	22.6	22.2	-0.4
Canada	-0.40	-6.27	-0.99	-1.41	-0.01	0.13	-0.11	-5.6	-3.7	1.9
China	-50.90	·	-7.85	-8.12	-0.15	-0.37	-0.29	639.9	594.5	-45.4
EU	5.86	-3.01	0.27	0.12	0.01	0.04	0.01	126.0	134.5	8.5
India	2.97	-2.36	0.42	0.22	0.00	0.01	0.01	-115.9	-115.5	0.4
Japan	9.10	-3.52	1.10	0.52	0.01	0.06	0.01	-19.0	-14.9	4.1
Korea	9.58	-3.33	0.27	0.22	0.02	0.03	0.02	98.1	98.6	0.5
Malaysia	20.84	-4.26	1.35	1.63	0.09	0.08	0.05	75.4	75.9	0.5
Mexico	6.62	-9.03	3.75	2.07	0.07	0.46	0.00	1.1	7.6	6.5
Norway	6.98	-3.00	0.09	0.03	0.00	0.02	0.00	28.2	28.3	0.1
Peru	6.58	-9.83	0.10	0.16	-0.01	-0.01	-0.01	-1.4	-1.5	0.0
Switzerland	9.67	-4.37	0.33	0.17	0.00	0.07	0.00	6.3	6.7	0.5
Thailand	14.67	-3.20	1.14	1.00	0.06	0.09	0.06	27.7	28.3	0.6
U.S.	·	-52.62	-9.51	-6.77	0.04	0.25	-0.27	-901.2	-878.2	23.0
ROW	4.29	-3.99	0.10	0.08	0.00	-0.01	0.00	-21.6	-20.6	1.0

Note: In this table, X stands for exports and M stands for imports. "Current" refers to 2016 trade balances, in billions of dollars. Numbers in this table are shown in percentage changes, except for the trade balances, which are shown in billions of dollars.

many sectors of its economy. As such, U.S. exports fall not only because of other countries' retaliatory tariffs on U.S. exports, but also because the cost for U.S. firms producing goods for exports rises and makes U.S. exports less competitive on the global market. The end results are lower imports, lower exports, and little improvement in the U.S. trade deficit.

4.3 Proposed automobile sector tariffs

Starting during the presidential campaign and culminating in the wake of the June 2018 G7 meetings, President Trump proposed imposing tariffs on imports of automobiles and automobile parts.[23] We therefore look at the impact of a potential 25 percent tariff on automobiles and automobile parts imposed by the United States without retaliation, starting from the U.S.-China January 2019 tariff scenario. In this exercise, Canada and Mexico are the only exempt countries, as they have recently renegotiated a trade agreement covering the automobile industry. The agreement specifies that Canada and Mexico have been granted limited but *à priori* non-binding exemptions from potential future tariffs on automobiles. For example, Canada's exemption is set to about twice the 2017 level of automobile exports to the United States.

The main impacts on the global economy are presented in **Table 10**. Similar to the steel and aluminum scenario, trade in the automobiles and parts sector is significantly affected by the tariff. Exports of automobiles and parts to the United States drop heavily for all countries but Canada and Mexico. This drop in automobiles and parts exports is especially important for the European Union, Japan, and South Korea, which are large exporters of automobiles and parts to the United States. In contrast, Canada and Mexico,

[23] On May 23, 2018, the U.S. Secretary of Commerce initiated a Section 232 investigation into whether imports of automobiles and automobile parts threaten to impair national security.

Table 10: Global impact from proposed U.S. tariffs on automobiles and automobile parts
(25 percent tariff on automobiles and automobile parts)
(in percentage change)

