Tariff Reciprocity*

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Abstract

U.S. President Trump's emphasis on 'tariff reciprocity' has focused public attention on relative height of tariffs as a measure of fairness in trade relations. The import-weighted average tariff subsequently used by USTR to rank how protectionist are trading partners is atheoretic and misleading for this purpose. We propose and implement a theory-consistent tariff index that combines thousands of tariff rates into an import volume equivalent uniform tariff. The index: (i) is consistent with the WTO principle that trade relations should aim at reciprocal exchange of market access, and (ii) decomposes neatly into each country's buyer and seller incidence of tariffs.

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1 Introduction

Tariff reciprocity is the notion that 'fair' tariffs should be equal across countries. Donald Trump's emphasis on tariff reciprocity to justify U.S. tariff increases has focused immense public attention on the notion. The instinctive mercantilist in most non-economists finds tariff reciprocity to be reasonable. Imports are bad, exports are good; our trade barriers limit our imports, others' trade barriers limit our exports. International fairness thus suggests reciprocity – equal height of tariff walls obtains equal deflection of imports and exports. Public perception that 'average' tariffs should be reciprocally fair is thus likely to survive the errors of its application by the Trump administration.

The standard rationale for the GATT/WTO is strikingly similar. Trade barrier reduction aims at reciprocal exchange of market access – more bad imports in return for more good exports. Reciprocity applies in both directions – the reciprocal barrier response to foreign barrier rise takes away as much market access from the foreigner as was lost to the initial foreign barrier increase. Thus the system accommodates changes in protectionist pressure and changes in economic conditions that may result in tariff changes and reciprocal countering changes in partner tariffs.

We propose an appropriate measure of the 'average' tariff for reciprocity comparisons. Application to 2019 data results in tariff indexes that diverge substantially from the import-weighted average tariffs currently used. The tariff index problem is that many thousands of highly varying tariff rates must be appropriately weighted into a single representative average. Appropriate with respect to what objective? An individual product tariff measures how much the exporter's cost of selling to the importing country is raised by the tariff. An appropriate tariff index that measures the height of protection walls facing exporters is the amount by which the cost of imports is raised relative to free trade: the uniform (across trade partners and products) tariff that yields the same total value (net of tariffs) of imports as the actual differentiated tariff structure.

The index developed below has the additional feature that the inward face of a country's protection wall combines the cost to buyers offset by the benefit to domestic sellers who enjoy higher net seller prices as a result of the tariffs on the foreign substitute goods. Thus we call the index the True Cost of Protection index. Like the true cost-of-living index, the TCP has a transparent meaning to non-economists. The TCP also features reciprocity in its structure, since the measure reflects the complete bilateral tariff structure of all the world's tariffs. For these reasons we argue that the TCP can be a helpful guide for negotiations aimed at reciprocal exchange of market access. TCP reciprocity may thus help rebuild support for a multilateral trade system like the WTO.

The true cost of protection index is developed and applied in the context of the CES (Constant Elasticity of Substitution) structural gravity model of bilateral trade [(Eaton and Kortum, 2002; Anderson and van Wincoop, 2003; Arkolakis et al., 2012; Allen et al., 2020)]. Gravity has become the current workhorse model of trade policy analysis because it fits the data extremely well, and its use in projections is remarkably more successful than most economic models.

The TCP inherits several important properties of structural gravity. First, the gravity model predicts bilateral trade imbalances very well (Felbermayr and Yotov, 2021), hence the TCP embeds revealed comparative advantage. Second, gravity is a spatial general equilibrium (GE) model. Thus the TCP is a GE index that takes into account all active spatial links in the complete bilateral trade system. The account includes the impact of tariff changes on the incidence of the much larger non-tariff frictions. Third, the multilateral resistances of the structural gravity model (Anderson and van Wincoop, 2003; Anderson and Yotov, 2010) imply that the TCP decomposes into the product of the buyer and seller incidences of tariffs in each country. Tariff increases reduce the domestic seller's incidence of trade costs and thus raise their incomes, while they raise the buyer's incidence of trade costs. The net cost of protection to a country combines the buyer incidence of the tariffs (some of which is paid by foreign sellers) netted with an offset by the decline in domestic seller incidence of frictions as its sales shift to the lower trade friction domestic market. The decomposition sheds light on the important debate about who bears the cost of tariffs.

Indirectly, the tariff crowds out foreign sellers who must absorb the cost of a shift in sales to higher friction foreign destinations, a rise in foreign seller incidence. The model features this negative externality in spatial general equilibrium and permits quantification. Finally, under relatively standard assumptions and due to advances in the empirical trade literature, the TCP is straightforward to implement empirically.

The TCP differs from previous related literature in being an all-else-equal compensated concept like the true cost-of-living index. It is otherwise related to the Mercantilist Trade Restrictiveness Index of Anderson and Neary (2005) – a uniform tariff that results in the same level of imports as the existing set of differentiated tariffs on all sectoral imports and across all trade partners. In contrast, the TCP is applied to the non-small country case in which terms of trade externalities are the focus. The TCP index is also distinct from the welfare cost of protection because it excludes the benefit to the levying country's government revenue. The welfare cost of protection has been the main focus of a voluminous preceding literature.

Reciprocity is understood [Bagwell and Staiger (2002)] by economists to offset the tendency for tariffs to be over-used by governments because foreign sellers pay part of the tariff as its incidence falls partly on them. Reciprocity implies that foreign tariffs may rise in response and thus domestic sellers absorb their incidence of the reciprocal tax. Thus, Bagwell and Staiger (2002) show theoretically that the GATT/WTO mutual exchange of market access principle tends to internalize the negative international externality whereby tariffs harm trade partners' terms of trade. This paper operationalizes the intermediate step whereby tariffs raise buyer and seller incidences of trade costs, appropriately aggregated from tariffs across many countries and products. Our all-else-equal compensated setting includes trade imbalances that are preserved by the reciprocal tariff changes. Tariff change reciprocity measured by changes in true cost of protection indexes has an impact effect that similarly tends to internalize the the terms of trade externality. Thus, reciprocity in tariff changes is (very loosely speaking) dual to the equal exchange of market access to the rest of the world that is the focus of the GATT/WTO system.

2 The True Cost of Protection Index

The TCP is derived and applied in the context of the gravity model, reviewed here as the first step. The CES (Constant Elasticity of Substitution) gravity model[1] conveniently and accurately simplifies further to a specification in which bilateral trade flows are a decreasing function of relative resistance with constant trade elasticity. All trade flows are evaluated at buyer (destination) prices.

