An Evaluation of Ad Valorem Equivalent Tariffs: Evidence from a Partial Equilibrium Model

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Abstract

Economists often replace specific tariffs with their ad valorem equivalents, or AVEs, when doing modeling. However, the computation of AVEs under a counterfactual tariff schedule is impossible without assuming that unit prices do not change, and this assumption results in misleading estimates if unit prices do change. In this paper, I set up a partial equilibrium trade model that includes both specific and ad valorem tariffs; I then compute counterfactual equilibria both with specific rates from the data and the AVEs of those rates, and the difference between these estimates provides an indicator of AVEs' reliability as a measure. I perform this analysis under two counterfactual scenarios: one in with all specific tariffs increase by ten percent and one in which some imports become subject to column 2 tariffs instead of the lower permanent normal trade relations (PNTR) tariffs. Results indicate very little difference between import quantity estimates computed with specific rates and estimates computed with AVEs, suggesting that AVEs are a reliable substitute for specific tariff rates when doing economic modeling.

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1 Introduction

Over ninety percent of Harmonized Tariff System 8–digit (HTS8) products imported into the United States face either no tariff, an ad valorem rate charged as a percentage of the import value, or a specific tariff charged as a monetary value per unit of quantity. Because units of quantity vary across HTS products, specific tariffs present challenges when comparing tariff burdens across different products or aggregating across product codes to form more inclusive industries or sectors. We may address these issues with specific tariffs by computing their ad valorem equivalent (AVE), or the ad valorem rate that generates the same amount of revenue as the observed specific tariff. The conversion of a specific tariff into its AVE requires knowledge of unit prices, which we can impute using data on import quantity and customs value.

However, this requirement introduces challenges when performing counterfactual analysis because counterfactual unit price data does not exist, and so to calculate the AVE of a counterfactual specific rate one must assume that the unit price of the product or sector does not change. If changing the specific tariff rate alters the unit price as well, then the counterfactual AVE would not be an accurate representation of the new specific rate, and any changes in quantity estimated using this AVE would be biased.

As an example, consider fresh or chilled garlic, which faces a specific tariff of .43 cents per kilogram. Using data on the import quantity and customs value of garlic, we can extract a unit price and calculate the AVE that replicates the exact revenue of this specific tariff. When considering hypothetical changes in the specific rate, however, we know the value of the new specific rate but must impute its AVE using current quantity and value data because we do not know how precisely the tariff increase will affect garlic imports. This AVE delivers the same revenue as the counterfactual specific tariff if raising tariffs does not change the unit price of garlic, but if the unit price of garlic increases or decreases, the AVE is no longer accurate.

In this paper, I determine the divergence between counterfactual estimates made with data on specific tariff rates with counterfactual estimates made with imputed AVEs. To build such counterfactual estimates, I set up a partial equilibrium (PE) model where agents consume domestically produced goods and imported goods. I calibrate parameters of the model using 2022 data on customs value and quantity imported for each HTS8 product that faces a specific tariff. Analysis at such a disaggregated level allows me to estimate the model separately using specific tariff rates and AVEs, and compare equilibrium quantities in counterfactual situations where the specific tariff is known but the AVE is computed using unit price data from the baseline (non–counterfactual) period. Since data on U.S. domestic production at the HTS8 level does not exist for many products, I calibrate and solve the model once for a selection of agricultural goods for which I do observe domestic unit prices, and once for all HTS8 products facing specific tariffs with the assumption that changes in specific tariffs do not affect domestic prices.

I calculate equilibria for these two sets of data under two counterfactual scenarios. In the first scenario, consumers import goods from one foreign country and face a ten percent increase in all specific tariffs. In the second, I alter the model slightly to include two foreign countries. Both countries initially face the permanent normal trade relations (PNTR) tariff rate that the U.S. levies on the majority of its imports,[1] but in the counterfactual one of the countries loses its PNTR status, instead facing the substantially higher 'column 2' tariffs.

Simulations reveal that the counterfactual import quantities calculated using AVEs are similar to those calculated using specific tariff rates given in the data, with the median percent difference between the two measures less than one–hundredth of a percent. I conclude that AVEs are an accurate way to represent specific tariffs for the vast majority of HTS8 products. The difference between AVE–computed quantities and specific tariff–computed quantities does increase with greater counterfactual changes in AVEs or greater counterfactual decreases in imports, suggesting that some caution is warranted when using AVEs to estimate the impacts of especially large changes in the tariff schedule.

1.1 Literature

The academic trade literature does not focus much on the AVEs of specific tariffs, with a much larger body of scholarship looking at the ad valorem equivalents of non–tariff measures (NTMs). Papers that discuss methodology for calculating AVEs include Babili (2009), WTO (2003) and Stawowy (2001). While these papers discuss some of the theoretical limitations of AVE computations, they do not directly evaluate the compatibility between AVEs and the non–ad valorem tariffs these AVEs represent.