	Exposure		Exports of Autos and Parts to		Total Exports to		Terms of Trade	GDP Deflator	Real GDP
	Auto tariffs	Exports to U.S.	U.S.	World	U.S.	World			
Australia	0.13	4.34	-59.95	-6.69	11.28	-0.48	-0.04	-0.20	-0.03
Brazil	0.40	12.44	-60.18	-3.17	3.94	-0.53	-0.01	-0.04	-0.01
Canada	13.84*	76.09	27.76	26.12	3.86	0.98	-0.01	0.50	-0.11
China	0.59	17.53	-84.79	-17.87	-49.96	-6.81	-0.22	-0.58	-0.33
EU	1.08	7.38	-59.17	-5.03	-0.54	-0.21	0.00	-0.02	0.00
India	0.46	14.30	-60.20	-6.01	3.02	0.36	0.01	-0.01	0.01
Japan	7.13	19.65	-58.85	-18.53	-8.79	-0.91	-0.02	-0.23	-0.02
Korea	3.90	12.80	-59.97	-18.87	-6.02	-0.65	-0.09	-0.16	-0.07
Malaysia	0.06	8.80	-59.69	-5.25	24.23	1.33	0.10	0.05	0.07
Mexico	22.85*	80.75	27.55	22.69	11.74	5.74	0.24	1.35	0.18
Norway	0.02	3.92	-59.75	-4.01	9.81	0.06	0.00	0.01	0.00
Peru	0.02	15.72	-60.32	-9.12	9.38	-0.05	-0.04	0.01	-0.03
Switzerland	0.07	10.30	-59.85	-7.17	11.18	0.23	0.00	0.06	0.00
Thailand	0.37	10.81	-59.53	-2.04	16.03	0.99	0.08	0.06	0.08
U.S.	·	·	·	-8.31	·	-12.64	0.09	0.86	-0.37
ROW	0.13	6.04	-59.38	-1.92	6.00	0.00	0.00	-0.05	0.01

Note: * Canada and Mexico are exempt under the new USMCA trade agreement. Without a trade agreement, Canada's automobiles and automobile parts tariff exposure would be 13.8 percent, while that of Mexico would be 22.9 percent.

whose automobiles and automobile parts markets are already well integrated with the United States, see their exports increase: Canada's exports of automobiles and automobile parts to the United States increase by 27.8 percent, while those of Mexico increase by 27.6 percent. Given reasonable annual growth rates in addition to the increase in exports due to the tariffs, the current exemptions could become binding within a decade, long before the agreement is due to be renegotiated. The imposition of these tariffs would be particularly beneficial for Mexico, whose marginal increase in real GDP growth would match the marginal losses of the United States. Despite a significant rise in exports, Canada would experience almost no change in real GDP growth. Outside of the United States, Japan and Korea would be most negatively affected.

The additional U.S. tariffs on automobiles and parts imports also have large impacts on prices, more than doubling the growth in the GDP deflator for Canada, Mexico, and the United States. In particular, the impact on sectoral prices is broad-based in the United States, having an important impact on both traded and non-traded sectors. On aggregate, the model suggests an increase in the U.S. GDP deflator of 0.87 percent—compared with 0.42 percent in the U.S.-China January 2019 tariff scenario. In addition, the model suggests an increase in the automobile sector deflator of 6.24 percent—from 1.04 under the U.S.-China January 2019 tariff scenario.[24] Considering an estimated average transaction price for light vehicles in the United States

[24]Most analysis reported estimates on the impacts of the proposed U.S. tariffs on automobiles and parts imports, including imports from Canada and Mexico. In this case, the impact on the U.S. GDP deflator increases to 1.24 percent, while the automobile sector deflator increases by 12.49 percent when we also impose tariffs on the imports of automobiles and parts from Canada and Mexico.

of \$37,007 in October 2018, the impacts of the tariffs sum up to an average increase of \$2,310—which is in line with what has been reported by the media.[25]

5 Conclusion

In this paper, we build upon new developments in the international trade literature to identify and quantify the impact of tariff changes on the United States and the global economy. In particular, we apply the most recent data and trade elasticity estimates using the Ricardian model of Caliendo and Parro (2015) to quantify the impact of recently applied and proposed tariff changes. Overall, our results suggest that the newly imposed and proposed tariff schemes imply considerable changes in trade flows and sectoral output reallocations, but modest impacts on long-run aggregate prices and output levels. The size of the sectoral output reallocations suggests important short-run price movements, as they appear too large to be absorbed given the current industry structure due to the slow movements of labor and capital across sectors. Additionally, endogenizing trade balances reduces the U.S. trade deficit and the Chinese surplus some, but the main takeaway is that it only marginally changes the results.

[25] Average transaction price for light vehicles in the United States as reported by Kelley Blue Book. Early media citations are reported in Lovely et al. (2018). In a July 2018 U.S. Commerce Department hearing, the National Automobile Dealers Association estimated that a 25 percent tariff on automobiles and automobile parts would add \$2,270 to the cost of U.S.-built cars, which is close to the estimate presented above.