We begin with the simple case where each country exports a single bundle of goods also sold at home and imports goods from each other country. The multiple sectors case is developed later when needed. Each country potentially exports to all others and imports from all others. Spatial arbitrage drives reallocation profits to zero in equilibrium. The trade flow effects of the complete bilateral system of trade frictions are reduced by arbitrage to a simple bilateral relative resistance. Relative resistance is the ratio of bilateral resistance (tariffs and all other trade frictions) to the product of buyer and seller multilateral resistances. The multilateral resistances are also the buyer and seller incidences of trade frictions on *all* sales, domestic and foreign.

The CES demand model implies that sales $X_{ij} = p_{ij}x_{ij}$ at buyer prices of goods from origin i to destination j are given by:

$$X_{ij} = E_j \left(\frac{\beta_{ij} p_{ij}}{P_j} \right)^{-\theta}, \ \theta > 0.$$

Here, E_j is the total expenditure in destination j on goods from all origins i including $i = j$, $\beta_{ij} > 0$ is a taste parameter and $P_j = [\sum_i (\beta_{ij} p_{ij})^{-\theta}]^{-1/\theta}$ is the CES price index.

World sales of each country i's goods at buyer prices p_{ij} to each destination j are modeled

[1]The CES structure represents a reasonably wide class of models, Arkolakis et al. (2012)

as if to a world buyer at a world price $c_i\Pi_i$, the product of seller cost c_i and multilateral resistance Π_i that reflects the average efficient (due to spatial arbitrage) distribution pattern of country i's supply y_i. World sales from i must equal world expenditure so

$$\sum_j X_{ij} = Y_i = Y\left(\frac{c_i\Pi_i}{P^*}\right)^{-\theta},$$

where P^* is the "world" price index, equal to $[\sum_i (c_i\Pi_i)^{-\theta}]^{-1/\theta}$ from $\sum_i Y_i/Y = 1$. The normalization $P^* = 1$ is applied for simplicity. Apply the same normalization to the actual price indexes, $1 = \sum E_j P_j/Y$, so that the two equilibria are comparable. Country j's benchmark hypothetical expenditure on goods from i at "world" prices is $E_j Y_i/Y = E_j(c_i\Pi_i)^{-\theta}$. Country j's actual expenditure on goods from i reduces the benchmark hypothetical expenditure by the ratio

$$\left(\frac{\beta_{ij}p_{ij}/P_j}{c_i\Pi_i}\right)^{-\theta}.$$

Simplify the ratio to $\tau_{ij}t_{ij}/\Pi_i P_j$ where τ_{ij} is the tariff factor that j places on i's goods and $t_{ij} = \beta_{ij}p_{ij}/c_i$, the friction factor due to all other price and non-price frictions in the efficient arbitrage equilibrium. $c_i\Pi_i$ is the opportunity cost of sending a unit of good i to destination j. The effective willingness-to-pay $\beta_{ij}p_{ij}$ at the arbitrage equilibrium volume of trade must cover the extra friction cost represented by the ratio.

The result is the CES gravity equation:

$$X_{ij} = \frac{E_j Y_i}{Y}\left(\frac{\tau_{ij}t_{ij}}{\Pi_i P_j}\right)^{-\theta}. \tag{1}$$

The right-hand side gives the arbitrage equilibrium value of bilateral trade X_{ij}. The first term is the benchmark as-if-frictionless bilateral trade flow. The second term in brackets represents the effect of trade frictions, which reduce trade by the power of the trade elasticity $\theta > 0$.[2] τ_{ij} in the numerator is the tariff factor placed on origin i by destination j ($\tau_{jj} = 1$ for

[2] The trade elasticity is a reduced form 'parameter' that represents a combination of demand and supply responses to price variation. The gravity literature has several special cases in which the trade elasticity is

domestic sales), while t_{ij} in the numerator is the effect of all other trade frictions, absorbing the β_{ij} taste differences.

The denominator is the product of the inward (P_j) and outward (Π_i) multilateral resistances of Anderson and van Wincoop (2003). These are general equilibrium trade cost indexes that consistently aggregate bilateral trade costs and decompose their incidence on the buyers (the inward multilateral resistance, P_j) and the sellers (the outward multilateral resistance, Π_i) in each country as if they buy from and sell to, respectively, a unified world market.

Two properties of the multilateral resistances (MRs) will be crucial for the construction and implications of the TCP index. First, MRs consistently aggregate bilateral buyer and seller incidences of trade frictions to the country level, so the TCP is a general equilibrium index that takes into account interaction of all active spatial links in the complete bilateral trade system. Second, the product of the MRs relative to their free trade values comprises the TCP, which implies its interpretation as the product of the buyer and seller incidences of trade costs(Anderson and Yotov, 2010).

Imports M_j are given by $M_j = \sum_{i \neq j} X_{ij}$. Then protected and free trade imports are:

$$M_j = \sum_{i \neq j} \frac{Y_j E_j}{Y} \left(\frac{\tau_{ij} t_{ij}}{\Pi_i P_j} \right)^{-\theta}, \; M_j^F = \sum_{i \neq j} \frac{Y_j E_j}{Y} \left(\frac{t_{ij}}{\Pi_i^F P_j^F} \right)^{-\theta}. \tag{2}$$

The true cost of protection for country j nets out the transfer from domestic buyers to sellers implied by the effect of tariffs on the true cost of living for country j.[3] To see this, use the budget constraint $\sum_i X_{ij} = E_j$ to replace the set of tariff factors $\{\tau_{ij}\}$ in the direct expression (2) for M_j with an expression using the uniform tariff factor τ_j^{μ} that maintains

a parametric function of more basic supply and demand parameters.

[3]The true cost of living index is the theoretical exact price index, approximated in most practice by the Laspeyres index, and here approximated by the CES price index P_j.

the same level M_j. τ_j^{μ} is the true cost of protection index.

$$M_j = E_j \left[1 - \frac{Y_j}{Y} \left(\frac{t_{jj}}{\Pi_j P_j} \right)^{-\theta} \right] = E_j \left[1 - \frac{Y_j}{Y} \left(\frac{t_{jj}}{\Pi_j^F P_j^F} \right)^{-\theta} (\tau_j^{\mu})^{\theta} \right]. \tag{3}$$

The true cost of protection index (the uniform tariff factor) implied is decomposed as

$$TCP \equiv \tau_j^{\mu} = \frac{\Pi_j P_j}{\Pi_j^F P_j^F} = \frac{\Pi_j}{\Pi_j^F} \frac{P_j}{P_j^F}. \tag{4}$$

The proposed TCP has several attractive properties. First, the TCP is a general equilibrium index that takes into account all possible links in the complete bilateral trade system. Thus the size of the tariff changes depends on the full spatial equilibrium effects of the tariff as measured by the changes in the product $\Pi_j P_j$. Second, by construction, the TCP is reciprocal in the sense that its construction (applied to all countries j) maintains constant international trade volumes for all countries. Third, equation (3) implies that imports are monotonically decreasing in τ_j^{μ}. This establishes a close relationship between tariff reciprocity and the GATT/WTO interpretation of trade negotiations as reciprocal exchange of market access. Moreover, even though the all-countries multilateral free trade calculation is natural in the international policy relations context, the TCP can be applied to negotiations over changes either to one country at a time or to subsets or all countries at once.