This research also fits into a large body of scholarship at the International Trade Commission that uses product–specific partial equilibrium models to examine trade policy effects. Hallren and Riker (2017) introduces an archetypical PE model and uses that model to simulate the reduction of an ad valorem tariff and the introduction of a binding import quota, while Hallren and Riker (2017b), Hallren and Riker (2018), and Riker (2024) incorporate tariff–rate quotas into a PE model. Riker (2021) and Riker (2020) estimate

[1] Iran, North Korea, Cuba, Russia, and Belarus are the only countries whose exports to the U.S. do not have PNTR status.

the effects of trade policy changes using more sophisticated PE models that include respectively labor dynamics and the aggregation of discrete sectors into a global economic model. This paper does not make any theoretical contributions to PE modeling, but rather expands on the USITC's current PE scholarship by using a PE model to distinguish between two different types of tariff measurements.

Section 2 introduces the partial equilibrium model used in this paper, while Section 3 goes through the calibration and solution process used for both sets of data–agricultural products and all products– and both counterfactuals. Section 4 discusses the results of counterfactual simulations, and Section 5 concludes.

2 Model

In the baseline version of the model, there are two countries: the United States, indexed by d for domestic, and an amalgamation of all other countries in the world, indexed by f for foreign. U.S. consumers consume both domestically produced goods and imports of all given products. Since I compute equilibria separately for each product, I omit a product–level index in presenting the model.

Consumers consume domestic and foreign goods according to a CES utility function with elasticity of substitution σ. Without import tariffs, the consumer demand functions and price index would be

$$q_d = YP^{-\varepsilon}(\frac{P}{p_d})^{\sigma} \tag{1}$$

$$q_f = YP^{-\varepsilon}(\frac{P}{p_f})^{\sigma}$$

$$P^{1-\sigma} = p_d^{1-\sigma} + p_f^{1-\sigma} \tag{2}$$

where Y is the total consumption expenditure across domestic and foreign goods and ε represents the price elasticity of demand, set equal to one. A crucial difference between this setup and that of most PE models is that, since we will be considering tariffs that vary by quantity, I express equations in terms of quantities rather than values.

Specific tariffs are charged per unit of quantity, in effect increasing the price additively. If a product faces specific tariff τ_s, then demand for that product becomes

$$q_f = YP^{-\varepsilon}(\frac{P}{p_f + \tau_s})^{\sigma} \tag{3}$$

Ad valorem tariffs, meanwhile, are levied as percentages of the import value, and so enter into the demand equation multiplicatively. If a product faces ad valorem tariff τ_a, then demand for that product becomes

$$q_f = YP^{-\varepsilon}(\frac{P}{p_f(\tau_a + 1)})^{\sigma}$$

The primary subject of interest in this paper is the ad valorem equivalent (AVE) of a specific tariff, or the ad valorem tariff that would raise an equivalent amount of revenue to this specific tariff. I find this tariff rate by setting the two revenue expressions equal to one another.

$$\begin{aligned} p_f q_f \tau_a &= q_f \tau_s \\ p_f \tau_a &= \tau_s \\ \Rightarrow \tau_a &= \frac{\tau_s}{p_f} \end{aligned} \tag{4}$$

This expression delivers the AVE of any given specific tariff. The AVE varies inversely with the price of the imported good, p_f.

Exogenous supply functions follow Hallren and Riker (2017):

$$q_d^s = a_d p_d^{\theta_d} \tag{5}$$

$$q_f^s = a_f p_f^{\theta_f} \tag{6}$$

Market clearing stipulates that $q_d^s = q_d$ and $q_f^s = q_f$.

2.1 PNTR Removal Counterfactual

The United States currently charges a permanent normal trade relations (PNTR) tariff rate on the majority of its trading partners, as well as a second, much higher 'column 2' tariff rate on a select few countries. I evaluate the performance of ad valorem tariffs in a counterfactual situation where the United States revokes PNTR status from some subset of imports. Since it is not realistic to assume that all U.S. imports will no longer face column 2 tariffs, I amend the model to feature two countries from which the U.S. imports products: one country that continues to face PNTR tariffs in the counterfactual, and another country that faces PNTR tariffs in the baseline but column 2 tariffs in the counterfactual. I assume that the second country accounts for twenty percent of the quantity of U.S. imports in the baseline scenario.

I use m to index the PNTR country and n to index the country that loses PNTR status. Demand functions in this slightly altered model are

$$q_d = YP^{-\varepsilon}(\frac{P}{p_d})^{\sigma} \tag{7}$$

$$q_m = YP^{-\varepsilon}(\frac{P}{p_m + \tau_s})^{\sigma} \quad \text{where } q_m = .8q_f \tag{8}$$

$$q_n = YP^{-\varepsilon}(\frac{P}{p_n + \tau_s})^{\sigma} \quad \text{where } q_m = .2q_f \tag{9}$$

and supply functions are $q_m^s = a_m p_m^{\theta_f}$ and $q_n^s = a_n p_n^{\theta_f}$. In the counterfactual scenario, country n faces new specific rate τ_{s2}, while country m continues to face τ_s.