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A Additional Tables and Results

Table A-1: Sector decomposition and corresponding ISIC

Number	ISIC	Sector
1	01,05	Farm
2	02,20	Wood
3	10,12,23	Other energy
4	11	Oil and gas
5	13	Ores
6	14	Non-metals
7	15-16	Food
8	17-19	Clothing
9	21	Paper
10	22	Printing
11	24	Chemicals
12	2423	Pharmacy
13	25	Rubber
14	26	Non-metal products
15	27	Metals (intermediate)
16	28	Metals (fabricated)
17	29	Machinery, n.e.c.
18	30-33	Medical and communication
19	31	Electrical machinery
20	34	Auto
21	351,352,359	Other transportation
22	353	Aircraft
23	36	Other manufacturing, n.e.c.
24	37	Recyclable
25	40-41	Electricity
26	45	Construction
27	50-52	Retail
28	55	Hotels
29	60	Land transport
30	61	Water transport
31	62	Air transport
32	63	Aux transport
33	64	Post
34	65-67	Finance
35	70	Real estate
36	71	Renting machinery
37	72	Computer
38	73	Research and development
39	74	Other business
40	75	Public
41	80	Education
42	85	Health
43	90-93	Other services
44	95	Private

Table A-2: Shares of gross output versus gross value added

Sector	Share of gross output				Share of gross value added			
	Canada	Mexico	U.S.	China	Canada	Mexico	U.S.	China
Farm	1.5	2.2	1.0	3.6	1.5	2.3	0.8	6.6
Wood	1.4	1.3	0.8	3.3	1.1	1.3	0.5	4.4
Other energy	5.2	5.4	3.8	4.6	3.8	4.5	1.9	4.1
Oil and gas	2.9	1.6	0.5	0.9	3.8	2.3	0.5	1.2
Ores	1.4	1.6	0.6	0.9	1.8	2.3	0.6	1.3
Non-metals	1.6	1.6	0.6	1.1	2.1	2.3	0.6	1.5
Food	3.1	7.2	3.2	5.1	1.7	4.7	1.5	3.2
Clothing	0.2	1.1	0.3	4.2	0.2	0.7	0.2	2.5
Paper	0.9	0.5	1.1	0.6	0.8	0.4	0.8	0.4
Printing	0.9	0.5	1.1	0.6	0.8	0.4	0.8	0.4
Chemicals	1.5	2.8	2.5	4.2	1.0	1.4	1.6	2.4
Pharmacy	0.2	0.2	0.3	0.3	0.2	0.1	0.2	0.2
Rubber	0.8	0.8	0.7	2.7	0.5	0.4	0.5	1.4
Non-metal products	0.5	1.0	0.3	3.1	0.4	0.9	0.2	2.0
Metals (intermediate)	2.2	2.5	1.2	6.7	0.8	1.6	0.4	3.8
Metals (fabricated)	1.1	0.9	1.2	1.8	0.9	0.5	0.8	1.1
Machinery, n.e.c.	1.1	1.5	1.3	5.0	0.8	0.9	0.9	3.4
Medical and communication	0.6	3.6	1.3	4.3	0.4	0.8	1.5	2.0
Electrical machinery	0.3	1.4	0.4	3.4	0.2	0.7	0.3	1.7
Auto	2.2	5.4	1.7	3.6	0.6	3.1	0.5	1.8
Other transportation	0.6	0.1	0.7	0.7	0.4	0.1	0.5	0.5
Aircraft	0.5	0.1	0.3	0.2	0.3	0.1	0.2	0.2
Other manufacturing, n.e.c.	0.4	0.7	0.4	0.9	0.3	0.5	0.4	1.3
Recyclable	0.4	0.4	0.4	0.7	0.3	0.2	0.4	1.0
Non-tradables	68.7	55.5	74.4	37.5	75.6	67.5	83.5	51.5
Total	100	100	100	100	100	100	100	100

Note: This table shows the share differences between gross output and value added. Gross output is principally a measure of sales or revenue from production for most industries, although it is measured as sales or revenue less cost of goods sold for margin industries like retail and wholesale trade. Intermediate inputs are the foreign and domestically produced goods and services used up by an industry in the process of producing its gross output. Value added is the difference between gross output and intermediate inputs and represents the value of labor (and capital) used in producing gross output. The sum of value added across all industries is equal to GDP for the economy. In this paper, we report the shares of gross value added as they are directly linked to the results on real GDP and GDP deflators.