Fourth, the TCP decomposes into the product of the incidence of tariffs on buyers (via P_j/P_j^F) and sellers (via Π_j/Π_j^F) in each country. This property is a structural general equilibrium version of the tariff pass-through literature, which is based on high-frequency price responses and mainly relies on reduced-form and partial equilibrium analysis. Finally, the TCP is easy to implement empirically due to advances in the empirical trade literature. The next section demonstrates by applying structural gravity to calculate TCPs based on the USITC gravity database.

TCP Measurement. The measurement of the TCP requires determination of the multilateral resistances Π_j, P_j at the observed and free trade (F) equilibria. Equation (3) may be applied either to one country at a time (unilateral free trade) or to all countries together. In the international policy relations context the all countries multilateral free trade calculation is natural. Measurement requires a more realistic model with multiple sectors, denoted by subscript k. For all situations of tariff change, including the switch to uniform tariff factors, the multilateral resistances are the solutions to

$$\Pi_{i,k}^{-\theta_k} = \sum_j \frac{E_{j,k}}{Y_k} \left(\frac{\tau_{ij,k} t_{ij,k}}{P_{j,k}} \right)^{-\theta_k}, \ \forall i, k \tag{5}$$

and

$$P_{j,k}^{-\theta_k} = \sum_i \frac{Y_{i,k}}{Y_k} \left(\frac{\tau_{ij,k} t_{ij,k}}{\Pi_{j,k}} \right)^{-\theta_k}, \forall j, k. \tag{6}$$

Note that a number of variables are kept fixed in these calculations: $\{E_j, Y_i, t_{ij,k}\}$ as well as the trade elasticities. The system (5)-(6) solves only up to a normalization (as is obvious from dividing through both sides by the left hand side variables). In the results reported below, the normalization sets Canada's price index equal to 1.

This setup evaluates the height of current tariffs relative to an alternative hypothetical tariff position that changes only trade flows. General equilibrium forces are active only as arbitrage drives shifts in trade flows and the resulting shifts in multilateral resistances. Its simplicity and relative transparency is appropriate as a basis for trade negotiations. The alternative is allowance for more general changes in $\{E_j, Y_i, t_{ij,k}\}$. This requires embedding the spatial general equilibrium module into speculative general equilibrium models with many parameters less likely to be generally accepted as a basis for negotiated tariff changes.

The system of equations (5)-(6) is simple enough in form to be easily solved computationally for tariff changes, but it is complex enough to eliminate simple rules such as cutting all tariffs τ_{ij} by the same proportion. More importantly, political economy reasons lie behind the highly differentiated tariff structures of countries, suggesting the impossibility of broad uniform reduction rules. Solutions of system (5)-(6) for various proposed tariff factor sets

$\{\tau'_{ij}\}$ combine with (3) to yield the resulting vector of τ_j^μs. These are the basis for evaluating the various tariff changes for reciprocity and progress toward lower trade barriers.

For the many sectors case, the set of CES gravity equations for each sector k nest within an upper level aggregator. For simplicity the aggregator is Cobb-Douglas (the limit case where the trade elasticity $\theta \to 0$). For each sector k there is an equation (3) that defines a sector-specific $\tau_{j,k}^\mu$. The Cobb-Douglas aggregator implies that $E_{j,k}/E_j = \alpha_{j,k},\ \alpha_{j,k} \in (0,1),\ \sum_k \alpha_{j,k} = 1$. Then the country j uniform tariff factor replaces the vector of $\tau_{j,k}^\mu$s with the scalar τ_j^μ that satisfies the constant M_j constraint (hence $\sum_k \alpha_{j,k} b_{jj,k}$ is constant):

$$\sum_k \alpha_{j,k} \frac{Y_{j,k}}{Y_k} \left(\frac{\tau_{j,k}^\mu t_{jj,k}}{(\Pi_{j,k}^\mu)^F (P_{j,k}^\mu)^F} \right)^{-\theta_k} = \sum_k \alpha_{j,k} \frac{Y_{j,k}}{Y_k} \left(\frac{\tau_j^\mu t_{jj,k}}{(\Pi_{j,k}^\mu)^F (P_{j,k}^\mu)^F} \right)^{-\theta_k},\ \forall j. \tag{7}$$

τ_j^μ does not have a closed form solution except in the case where $\theta_k = \theta,\ \forall k$. Equation (7) is operational given the set of solutions $\{\tau_{j,k}^\mu\}$. Solve (7) for τ_j^μ to obtain:

$$\tau_j^\mu = \left(\sum_k \frac{X_{jj,k}^F}{\sum_k X_{jj,k}^F} \left(\tau_{j,k}^\mu\right)^{-\theta} \right)^{-\frac{1}{\theta}}. \tag{8}$$

Local TCP Changes. Local tariff changes are analyzed for two reasons. First, small tariff changes are typically appropriate for tariff negotiations and are one-to-one with TCP changes. Second, the local changes analysis yields a relationship between the volume equivalent tariff and the trade weighted average tariff, which will develop further intuition and highlight some of the TCP properties.

It is eases notation in what follows to denote expenditure shares as

$$b_{ij} = \frac{X_{ij}}{E_j} = \frac{Y_i}{Y} \left(\frac{\tau_{ij} t_{ij}}{\Pi_i P_j} \right)^{-\theta},\ \forall i, j.$$

The domestic share b_{jj} where $\tau_{jj} \equiv 1$ is especially useful for analysis of the true cost of protection (and other related purposes,as emphasized in the extensive modern gravity literature).

Log-differentiate the right hand side of the first equation in (3) to yield

$$\hat{M}_j = -\frac{b_{jj}}{1-b_{jj}}\theta(\hat{\Pi}_j + \hat{P}_j) = -\frac{b_{jj}}{1-b_{jj}}\theta\hat{\tau}^{\mu}_j. \tag{9}$$

Small tariff changes are typically appropriate for tariff negotiations and are one-to-one with MTRI changes. Locally, $\hat{\tau}^{\mu}_j = \hat{\Pi}_j + \hat{P}_j$. A unilateral rise in tariffs τ_{ij} raises the buyer multilateral resistance P_j and will somewhat reduce seller multilateral resistance Π_j as sales shift from higher friction exports into the domestic market. The net effect is the buyer passthrough rate of the tariffs, the net cost to the country. Reciprocal tariff increases raise both P_j and Π_j for all countries j. The structural buyer and seller passthrough rates are analogous to the same concept estimated with partial equilibrium econometric techniques, but differ in being consistent with standard trade policy modeling.