3 Data and Calibration

The data used to estimate this PE model comes from the USITC's DataWeb. I download 2023 annual tariff rate information as well as information on customs value, landed duty–paid value, and import quantity for all eight–digit HTS products with nonzero imports that were charged a specific tariff in 2023. This description applies to 648 products, which is slightly over five percent of all products in HTS two–digit sectors 1–97.[2]

I calibrate model parameters θ_f, representing the elasticity of supply for foreign–supplied goods, and σ, the elasticity of substitution, using external data. I estimate σ empirically using the procedure described in Riker (2019), wherein I regress customs values of U.S. imports on the ratio of landed duty–paid values to customs values with fixed effects for country of origin and port district of entry. Since some HTS8 products do not contain enough country– and port district–level observations to estimate such regressions with precision, I estimate the regressions at the HTS 2–digit level and assign to each HTS8 product the relevant HTS2 elasticity. The median elasticity of substitution is 3.81, and elasticities of substitution range from -.369 for vegetable plaiting materials to 10.5 for pharmaceutical products.

θ_f values come from Soderbery (2018), which estimates supply elasticities at the HTS4 level for trade between pairs of countries. I isolate elasticities specifically for exports to the United States and construct a supply elasticity for the aggregated country in the model by computing an average elasticity across all

[2] HTS2 sectors 98 and 99 are U.S.–specific chapters that contain special provisions and temporary reductions or increases in duty. USITC tariff analysis typically does not include them.

exporting countries, weighted by the customs value of 2023 imports from each country to the United States in the given HTS4 sector. I determine each HTS8 product's θ_f parameter based on the weighted average supply elasticity of the HTS4 sector to which the product belongs. I set θ_d equal to 1.1, or the median foreign supply elasticity, for all products.

3.1 AVEs

Sector	Percentage of all HTS Products	Percentage of HTS Products Facing Specific Tariffs	Median AVE
All	100	100	1.13%
Animal Products	6.20	20.7	2.10%
Vegetable Products	5.09	38.0	.802%
Prepared Foodstuffs	6.99	26.7	1.58%
Chemical or Allied Industries	16.3	1.08	.356%
Plastics and Rubber	3.32	0	–
Paper and Wood	5.31	.309	3.33%
Clothing and Footwear	16.5	2.47	2.35%
Ceramics, Glass, Jewelry	8.74	.309	1.03%
Base Metals	8.74	.309	.141%
Machinery, Electrical equipment	7.23	0	–
Vessels, Aircraft	2.67	0	–

Table 1: Descriptive statistics of HTS8 products at the sector level

Equation (4) generates AVEs of the specific tariffs, given specific rates and constructed unit prices p_f. Table 1 displays the median tariff for broader product categories, as well as the relative frequency with which products in a given sector face a specific tariff. Food products are disproportionately likely to have specific tariffs, while products in chemical or allied industries, clothing and footwear, and base metals are disproportionately unlikely to have specific tariffs. The AVEs of specific tariffs are in general small, with a median of 1.13%. Apparel and animal products face slightly higher AVEs of 2.35% and 2.10%, respectively, while products in the base metals and chemical industries face AVEs lower than half a percent.

Specific tariffs in the first counterfactual are simply the original specific tariffs multiplied by 1.1, and in the second counterfactual come from column 2 of the annual tariff data. Counterfactual AVEs again come from equation (4), but require an additional assumption that the unit price does not change since there is no information on what that price would look like in the counterfactual. The limits of this assumption drive most of the analysis in this paper, because if the unit price changes substantially when tariffs change, then the AVE is no longer an accurate equivalent of the new specific rate.

If a tariff increase causes unit prices to increase, then an AVE representation based on the previous unit price will overestimate the 'true' ad valorem equivalent of the new specific tariff. Since tariffs vary inversely with import demand, this overestimation results in an import demand that is too small, thus overestimating the negative effects of the specific tariff change. Likewise, if a tariff increase causes unit prices to fall, counterfactuals done with an AVE based on the previous unit price will underestimate the effects of the specific tariff change. Since tariff increases cause both the value of imports and quantity of imports to decline, the response of unit prices to a change in tariffs is uncertain and either an overestimation or underestimation is possible.

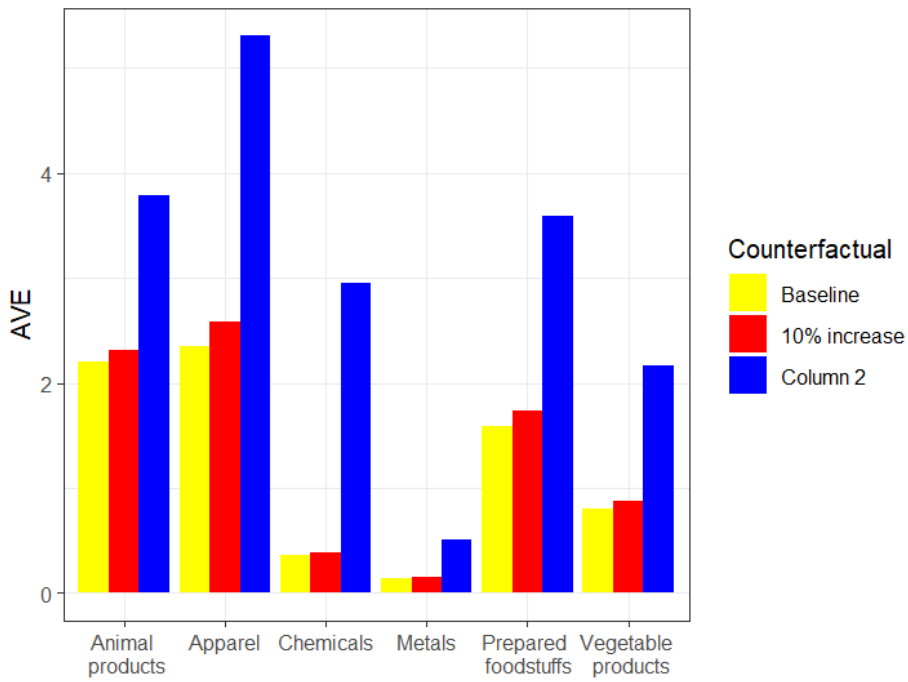


Figure 1: Median ad valorem equivalents for selected sectors, baseline and counterfactual