Table A-3: Sectoral gross output reallocation from U.S. tariffs on steel and aluminum

	Share of gross output			Percentage change in real gross output		
Sector	Canada	Mexico	U.S.	Canada	Mexico	U.S.
Farm	1.5	2.2	1.0	0.26	0.08	-0.24
Wood	1.4	1.3	0.8	0.70	0.16	-0.19
Other energy	5.2	5.4	3.8	-0.31	-0.15	0.20
Oil and gas	2.9	1.6	0.5	1.09	-0.01	0.02
Ores	1.4	1.6	0.6	0.20	-0.09	0.53
Non-metals	1.6	1.6	0.6	-0.62	-0.20	0.51
Food	3.1	7.2	3.2	0.06	0.12	-0.40
Clothing	0.2	1.1	0.3	0.06	0.00	-0.17
Paper	0.9	0.5	1.1	1.66	-0.08	-0.20
Printing	0.9	0.5	1.1	0.05	-0.04	0.04
Chemicals	1.5	2.8	2.5	0.15	-0.02	-0.09
Pharmacy	0.2	0.2	0.3	0.95	0.17	1.38
Rubber	0.8	0.8	0.7	-0.04	-0.10	-0.23
Non-metal products	0.5	1.0	0.3	-0.02	0.05	0.03
Metals (intermediate)	2.2	2.5	1.2	-12.23	-3.35	4.47
Metals (fabricated)	1.1	0.9	1.2	-0.37	-0.54	-2.45
Machinery, n.e.c.	1.1	1.5	1.3	-2.27	-1.05	-2.97
Medical and communication	0.6	3.6	1.3	-0.14	-0.34	0.03
Electrical machinery	0.3	1.4	0.4	-3.20	-0.35	-4.52
Auto	2.2	5.4	1.7	-0.33	-0.05	-0.97
Other transportation	0.6	0.1	0.7	1.78	0.06	-1.03
Aircraft	0.5	0.1	0.3	-0.51	-0.50	-0.37
Other manufacturing, n.e.c.	0.4	0.7	0.4	-0.03	-0.05	-0.70
Recyclable	0.4	0.4	0.4	0.08	0.12	-1.84
Non-tradable	68.7	55.5	74.4	-0.06	0.03	0.01
Total	100	100	100	-0.31	-0.11	-0.07

Table A-4: Sectoral gross output reallocation
from U.S. tariffs on $250 billion of Chinese goods imports
(proposed tariff schedules starting in January 2019, with China retaliation)

	Share of gross output				**Percentage change in real gross output**			
Sector	Canada	Mexico	U.S.	China	Canada	Mexico	U.S.	China
Farm	1.5	2.2	1.0	3.6	-0.04	-0.43	-3.30	-0.07
Wood	1.4	1.3	0.8	3.3	0.51	-0.36	-0.25	0.02
Other energy	5.2	5.4	3.8	4.6	-0.93	-1.12	-0.32	1.02
Oil and gas	2.9	1.6	0.5	0.9	-1.12	-11.16	-5.59	8.24
Ores	1.4	1.6	0.6	0.9	-3.09	-8.81	-2.30	9.77
Non-metals	1.6	1.6	0.6	1.1	-1.14	-0.87	-0.37	0.61
Food	3.1	7.2	3.2	5.1	0.05	0.04	-0.81	-0.40
Clothing	0.2	1.1	0.3	4.2	0.83	0.30	-0.77	-0.33
Paper	0.9	0.5	1.1	0.6	1.72	-1.10	-0.38	-0.39
Printing	0.9	0.5	1.1	0.6	0.19	0.28	-0.61	0.42
Chemicals	1.5	2.8	2.5	4.2	0.35	-0.27	-1.08	-0.71
Pharmacy	0.2	0.2	0.3	0.3	-4.55	-14.40	-9.87	8.39
Rubber	0.8	0.8	0.7	2.7	3.45	1.07	-1.14	-1.84
Non-metal products	0.5	1.0	0.3	3.1	0.66	0.40	0.27	-0.65
Metals (intermediate)	2.2	2.5	1.2	6.7	-11.98	-2.58	3.29	-0.48
Metals (fabricated)	1.1	0.9	1.2	1.8	0.32	-0.10	0.42	-2.19
Machinery, n.e.c.	1.1	1.5	1.3	5.0	4.01	7.20	-4.53	-1.97
Medical and communication	0.6	3.6	1.3	4.3	7.43	15.31	1.41	-7.34
Electrical machinery	0.3	1.4	0.4	3.4	8.13	16.62	-4.55	-1.65
Auto	2.2	5.4	1.7	3.6	0.86	0.36	-3.85	-0.51
Other transportation	0.6	0.1	0.7	0.7	2.10	-0.81	-0.45	-0.49
Aircraft	0.5	0.1	0.3	0.2	-0.66	-1.58	-2.66	-0.23
Other manufacturing, n.e.c.	0.4	0.7	0.4	0.9	3.53	4.56	-1.41	-5.49
Recyclable	0.4	0.4	0.4	0.7	0.27	1.19	-5.48	2.36
Non-tradable	68.7	55.5	74.4	37.5	0.05	0.71	0.05	-0.58
Total	100	100	100	100	-0.17	0.85	-0.28	-0.71