Trade-weighted average tariff factors on the domestic price base are closely related to buyer price indexes for the full set of goods. It is instructive to compare them with the true cost of protection index. Local changes to tariff factors based on the change in M_j using expression (2) are given by

$$\hat{M}_j = -\theta\sum_{i\neq j}\frac{b_{ij}}{\sum_{i\neq j} b_{ij}}[\hat{\tau}_{ij} - (\hat{\Pi}_i + \hat{P}_j)] = -\theta\hat{\tau}^a + \theta\sum_{i\neq j}\frac{b_{ij}}{\sum_{i\neq j} b_{ij}}\hat{\Pi}_i + \theta\hat{P}_j.$$

Here, $\hat{\tau}^a_j$ is the percentage change in the trade weighted average tariff and the remaining terms are needed to bring in the general spatial equilibrium effects of the tariff change to equate with a given trade volume percentage change. Combine with equation (9) and solve:

$$\hat{\tau}^{\mu}_j = \frac{1-b_{jj}}{b_{jj}}\hat{\tau}^a_j - \frac{1}{b_{jj}}\sum_{i\neq j} b_{ij}\hat{\Pi}_i - \frac{1-b_{jj}}{b_{jj}}\hat{P}_j.$$

Trade weighted average tariff factor $\hat{\tau}^a$ omits spatial effects of tariffs that are neatly combined with $\hat{\tau}^a_j$ in τ^{μ}_j.

Trade weighted average tariffs on the domestic price base (for comparability with τ^{μ}_j) are typically computed in levels as

$$(\tau_j^k)^a = \sum_{i \neq j} \frac{b_{ij}^k}{\sum_{i \neq j} b_{ij}^k} \frac{\tau_{ij}^k}{1+\tau_{ij}^k} = \sum_{i \neq j} \frac{b_{ij}^k}{1-b_{jj}^k} \frac{\tau_{ij}^k}{1+\tau_{ij}^k}.$$

τ_j^μ implied by (7) differs from τ_j^a due to the general equilibrium set of buyer and seller incidences $\{P_j^k, \Pi_j^k\}$.

3 Empirical Application

A key feature of the data needed to construct our tariff index is the availability of domestic trade flows (production data). Therefore, we rely on two datasets that include domestic trade flows, which are constructed and maintained by the United States International Trade Commission (USITC). Specifically, we employ the *International Trade and Production Database for Estimation* (ITPD-E) and the *International Trade and Production Database for Simulation* (ITPD-S). Both datasets include trade and production data for many countries (more than 200) and 170 industries over a long period of time (1988-2019 for goods and 2000-2019 for services). The ITPD-E uses only raw administrative data, which renders it suitable for estimation. The ITPD-S is based on the ITPD-E but fills any missing trade values and it is perfectly balanced. Thus it is suitable for counterfactual analysis, including the construction of our tariff index.

In addition to the two trade and production datasets of the USITC, we also use a new (not yet released) USITC dataset on tariffs, which consistently aggregates product-level tariffs to match the dimensions of the ITPD-E and the ITPD-S datasets. Finally, we also employ various datasets to construct proxies for bilateral trade costs, which are used in our gravity estimations. Specifically, we rely on the *Dynamic Gravity Dataset* (DGD) of the USITC (Gurevich and Herman, 2018)[4] for data on European Union (EU) and World Trade Organization (WTO) membership, and all standard time-invariant gravity variables,

[4]https://www.usitc.gov/data/gravity/dgd.htm

e.g., disatnce, contiguity, common official language, and colonial relationships. An indicator variable for Euro membership is based on data from the European Union,[5] while data on other currency unions are from Jose de Sousa's database.[6] Data on membership in Regional Trade Agreements (RTAs) are from Egger and Larch (2008).[7] Finally, data on sanctions are from the latest edition of the *Global Sanctions Database* (Syropoulos et al., 2024).[8]

In terms of practical implementation, we focus on the manufacturing industries in the ITPDs, i.e., we do not include the services industries since there are no tariffs for services and we also exclude agriculture and mining. Due to availability of tariff data and convergence issues, we are not able to obtain uniform tariff estimates for 11 of the 118 manufacturing industries in the ITPD. Thus we report and analyze results for 107 industries, which are listed in Table 1. To obtain our estimates, we proceed in two steps. First, we rely on the ITPD-E and we capitalize on the 'separability' property of the gravity model to estimate gravity for each of the industries in our sample in order to obtain trade cost estimates that are needed for the counterfactuals. Then, we rely on the ITPD-S to construct our tariff index by solving the gravity system with and without tariffs for each industry in the data. We focus on the most recent year that is available in the ITPDs - 2019. We use a common trade elasticity of 4. Finally, to mitigate/avoid convergence issues, e.g., due to some very small countries, we select the 99 largest exporters, which account for more than 99% of the exports in the data. As a result, we have about 99 countries in each of the 107 manufacturing industries in the ITPD dataset for which we construct our uniform tariff index.

Since the number of TCP tariffs that we obtain is very large ($99 \times 107 = 10,593$), we analyze them in four steps. First, we offer some summary statistics based on the full set of the indexes. Second, we zoom in on the U.S. industry-specific tariffs. Third, we discuss the cross-country variation of the aggregate TCP tariffs compared to the corresponding import-weighted tariffs. Finally, we decompose the TCP index into the incidences of tariffs on buyers

[5] https://european-union.europa.eu/institutions-law-budget/euro/countries-using-euro_en
[6] http://jdesousa.univ.free.fr/data.htm
[7] https://www.ewf.uni-bayreuth.de/en/research/RTA-data/index.html
[8] https://www.globalsanctionsdatabase.com/

and sellers in each country and industry.

First, the TCP tariffs and the import-weighted tariffs in the full set of 10,593 tariffs are positively but far from perfectly correlated. The average correlation across all industries is 0.65, but it varies between 0.10 (for 'Distilling rectifying and blending of spirits') and 0.86 (for 'Starches and starch products'). The industries with the highest correlation are "Starches and starch products" and "Medical surgical and orthopedic equipment". Interestingly, the lowest correlations are for "Distilling rectifying and blending of spirits", "Wines", and "Malt liquors and malt".

The results show that uniform tariffs are predominantly smaller but can be larger than the import-weighted tariffs. The predominance of smaller TCPs is due to concavity of the CES price index function and Jensen's inequality, even if sectoral trade balance prevailed. Instead, revealed comparative advantage (sectoral exports larger than sectoral imports) is negatively associated with domestic expenditure share $b_{jj,k}$. The combination of revealed comparative advantage and its likely effect on reducing sectoral tariff uniform measures τ_k^{μ} would reduce the TCP below the import weighted average tariff even in the linear case $\theta = -1$.