Figure 1 shows the ad valorem equivalent of specific tariffs in the observed data and in both counterfactual situations this paper considers. When specific tariffs increase by ten percent, their AVEs will increase by around that amount as well. The AVEs of column 2 rates increase substantially from their PNTR levels, although they continue to be lower than ten percent. Base metals show the smallest increase in median column 2 AVE relative to the median PNTR AVE, while for chemicals the AVE multiplies by a factor of ten relative to its initial level. Products in the apparel and footwear sector have the highest column 2 AVE, of 6.41 percent.

3.2 Foreign Supply Shifters

I impute unit import prices p_s in the baseline version of the model by dividing the customs value for each HTS8 code by its import quantity. Given these prices, data on import quantities q_s, and calibrations of θ_f, equation (6) generates calibrated values of the import supply shifter a_f.

Calibration of a_f changes slightly in the counterfactual with two foreign importers. I use m to index the first country, which will always face the PNTR rate, and n to index the second country. While I can no longer calculate unit prices for each country from the data, I do know that the total customs value observed in the data will equal the combined import value from country m and country n.

$$p_n q_n + p_m q_m = \text{Value}_{2023}$$

Combining (8) and (9) and rearranging variables, I express p_n in terms of p_m as well as quantities and specific tariffs observed in the data.

$$p_n = \big(\frac{q_m}{q_n}\big)^{\frac{1}{\sigma}}(p_m + \tau_s) - \tau_s$$
$$\Rightarrow \big[\big(\frac{q_m}{q_n}\big)^{\frac{1}{\sigma}}(p_m + \tau_s) - \tau_s\big]q_n + p_m q_m = \text{Value}_{2023}$$

p_m is the only unknown quantity in this equation, so I can solve for it. I use p_m to get p_n, and with knowledge of prices I use the supply functions to find a_m and a_n, the supply parameters under this new counterfactual.

I do not, however, observe domestic production data at the HTS8 level, which presents a major difficulty in calibrating domestic supply shifters a_d.[3] In face of this difficulty, I perform two sets of estimates for each counterfactual: I first explore a subset of HTS8 products for which I do observe domestic price data, and then I perform estimations for all HTS8 products under the assumption that domestic prices do not change in the counterfactual. The following two subsections will go through each product subset in turn, explaining

[3] I can use the Annual Survey of Manufactures, whose most recent data is from 2021, to impute domestic production values at more aggregated levels such as that of NAICS four–digit industries. However, an aggregation of specific tariff rates from HTS8 to NAICS4 or other aggregated levels is impossible due to the different units in which such rates are expressed.

calibrations for a_d and how to solve the model to generate counterfactual equilibria.

3.3 Calibration and Solution Method for Agricultural Products

The Food and Agriculture Organization (FAO) provides 2022 U.S. domestic unit price data, in dollars per ton, for 107 agricultural goods. Given these prices, I can estimate the model for a subset of HTS8 products represented in this dataset by merging FAO price with the HTS import data using a crosswalk between FAO item codes and HTS8 codes. A total of 124 HTS8 agricultural products facing specific tariffs and measured by weight are also included in the FAO dataset, representing major agricultural sectors such as meat, dairy, vegetables, and fruits but excluding all food manufactures.

Category	Domestic price ($/kg)	Import price ($/kg)
All products	0.983	1.45
Meat	2.06	3.89
Dairy	5.48	3.43
Fruits	.975	1.19
Vegetables	1.58	2.41
Cereals	0.365	0.480

Table 2: Median unit prices for selected product categories

Table 2 presents unit prices of domestic production and imports for selected agricultural products.[4] Import unit prices are higher than domestic unit prices for all product categories except for dairy. Cereals have the lowest price by weight and meat products the highest, with fruits having a higher median unit prices than vegetables. Meat products also display the highest discrepancy between domestic unit prices and import unit prices, with the median foreign price almost twice as high as its domestic counterpart.

In calibrating a_d for these agricultural products, I begin with the product $P^{\sigma-\varepsilon}Y$, which appears in both demand equations (1) and (3). I solve for it in the baseline version of the model by inputting data on import quantities, specific tariffs, and unit import prices into (3):

$$P^{\sigma-\varepsilon}Y = q_f(\tau_s + p_f)^{\sigma} \tag{10}$$

[4]Cereals are plants grown to produce grain, and include staple crops such as rice, wheat, barley, and corn.