B Data

B.1 Bilateral trade flows

We use bilateral trade flow data from the United Nations Statistical Division (UNSD) Commodity Trade (COMTRADE) database. We take an average of the values from 2014 and 2015 for each of the 16 countries and areas in our sample. We create a representative European Union by combining COMTRADE data for each of the 28 member states. We also create a representative rest of world (ROW) by taking the combined trade value between a country and all its partners in our sample, and subtracting it from the trade value between this country and the entire world (as reported in the COMTRADE database). Trade flow values are reported in U.S. dollars at current prices and include cost, insurance and freight (CIF). Commodities are defined using the 2012 Harmonized Commodity Description and Coding System (HS), at a six-digit level of aggregation. We concord the HS12 data to ISIC Revision 3 at a two-digit level of aggregation by first using the Bank of Canada's concordance table purchased from Statistics Canada to map HS12 to NAPCS. We then manually map the NAPCS codes to ISIC Revision 3 for the sectors of interest, which can be found in **Table A-1**.

B.2 Tariffs

We use bilateral tariff data at the sectoral level from the World Trade Organization (WTO) Tariffs Download Facility, for the year 2016. We select 2016 (HS 12) tariffs for the reporting country of interest, and select products reported using the same HS 12 classification at a six-digit level of aggregation. We construct a tariff matrix for each country by first applying any existing trade agreement that is in place. We apply these agreements to the HS code only if the tariff rate is less than the most-favored-nation (MFN) tariff rate. If trade agreement data are not available in a country due to a reporting issue, we apply reciprocity across these agreements. For example, Mexico does not report any agreements; therefore, we apply reciprocity to ensure that NAFTA tariff rates between Mexico, Canada, and the United States are accurate. We weight each tariff matrix against the average bilateral trade values for 2014 and 2015, as noted above. We create the ROW tariff matrix by combining the MFN tariff rates for each country/area in our sample and then weighting it against average ROW trade values.

B.3 Value added and gross production

We use gross output and value added data at the sectoral level from the OECD input-output tables, for the year 2011. We use 2011 data because at the time of publication, this is the most up-to-date data that the OECD provides that can give us consistency across countries and concepts. We create gross output and value added data for the European Union by combining values from each of the 28 member states. We create gross output and value added data for the ROW by combining values from the remaining countries in the database that are not in our sample (including an OECD-built ROW). The value added and gross output data from the OECD are reported in millions of U.S. dollars. For a few sectors in our sample, we split sectoral gross output and value added data to align with our list of sectors in **Table A-1**. For example, we split the gross output and value added sector 21-22 data evenly to create our sector 21 (paper) and sector 22 (printing).

B.4 Input-output tables and intermediate consumption

We construct the share of intermediate inputs from each sector in sectoral gross output, using information from the OECD Input-Output Database for 2011. We create the European Union Input-Output table by combining values from each of the 28 member states. We create the Rest of World Input-Output table by combining values from the remaining countries in the database that are not in our sample. Like the value added and gross output data, we must split certain sectors to match our list of sectors in **Table A-1**.

B.5 Estimation of dispersion of productivity

We estimate the dispersion of productivity following Caliendo and Parro (2015) and using equation (26). We use all trade and tariff data used in the model calibration, while removing some outliers in specific cases, which we list here. For each sector, we remove a country if its share of exports in that sector is less than 0.1% of global exports. We also remove Switzerland from all sectors since its tariffs are set to zero. In addition, we remove Malaysia from the clothing and other manufacturing sectors, Peru from the printing, machinery n.e.c., auto and other manufacturing sectors, and Norway, Thailand, Brazil, and India from the auto sector. These represent outliers in our estimates. Estimates are robust to the removal of other observations.

C Timeline of Additional Tariffs

Below is a detailed timeline of additional tariffs. Official releases from the United States and its trading partners containing HS tariff lines are hyperlinked in the text. These are the additional tariffs, quotas, and exemptions that have been incorporated in the scenarios discussed in section 4. Bown and Kolb (2018) at the Peterson Institute for International Economics provide an excellent timeline of events.