Some TCPs are larger than the import-weighted tariffs (see Figure 2). This anomaly is explained by *overall* trade deficits for such countries. The international borrowing implied by country j's trade deficit enables more spending on j's imports while the lending implied by its partners implies less spending on j's exports. All else equal, this raises the TCP relative to what it would be with balanced trade.

Formally, j's seller's incidence is increased by its external borrowing. In equation (5), replace $E_{j,k}$ with $\phi_j Y_j \alpha_{j,k}$ where $E_j = \phi_j Y_j$ and $\phi_j > 1$ is associated with external borrowing. World balanced budget equilibrium requires $\sum_i \phi_i Y_i / \sum_i Y_i = 1$, which implies that the lending countries have $\phi_i < 1$. Turn to the impact on j's seller incidence:

$$\Pi_{i,k}^{-\theta_k} = \sum_j \frac{\phi_j Y_j \alpha_{j,k}}{Y_k} \left(\frac{\tau_{ij,k} t_{ij,k}}{P_{j,k}} \right)^{-\theta_k}, \ \forall i, k.$$

Country j's borrowing ($\phi_j > 1$) raises the weight on its (lower friction) domestic sales while the lending of other countries ($\phi_i \leq 1, \ i \neq j$) reduces their spending on j's exports to higher friction destinations. This reallocation lowers the right hand side of the equation and thus raises Π_j. Notably in Figure 2, the US TCP is relatively far above its import-weighted average due to its overall trade deficit.

Tariff reciprocity in this perspective is a sharp tool to be used with care. Reciprocity applied to eliminating sectoral imbalances negates comparative advantage and thus eliminates the specialization gains from trade. Reciprocity applied to aggregate international trade balances tends to negate potential gains from intertemporal trade. In this setting tariff reciprocity is relatively weak and indirect, but it may still have powerful effects in negating inter-temporal comparative advantage.

In contrast, tariff reciprocity applied to *negotiations over tariff policy changes* can increase gains from trade for all countries while allowing for tariff changes due to protectionist pressures and domestic externalities in the individual countries. Thus its application may be consistent with effective management of international relations and the WTO principles.

Second, the sectoral variation of TCPs is a measure of relative protection offered by a country. The sectoral TCP tariffs for the U.S. are reported in Table 1. All but one of the U.S. TCP tariffs are positive. The single negative value is for "Publishing of books and other publications", but it is essentially zero (-0.0003). Some other country-sector TCPs (not shown) are also negative. Negative sectoral TCPs are explained by trade diversion as the observed tariffs divert the sectoral trade into low or zero tariff destinations. The switch to uniform tariffs in the hypothetical equilibrium implies that import subsidies are required to maintain the observed import totals for the low sector-country destinations.

Returning to the variation of U.S. sectoral TCPs, the smallest positive uniform tariff (0.0004) is for "Publishing of newspapers journals etc.". The largest uniform tariffs of about 7% are for industries marked by large Chinese imports, e.g., "Industry Luggage handbags etc.", "Wearing apparel except fur apparel", "Pottery china and earthenware", "Textile fibre preparation; textile weaving", and "Refractory ceramic products". The correlation between the TCP and import-weighted tariffs for US is 0.6 - high but far from perfect. Figure 1 visualizes the indexes from Table 1 and shows that most of the import-weighted tariffs for the U.S. are actually lower than the corresponding TCP tariffs. This reflects the overall trade balance deficit, as previously noted.

Third, we examine cross-country variation in TCP indexes vs. import-weighted average tariffs. Table 2 reports the uniform TCP tariffs per country, which are aggregated according to equation (8). The lowest uniform TCP tariffs, i.e., subsidies, are about -3% for Peru, Iraq, and Chile, and the largest TCP tariffs vary between 5% and 13% for BGD (5%), PAK (5%), BMU (6%), LKA (6%), BRA (7%), IND (9%), MNG (12%), and KEN (13%). Notably some of the largest tariffs are for Asian economies other than China. The correlation between the TCP and the import-weighted country tariffs is 0.53 - high but far from perfect. Figure 2 visualizes the indexes from Table 2 and shows that most of the import-weighted tariffs are higher than the corresponding TCP tariffs. Consistent with Figure 1, the U.S. is one of the countries whose TCP index is larger than the corresponding import-weighted average tariff. Interestingly, some of the other countries whose TCP tariffs are larger than their import-weighted tariffs are countries that are peripheral but not members of the EU, e.g., Norway, Switzerland, and Turkey.

Fourth and finally, we discuss the variation of the TCP tariffs decomposition into buyer and seller incidences, according to equation (4). The decomposition of the large number of country-industry indexes is first represented by focus on one industry. "Dairy Products" is the industry where the cross-country incidence of tariffs was the most extreme/disproportionate, i.e., the tariff incidence on the sellers of dairy products in some countries was the lowest of all the industries in our sample, while the tariff incidence on the sellers of dairy products in other countries was the largest of all the industries in the sample. Thus, the estimates that we report in the top panel Figure 3 provide the lower and upper bound of the tariff incidence on buyers and sellers in all countries and across all industries.

Due to the large number of countries in our sample, the top panel of Figure 3 only reports the 10 countries with the lowest tariff incidence on producers of dairy products and the 10 countries with the largest tariff incidence on the producers of dairy products. The figure reveals that the tariff incidence on the producers of dairy products is between 26% and 70%. The largest incidence of tariffs falls on producers in European countries with pronounced comparative advantage in the production of dairy products. On the opposite side of the spectrum, i.e., with the smallest incidence of tariffs, we find producers from several Asian economies and some less developed countries. The main takeaways from Figure 3 are that (i) the tariff incidence on buyers vs. sellers can be very disproportionate, however (ii) even in the extreme case, each group bears at least 30% of the tariff costs.

The bottom panel of Figure 3 reports cross-sectoral estimates of the tariff incidence for one country, the United States. Due to the large number of industries in our sample, the top panel of Figure 3 only reports the 10 industries with the lowest tariff incidence on producers in the U.S. and the 10 industries with the largest tariff incidence on the producers in the U.S.. The figure reveals that the tariff incidence is split quite evenly in the United States. "Dairy Products" is the most extreme case, but this industry is an outlier and even here the incidence of tariffs on buyers vs. sellers is not too extreme.

4 Conclusion

This paper defines and applies a tariff index that measures the height of tariff walls that justifies comparison across countries and time. On its inward face the True Cost of Protection index measures the net cost of protection to a country's buyers adjusted for its benefit to the country's sellers. On its outward face, the TCP maintains the same total value of imports as the actual set of tariffs. The results demonstrate a "proof of concept". Refinements for future applications include sensitivity to trade elasticities and consideration of aggregate trade imbalances.

Higher trade elasticities will generally increase differences between TCPs and the import-weighted average tariffs because the higher elasticities increase the concavity of the CES aggregator. For the index to be widely used, there presumably needs to be consensus on the elasticities, a consensus still not attained in the received literature.