I can then substitute this expression into (1) to find the quantity of domestically produced goods, q_d. Knowing q_d and p_d allows me to calibrate a_d from equation (5):

$$a_d = \frac{q_f(\tau_s + p_f)^\sigma}{p_d^{\sigma+\theta_d}} \tag{11}$$

Solving the model also requires knowledge of Y, the total expenditure for each product, which does not change in the counterfactual. I find Y by calculating the price index, as represented by (2), and then dividing the quantity $P^{\sigma-\varepsilon}Y$ by $P^{\sigma-\varepsilon}$.

Calibration in the three–country case proceeds in a similar fashion, since the calibration of a_m and a_n does not depend on domestic prices. I find q_d and a_d using the same process detailed above, but replacing q_f and p_f in (11) with the equivalent figures from either country m or country n.

Given calibrated values, the equilibrium prices of this model are the solution to a system of three equations. This system of equations includes the price index formula as well as market clearing for domestically produced goods and imported goods. In the version of the model with specific tariffs, equations are as follows:

$$P^{1-\sigma} = p_d^{1-\sigma} + (p_f + \tau_s)^{1-\sigma} \tag{12}$$

$$a_d p_d^{\theta_d} = p_d^{-\sigma} P^{\sigma-\varepsilon} Y \tag{13}$$

$$a_f p_f^{\theta_f} = (p_f + \tau_s)^{-\sigma} P^{\sigma-\varepsilon} Y \tag{14}$$

The replacement of specific tariffs with AVEs alters (12) and (14) so that they are, respectively,

$$P^{1-\sigma} = p_d^{1-\sigma} + (p_f(1+\tau_a))^{1-\sigma}$$

$$a_f p_f^{\theta_f} = (p_f(1+\tau_a))^{-\sigma} P^{\sigma-\varepsilon} Y$$

Equilibrium quantities come from inputting equilibrium prices back into (5) and (6). Solving (5), (6), (12), (13), and (14) given baseline tariffs generates the original prices and quantities observed in the data, and I can compare these originals with the equilibrium outcomes generated when I solve the system of equations given counterfactual tariffs.

In the three–country version of the model, the system of three equations becomes a system of four equations:

$$
\begin{aligned}
P^{1-\sigma} &= p_d^{1-\sigma} + (p_m + \tau_m)^{1-\sigma} + (p_n + \tau_n)^{1-\sigma} \\
a_d p_d^{\theta_d} &= p_d^{-\sigma} P^{\sigma-\varepsilon} Y \\
a_m p_m^{\theta_f} &= (p_m + \tau_m)^{-\sigma} P^{\sigma-\varepsilon} Y \\
a_n p_n^{\theta_f} &= (p_n + \tau_n)^{-\sigma} P^{\sigma-\varepsilon} Y
\end{aligned}
$$

Note that τ_m does not change in the counterfactual, but τ_n increases to its column 2 specific value.

3.4 Calibration and Solution Method for All Products

Since other products may respond to trade policy changes differently from agricultural products, I consider an alternative calibration framework that includes all 648 products in the sample. For most of these products, though, I do not observe unit prices for domestic production, and therefore cannot calibrate or solve the PE model without making additional assumptions on price behavior. I assume that changes in tariffs do not affect domestic prices[5] and solve for counterfactual equilibria by rewriting (12)–(14) in terms of domestic price ratios rather than domestic prices.

In the following equations, I use a 2 subscript to indicate counterfactual allocations; variables without a 2 are baseline values from the data. By using (10) and (11) to replace a_d and Y in the market clearing condition (13), I obtain

$$
\begin{aligned}
& q_f (p_f + \tau_s)^{\sigma} \left(\frac{p_{d2}}{p_d}\right)^{\theta_d} p_d^{-\sigma} = p_{d2}^{-\sigma} P_2^{\sigma-\varepsilon} \left(\frac{q_f(\tau_s + p_f)}{P^{\sigma-\varepsilon}}\right) \\
\Rightarrow & \left(\frac{p_{d2}}{p_d}\right)^{\sigma+\theta_d} = \left(\frac{P_2}{P}\right)^{\sigma-\varepsilon}
\end{aligned}
$$

which contains price ratios rather than the cardinal values of those prices. If the price of domestic goods does not change in the counterfactual ($P_{d2} = P_d$), then the price index P will not change either.

I now proceed to (14), the market clearing condition for imports. Using (6), I replace a_f with $\frac{q_f}{p_f^{\theta_f}}$.

[5] We may rationalize this domestic price assumption by reasoning that domestic unit prices primarily reflect input costs, which are not markedly affected by changes in tariffs. I could impose an alternative assumption that domestic prices equal import prices net of tariffs, but the price differences in Table 1 suggest that such an assumption is not realistic.