C.1 Steel and aluminum tariffs

- March 8, 2018: The United States formally announces steel and aluminum tariffs, along with temporary exemptions for Canada and Mexico.
  - Steel proclamation
  - Aluminum proclamation
- March 22, 2018: The United States announces additional steel and aluminum tariff temporary exemptions.
  - Additional steel proclamation
  - Additional aluminum proclamation
- March 23, 2018: The United States steel and aluminum tariffs go into effect.
- March 28, 2018: South Korea agrees to an absolute quota that reduces steel exports to the United States, in return for a permanent exemption from the steel tariffs announced on March 8, 2018.
- April 2, 2018: In response to the U.S. steel and aluminum tariffs, China imposes retaliatory tariffs on United States products such as aluminum waste, pork, fruits, and nuts. A 25% tariff will be levied on aluminum waste and scrap, and pork products, while a 15% tariff will be levied on other products.
  - China retaliatory list
- April 30, 2018: The United States signs a proclamation that extends the steel and aluminum tariff exemptions for the European Union, Canada, and Mexico until June 1, 2018.
- June 1, 2018: The United States signs a proclamation that ends the steel and aluminum tariff exemption for Canada, Mexico, and the European Union. The proclamation also outlines the details of quotas negotiated by Argentina, Brazil, and South Korea with the United States. These quotas restrict steel and aluminum exports to the United States, in exchange for tariff exemptions.
- June 22, 2018: In response to the U.S. steel and aluminum tariffs, the European Union imposes retaliatory tariffs on United States products such as steel and aluminum, agriculture, and food.
  - European Union retaliatory list
- July 1, 2018: In response to the U.S. steel and aluminum tariffs, Canada imposes retaliatory tariffs of 25% on steel imports, and 10% on aluminum and a variety of other imports from the United States.
  - Canada retaliatory list

- July 5, 2018: In response to the U.S. steel and aluminum tariffs, Mexico imposes retaliatory tariffs on United States products such as pork and whiskey.
  - Mexico retaliatory list

- In addition, the United States increases the steel and aluminum tariff rates for Turkey, and Russia and Turkey impose retaliatory tariffs on U.S. imports. These tariffs are not accounted for because they are part of the rest of the world region.

- Finally, we leave out India and Japan because they have not officially imposed retaliatory tariffs. They have simply announced their intention to impose them. India retaliatory tariffs will take effect on December 17, 2018. We would not account for India's retaliatory tariffs anyway, because they are part of the rest of the world region.

C.2 U.S.-China trade tension

- June 6, 2018: China and the United States impose first phase of the June 15 tariffs.
  - The United States imposes the first phase of its $50 billion tariff plan on Chinese imports, which includes applying tariffs to $34 billion worth of Chinese products.
  - China also imposes the first phase of its $50 billion tariff plan on United States imports, which includes applying tariffs on $34 billion worth of U.S. products.

- August 23, 2018: China and the United States impose second phase of the June 15 tariffs.
  - The United States imposes the second phase of its $50 billion tariffs plan on Chinese imports, which includes applying tariffs to the remaining $16 billion worth of Chinese products.
  - China also imposes the second phase of its $50 billion tariff plan on U.S. imports, applying tariffs on the remaining $16 billion worth of U.S. products.

- September 24, 2018: China and the United States impose third phase of tariffs.
  - The United States imposes new tariffs on $200 billion worth of Chinese imports, originally announced on September 17. The list of Chinese imports are subject to a 10% tariff from September 24, 2018 to December 31, 2018, and will be subject to a 25% tariff beginning on January 1, 2019.
  - China also imposes new tariffs on $60 billion worth of U.S. imports, originally announced on September 18. The U.S. imports are subject to tariffs ranging from 5 to 10 percent until January 1, 2019.
    - China retaliatory list of U.S. imports at 5 percent
    - China retaliatory list of U.S. imports at 10 percent
    - China retaliatory list of U.S. imports at 20 percent
    - China retaliatory list of U.S. imports at 25 percent

C.3 Proposed automobiles and automobile parts tariffs

For this scenario, we impose a 25 percent tariff on all U.S. imported automobiles and automobile parts (worth about $350 billion). This is the tariffs assumption used in the Fall 2018 World Economic Outlook (International Monetary Fund (2018)), without trading partner retaliation.