Large aggregate trade imbalances are revealed to have substantial effects on the TCP, raising it for trade deficit countries and lowering it for trade surplus countries. How these differences should be treated in the context of trade negotiations is a question for future research.

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Table 1: Uniform (TCP) Tariffs vs. Import-weighted Tariffs, USA

Industry Description	Uniform (TCP) Tariffs	Import-weighted Tariffs	Correlation
Agricultural and forestry machinery	0.66	0.07	0.77
Aircraft and spacecraft	1.57	0.86	0.78
Articles of concrete cement and plaster	0.54	0.00	0.56
Automobile bodies trailers and semi-trailers	1.34	1.97	0.58
Bakery products	2.59	0.31	0.59
Basic chemicals except fertilizers	0.61	0.33	0.53
Basic iron and steel	1.68	0.25	0.72
Basic precious and non-ferrous metals	2.14	0.42	0.66
Bearings gears gearing and driving elements	2.05	0.50	0.67
Bicycles and invalid carriages	0.30	0.05	0.44
Builders' carpentry and joinery	1.38	0.61	0.74
Building and repairing of ships	3.05	0.72	0.44
Building/repairing of pleasure/sport. boats	0.84	0.49	0.75
Carpets and rugs	1.43	1.87	0.73
Cement lime and plaster	2.10	4.43	0.44
Cocoa chocolate and sugar confectionery	3.81	2.15	0.62
Cordage rope twine and netting	1.87	2.34	0.63
Corrugated paper and paperboard	0.13	0.15	0.78
Cutlery hand tools and general hardware	1.46	0.24	0.72
Cutting shaping and finishing of stone	1.78	0.54	0.58
Distilling rectifying and blending of spirits	0.27	0.27	0.10
Domestic appliances n.e.c.	3.37	1.15	0.51
Dressing and dyeing of fur; processing of fur	1.06	2.08	0.48
Electricity distribution and control apparatus	0.04	0.13	0.83
Electronic valves tubes etc.	2.29	1.48	0.68
Engines and turbines (not for transport equipment)	3.27	2.43	0.76
Fertilizers and nitrogen compounds	1.32	0.45	0.67
Food/beverage/tobacco processing machinery	1.17	0.17	0.71
Furniture	1.58	2.76	0.72
Games and toys	1.00	3.12	0.77
Insulated wire and cable	2.29	0.65	0.67
Jewellery and related articles	1.48	0.39	0.62
Lifting and handling equipment	3.02	1.86	0.78
Lighting equipment and electric lamps	1.30	1.12	0.79
Luggage handbags etc.; saddlery and harness	6.61	6.86	0.80
Macaroni noodles and similar products	3.07	1.91	0.65
Machine tools	1.67	0.69	0.78
Machinery for metallurgy	0.71	0.11	0.58
Machinery for mining and construction	2.63	1.64	0.72
Machinery for textile apparel and leather	0.74	0.32	0.73
Made-up textile articles except apparel	2.51	5.17	0.73
Malt liquors and malt	0.74	0.10	0.19
Man-made fibres	3.22	0.94	0.73
Measuring/testing/navigating appliances etc.	0.89	0.97	0.80
Medical surgical and orthopaedic equipment	0.10	0.29	0.85
Motor vehicles	1.14	1.33	0.46
Motorcycles	2.42	1.70	0.79
Musical instruments	0.55	0.50	0.77
Office accounting and computing machinery	0.47	0.60	0.78
Optical instruments and photographic equipment	0.24	0.47	0.63
Other articles of paper and paperboard	0.54	0.25	0.74
Other electrical equipment n.e.c.	2.01	1.24	0.73
Other fabricated metal products n.e.c.	1.40	2.03	0.80
Other food products n.e.c.	3.73	1.66	0.69
Other general purpose machinery	0.95	0.71	0.79
Other manufacturing n.e.c.	1.01	2.37	0.75
Other non-metallic mineral products n.e.c.	4.74	2.03	0.50
Other publishing	0.23	0.11	0.66
Other rubber products	3.02	1.04	0.70
Other special purpose machinery	1.78	0.69	0.62
Other textiles n.e.c.	2.99	2.35	0.67
Other transport equipment n.e.c.	0.63	0.09	0.78
Other wood products; articles of cork/straw	0.74	1.59	0.77
Ovens furnaces and furnace burners	3.85	0.96	0.73