Replacements of a_f and Y in (14) yield

$$\begin{aligned}\frac{q_f}{p_f^{\theta_f}} &= (p_{f2}+\tau_{s2})^{-\sigma} P_2^{\sigma-\varepsilon}\left(\frac{q_f(\tau_s+p_f)}{P^{\sigma-\varepsilon}}\right)\\ \Rightarrow \left(\frac{p_{f2}}{p_f}\right)^{\theta_f} &= \left(\frac{\tau_s+p_f}{\tau_{s2}+p_{f2}}\right)^{\sigma}\end{aligned}$$

In the end, there is one equation with one unknown, p_{f2}. Replacing specific tariffs with their AVEs, this equation becomes

$$\left(\frac{p_{f2}}{p_f}\right)^{\theta_f} = (p_{f2}(1+\tau_{a2}))^{-\sigma}((1+\tau_a)p_f)^{\sigma}$$

which has a closed–form solution

$$p_{f2} = p_f\left(\frac{1+\tau_a}{1+\tau_{a2}}\right)^{\frac{\sigma}{\sigma+\theta_f}}$$

In the three–country model, I assume that prices do not change either for domestically produced goods or goods imported from m, the foreign country whose tariffs remain at PNTR levels. Following the same method described above, the equilibrium equations become

$$\begin{aligned}\left(\frac{p_{n2}}{p_n}\right)^{\theta_f} &= (p_{n2}(1+\tau_{a2}))^{-\sigma}((1+\tau_a)p_n)^{\sigma}\\ p_{n2} &= p_n\left(\frac{1+\tau_a}{1+\tau_{a2}}\right)^{\frac{\sigma}{\sigma+\theta_f}}\end{aligned}$$

where the only difference is that prices and AVEs are specific to country n.

4 Results

Let q_{fs} designate a counterfactual import quantity computed using data on specific tariffs and q_{fa} designate a counterfactual import quantity computed using the AVEs of those specific tariffs. The primary measure of interest in this section is the percent difference between the two quantities, or $100\frac{q_{fa}-q_{fs}}{q_{fs}}$. I will henceforth refer to this quantity as 'import measurement dispersion.' In the counterfactual involving removal of PNTR status, I calculate import quantities as the sum of imports from both countries, even though only one country's tariff rate changes, because I wish to be analyzing the same allocations across both counterfactual situations.

4.1 Example: Garlic

To illustrate how these calculations proceed, I revisit the example of garlic, with its specific tariff of .43 cents per kilogram. A division of the 2022 customs value of imported garlic by the 2022 quantity of imported garlic reveals a unit price of \$2.28 per kilogram. To convert the specific tariff on garlic into its ad valorem equivalent, I divide .43 cents per kilogram by \$2.28 per kilogram to obtain an AVE of .189%.

If the specific tariff rate on garlic increases by ten percent, I know precisely that the new specific tariff will be .43(1.1) or .473 cents per kilogram. Likewise, I know from the HTS data that the column 2 specific tariff for garlic is 3.3 cents per kilogram. However, I do not know how changes in garlic tariffs affect the unit price of garlic, so to calculate the AVEs of these counterfactual specific tariffs, I assume that the unit price remains at \$2.28 per kilogram. Using this unit price, I find that the counterfactual AVEs are .207% and 1.15%.

I evaluate the accuracy of these AVEs by comparing counterfactual changes in quantity computed with specific rates to counterfactual changes in quantity computed with the AVEs. I perform this exercise both using garlic's observed domestic unit price of \$1.67 per kilogram and under the assumption that the domestic price of garlic does not change when its specific tariff rate does.

With a domestic price of \$1.67/kg, import quantities of garlic calculated using AVEs are $2.4 \times 10^{-5}\%$ higher in the ten percent counterfactual and .0971% higher in the counterfactual where twenty percent of garlic imports face column 2 rates. The use of AVEs therefore results in an overestimate of the counterfactual quantity of imported garlic, or alternatively an underestimate of how specific tariff increases affect garlic imports. These results imply that the unit price of garlic falls in the counterfactual, so that AVEs calculated using the previous unit price are too low and result in quantity estimates that are too high. However, these dispersion measures are incredibly small in magnitude, indicating that AVEs are an accurate way to represent specific tariffs on garlic.

I also evaluate the import measurement dispersion of garlic without using domestic price data, assuming that the domestic price of garlic does not change when tariffs on garlic go up. Under these conditions, import quantities of garlic calculated using AVEs are $4.23 \times 10^{-3}\%$ higher in the ten percent counterfactual and

2.08×10^{-3}% higher in the post–PNTR counterfactual.

4.2 Results for Agricultural Products, Estimated using Domestic Price Data

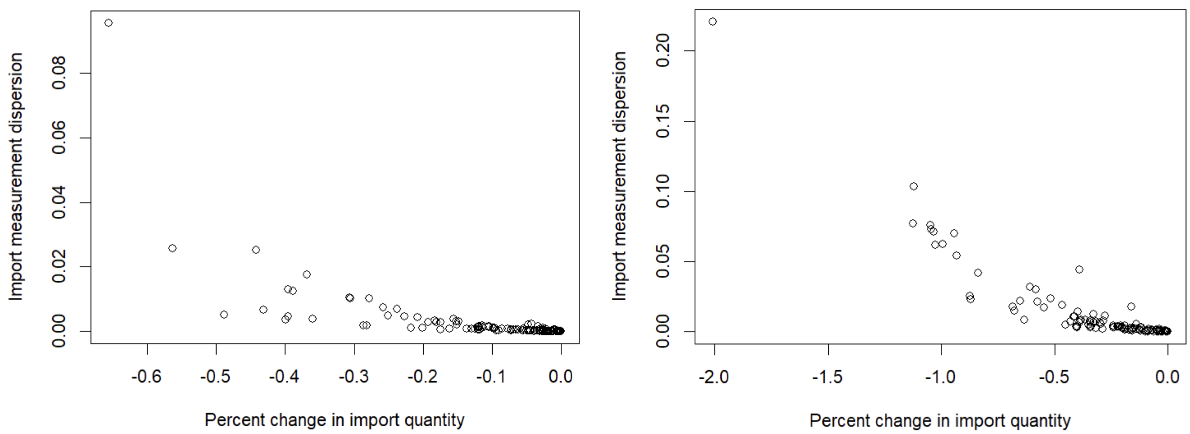
	Ten percent increase		Removal of PNTR status	
Sector	Median	Max	Median	Max
All products	5.62×10^{-4}	4.87	2.75×10^{-3}	0.650
Meat	7.97×10^{-5}	8.30×10^{-4}	2.19×10^{-3}	4.48×10^{-3}
Dairy	0.0513	4.87	0.0149	0.650
Fruits	5.62×10^{-4}	.0252	3.63×10^{-3}	.221
Vegetables	1.01×10^{-3}	5.08×10^{-3}	3.38×10^{-4}	8.11×10^{-3}
Cereals	4.73×10^{-5}	3.74×10^{-3}	2.08×10^{-3}	0.0176