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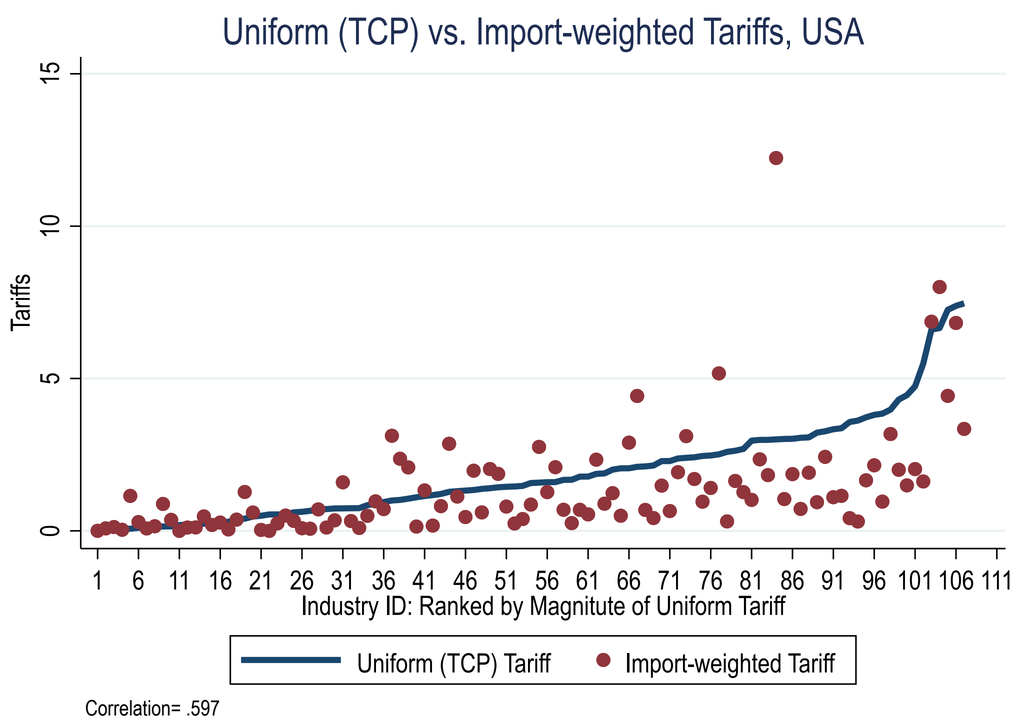
Industry Description	Uniform (TCP) Tariffs	Import-weighted Tariffs	Correlation
Paints varnishes printing ink and mastics	2.99	1.83	0.62
Parts/accessories for automobiles	3.34	1.10	0.75
Pesticides and other agro-chemical products	2.38	1.93	0.60
Pharmaceuticals medicinal chemicals etc.	4.31	2.01	0.66
Plastic products	1.60	1.27	0.72
Plastics in primary forms; synthetic rubber	0.50	0.03	0.36
Pottery china and earthenware	7.25	4.43	0.66
Prepared animal feeds	2.96	1.02	0.51
Printing	0.21	0.11	0.81
Processing of nuclear fuel	2.05	2.89	0.71
Processing/preserving of fish	2.46	0.96	0.59
Processing/preserving of fruit and vegetables	2.40	3.11	0.74
Processing/preserving of meat	1.60	2.09	0.43
Publishing of books and other publications	-0.03	0.00	0.54
Publishing of newspapers journals etc.	0.04	0.08	0.41
Publishing of recorded media	0.15	0.36	0.53
Pulp paper and paperboard	0.12	0.08	0.80
Pumps compressors taps and valves	2.69	1.27	0.76
Railway/tramway locomotives and rolling stock	1.10	0.14	0.67
Refined petroleum products	0.19	0.00	0.71
Refractory ceramic products	7.47	3.35	0.60
Rubber tyres and tubes	3.98	3.18	0.65
Sawmilling and planing of wood	0.06	0.04	0.56
Service activities related to printing	0.07	1.15	0.79
Soap cleaning and cosmetic preparations	0.37	0.37	0.67
Soft drinks; mineral waters	2.47	1.41	0.65
Sports goods	1.28	2.86	0.62
Starches and starch products	4.45	1.49	0.86
Steam generators	2.12	0.69	0.48
Struct.non-refractory clay; ceramic products	3.62	0.31	0.76
Structural metal products	1.89	0.89	0.78
Sugar	3.57	0.42	0.51
TV and radio receivers and associated goods	0.25	0.19	0.74
TV/radio transmitters; line comm. apparatus	1.21	0.81	0.63
Textile fibre preparation; textile weaving	7.38	6.82	0.65
Tobacco products	3.00	12.24	0.59
Vegetable and animal oils and fats	0.14	0.88	0.69
Veneer sheets plywood particle board etc.	1.45	0.80	0.77
Watches and clocks	0.40	1.28	0.79
Weapons and ammunition	0.74	0.35	0.74
Wearing apparel except fur apparel	6.66	8.00	0.67
Wines	5.49	1.62	0.12
Wooden containers	0.70	0.70	0.70

Notes: This table reports the uniform (TCP) U.S. tariffs and the corresponding import-weighted U.S. tariffs for 107 manufacturing industries from the ITPD-E data. Column (1) lists ITPD-E ID codes for each of the industries. Column (2) reports the TCP tariffs, and column (3) reports the corresponding import-weighted tariffs. See text for further details.

Figure 1: Industry-level Uniform (TCP) Tariffs vs. Import-weighted Tariffs, USA



Note: This figure is based on Table 1, and it visualizes the uniform (TCP) U.S. tariffs and the corresponding import-weighted U.S. tariffs for 107 manufacturing industries from the ITPD-E data. The blue curve plots the uniform (TCP) tariffs in increasing order, while the red scatterplot visualizes the corresponding import-weighted U.S. tariffs. See text for further details..

Table 2: Uniform (TCP) Tariffs vs. Import-weighted Tariffs

ISO3 Country Code	Uniform (TCP) Tariffs	Import-weighted Tariffs
AGO	1.99	5.79
ARE	2.64	2.93
ARG	3.08	6.79
AUS	-0.05	1.95
AUT	0.24	1.69
AZE	2.04	2.90
BEL	-0.04	1.42
BGD	5.07	8.77
BGR	0.27	0.67
BIH	1.15	1.27
BLR	2.73	3.60
BMU	5.53	6.91
BRA	7.11	8.84
BRB	0.42	4.65
CAN	0.83	1.32
CHE	0.17	0.00
CHL	-2.60	1.84
CHN	1.76	4.42
COL	0.35	4.84
CRI	3.29	2.12
CYP	0.43	1.21
CZE	0.15	0.70
DEU	0.30	1.51
DNK	0.45	1.76
DOM	-0.92	3.57
DZA	1.69	8.44
ECU	3.25	4.48
EGY	3.57	7.37
ESP	0.86	1.83
EST	0.52	0.73
FIN	0.80	1.77
FRA	0.59	1.76
GAB	2.75	8.04
GBR	0.61	1.80
GHA	2.48	4.65
GRC	0.55	1.95
HRV	0.03	0.58
HUN	0.41	1.08
IDN	1.07	2.69
IND	8.71	7.61
IRL	0.51	1.58
IRN	4.35	4.93
IRQ	-3.55	0.00
ISL	-0.48	0.81
ISR	0.09	1.21
ITA	0.47	1.53
JOR	-0.28	4.58
JPN	2.56	1.58
KAZ	1.64	2.72
KEN	13.24	6.62
KHM	0.76	2.60
KOR	1.97	4.87
KWT	0.79	2.98
LBN	0.62	2.43
LKA	6.07	5.58
LTU	0.49	0.36
LUX	-0.10	1.34
LVA	0.57	0.99
MAC	-0.07	0.00
MAR	2.28	5.38
MEX	-0.84	2.24
MLT	-0.14	1.33
MNG	11.85	2.36
MOZ	-0.03	2.57