Table 3: Percent differences between import quantities calculated with AVEs and import quantities calculated with observed specific tariffs

The headline result of Table 3 is that counterfactual quantity estimates computed using AVEs are very similar to quantity estimates computed using specific rates, with the median import measurement dispersion less than one–hundredth of a percent. This result suggests that AVEs are in general an accurate representation of specific tariff rates for agricultural goods, and that unit prices do not change that much in the counterfactual.

For all 124 HTS8 products analyzed in Table 3, the counterfactual quantity computed using AVEs is higher than the counterfactual quantity computed using specific tariffs, suggesting that AVEs slightly undervalue the tariff rise. These results also imply that unit prices fall when specific tariffs rise, so the assumption of constant unit prices produces counterfactual quantities slightly larger than they should be. Median import measurement dispersion is slightly higher under the post–PNTR scenario compared to the scenario where all specific rates rise by ten percent.

Table 3 also exhibits some heterogeneity across sectors, although in all sectors the median import measurement dispersion is close to zero. Dairy products have the highest measurement dispersion, suggesting that out of all agricultural sectors surveyed in this paper, trade policy changes affect their unit prices the most. Meat and cereal products, meanwhile, have the least measurement dispersion. HTS8 product 04041090, representing sour cream, has the highest level of import measurement dispersion under both counterfactual scenarios.



(a) Ten percent increase

(b) Removal of PNTR status

Figure 2: Decline in trade vs. import measurement dispersion

Figure 2 plots counterfactual percent changes in import quantity, calculated with specific rates, against import measurement dispersion. As shown in Figure 2, products more affected by tariff upticks also display a greater degree of dispersion in counterfactual import measurements. Researchers should be more careful using AVEs to evaluate the effects of a large tariff hike compared to a smaller one.

4.3 Results for All Products

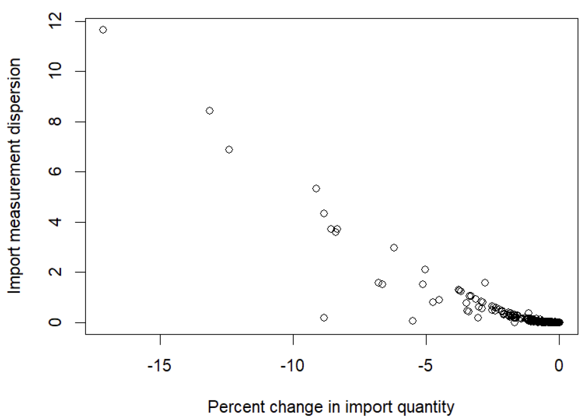
In this subsection, I discuss the results of running simulations on all 648 HTS8 goods with nonzero imports and specific tariff rates. Since domestic unit price data is not available for most of these products, I calculate an equilibrium using the assumption that domestic prices do not change when tariff rates do.

	Ten percent increase		Removal of PNTR status	
Sector	Median	Max	Median	Max
All products	9.10×10^{-4}	11.7	5.39×10^{-3}	5.98
Animal Products	2.80×10^{-3}	11.7	5.93×10^{-3}	1.60
Vegetable Products	4.33×10^{-4}	0.0344	3.07×10^{-3}	1.13
Prepared Foodstuffs	2.44×10^{-3}	1.57	0.0220	4.04
Chemical or Allied Industries	1.54×10^{-4}	.143	0.0204	0.0743
Paper and Wood	3.93×10^{-3}	4.80×10^{-3}	0.0220	0.0269
Clothing and Footwear	5.26×10^{-3}	.295	0.0264	2.69
Base Metals	2.51×10^{-5}	3.69×10^{-5}	1.03×10^{-3}	1.18×10^{-3}