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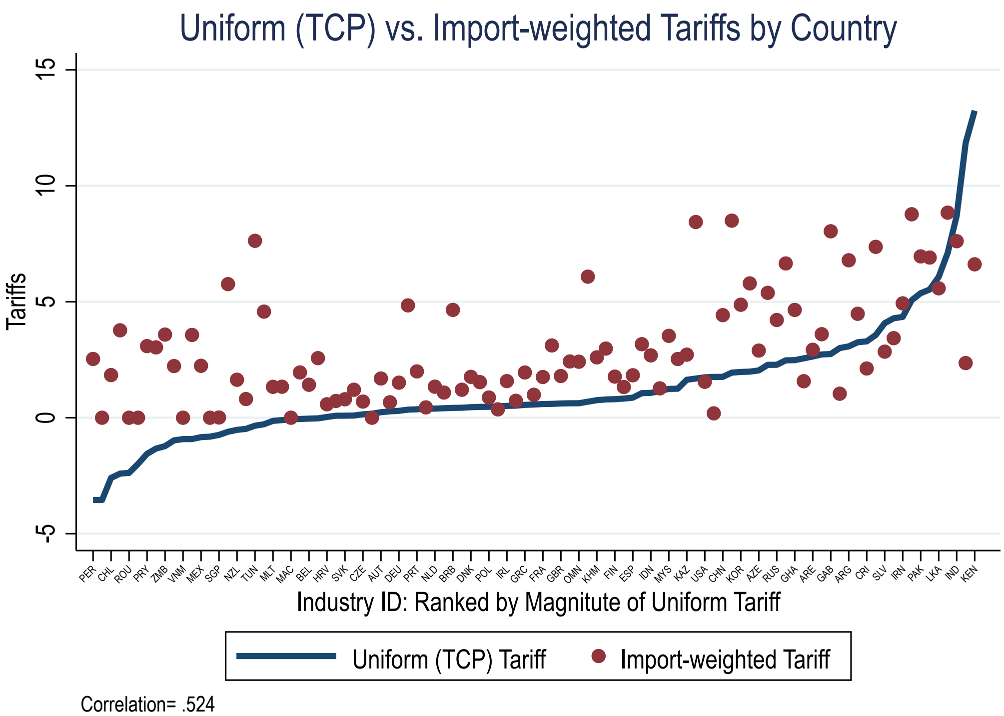
ISO3 Country Code	Uniform (TCP) Tariffs	Import-weighted Tariffs
MYS	1.24	3.53
NGA	-0.61	5.76
NLD	0.39	1.34
NOR	1.76	0.19
NPL	2.47	6.65
NZL	-0.52	1.64
OMN	0.62	2.41
PAK	5.37	6.96
PER	-3.55	2.53
PHL	1.06	3.17
POL	0.47	0.87
PRT	0.36	2.00
PRY	-1.56	3.09
QAT	0.60	3.12
ROU	-2.38	0.00
RUS	2.28	4.21
SAU	-1.33	3.03
SGP	-0.74	0.01
SLV	4.08	2.85
SRB	-1.99	0.00
SVK	0.09	0.80
SVN	0.09	0.72
SWE	0.39	0.45
THA	0.69	6.08
TTO	-2.41	3.77
TUN	-0.34	7.63
TUR	3.00	1.04
TWN	-0.82	0.00
UKR	1.25	2.53
USA	1.74	1.55
UZB	-0.98	2.23
VEN	1.95	8.50
VNM	-0.92	0.00
ZAF	4.29	3.43
ZMB	-1.23	3.59

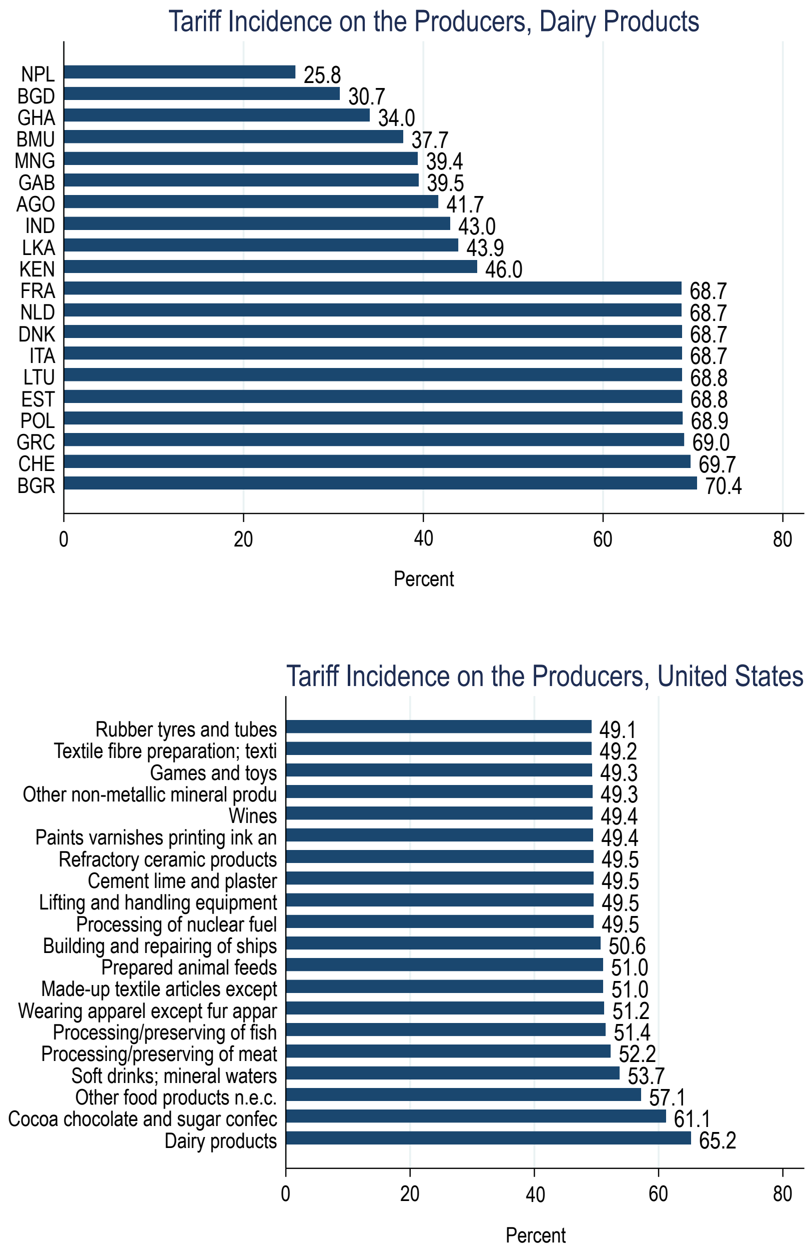
Notes: This table reports the uniform (TCP) tariffs and the corresponding import-weighted tariffs for each of the 99 countries in our sample. Column (1) lists the ISO3 codes for each of the countries. Column (2) reports the uniform TCP tariffs, and column (3) reports the corresponding import-weighted tariffs. See text for further details.

Figure 2: Uniform (TCP) Tariffs vs. Import-weighted Tariffs by Country



Note: This figure is based on Table 2, and it visualizes the uniform (TCP) tariffs and the corresponding import-weighted tariffs for each of the 99 countries in our sample. The blue curve plots the uniform (TCP) tariffs in increasing order, while the red scatterplot visualizes the corresponding import-weighted tariffs. See text for further details.

Figure 3: Uniform (TCP) Tariffs vs. Import-weighted Tariffs by Country



Note: This figure reports indexes that measure tariff incidence. The top panel of the figure lists the 10 countries with the lowest tariff incidence on the producers of dairy products and the 10 countries with the largest tariff incidence on the producers of dairy products. The bottom panel of the figure reports the 10 industries with the lowest tariff incidence on the producers in the U.S. and the 10 industries with the largest tariff incidence on the producers in the U.S.. See text for further details.