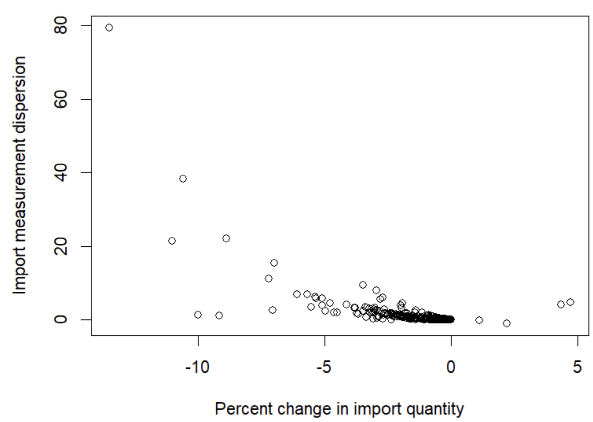
Table 4: Import measurement dispersion, for all products

Import measurement dispersion rates continue to be small when considering all products. The median dispersion rate under a ten percent tariff increase is 9.10×10^{-4} percent and the median dispersion rate under the post–PNTR counterfactual is 5.39×10^{-3} percent. As in Table 3, import measurement dispersion rates are uniformly positive, suggesting that unit prices fall when tariffs rise.

Since Table 4 presents estimates for over five times as many products as Table 3, its contents show a greater degree of heterogeneity. Manufactured goods display higher dispersion rates than agricultural goods, especially in the second counterfactual where dispersion rates for most manufactured goods products are above .01 percent. Base metals, however, have the lowest dispersion rate of any sector. Several individual products have import penetration rates above one percent in both counterfactuals, including sour cream, tobacco refuse, and watch movements.



(a) Ten percent increase



(b) Removal of PNTR status

Figure 3: Decline in trade vs. import measurement dispersion

Figure 3 juxtaposes changes in import quantity against import measurement dispersion for all 648 HTS8 products with a specific tariff.[6] As with Figure 2, a higher rate of decrease in import quantity results in higher levels of import measurement dispersion.

[6]Counterfactual changes in import quantity are positive for four sectors. For HTS 04014025 and HTS 04015025, the Harmonized Tariff Schedule lists PNTR specific rates of 77.2 cents per liter and column 2 specific rates of 15 cents per liter, so for these two products only the column 2 tariff is *lower* than the PNTR tariff. Meanwhile σ, the elasticity of substitution, is negative for the two products in the sample belonging to HTS2 14.

4.4 Robustness

I generate the equilibrium results discussed in Section 4.3 using the assumption that domestic prices do not change in the counterfactual. If this assumption is false or unrealistic, then results in Section 4.3 will not be accurate.

For the agricultural goods discussed in Section 3.3 and Section 4.2, most domestic prices increase in the counterfactual by very small amounts, with a median domestic price increase of about $4.68 \times 10^{-3}\%$ under the first counterfactual and 0.0293% under the second. Domestic prices do not increase by more than one percent for any product. These results imply that the assumption of constant domestic prices is a largely valid one.

I can further test my domestic price assumption by comparing results generated using the method in Section 3.3 with results for agricultural goods generated using the method in Section 3.4. If the two solution methods deliver vastly different results, we may infer that the domestic price assumption does not adequately substitute for data on domestic unit prices. In general, counterfactual import quantities estimated using data on domestic prices are similar to counterfactual import quantities estimated using the domestic price assumption; the median difference between these import quantities is 5.19×10^{-3} percent under the first counterfactual and 0.0347 percent under the second. No products have a difference in quantities higher than one percent under the first counterfactual, and only one product–a type of tobacco–has a difference higher than one percent under the second counterfactual.

These results provide evidence that an assumption of constant domestic prices does not appear unduly strong or unrealistic. For agricultural and non–agricultural goods, the replacement of specific tariffs with their AVEs will not distort counterfactual equilibrium results.

5 Conclusion

International trade economists use ad valorem equivalent measures to address some of the difficulties presented by the use of non–ad valorem tariffs in economic modeling, but have not done much numerical analysis into how reliably these AVEs represent specific or other tariffs. In this paper, I use a partial equilibrium setup to evaluate the performance of AVEs under two counterfactuals: one where all specific tariffs increase by ten percent and another where twenty percent of US imports become subject to column 2 tariff rates instead of the lower permanent normal trade relations rates. I compute these counterfactual simulations for a range of HTS8 products both using the observed specific rates and their AVEs, and the similarity of counterfactual decreases in trade provides an indicator of how reliable AVEs are in representing specific tariffs.

Under both counterfactual scenarios, import quantities computed using AVEs are similar to import quantities computed using observed specific rates. These results indicate that AVEs are generally an accurate representation of specific tariffs, and that the use of AVEs in a partial equilibrium model should not introduce major bias in results. The difference between AVE–computed imports and specific–computed imports is more pronounced for products whose imports are more affected by trade regime changes. Furthermore, differences between the two measures are larger for a few specified products, such as sour cream, so any future analysis done on those particular products should exercise caution if it were to use AVEs.

Future research in this area must consider how to overcome limitations in data on domestic unit prices for non–agricultural products. Any equilibrium analysis done using specific tariffs, and hence any analysis that evaluates the performance of AVEs, requires knowledge of these prices; since specific tariffs enter additively into consumer demand equations, we cannot simply choose a numeraire good whose price is normalized to one. This paper surmounts data limitations by assuming that changes in tariffs do not affect domestic prices, but future research should consider alternative methods. For example, given a reliable means of imputing domestic production at the HTS8 level, the research could use this information to obtain a data set on domestic unit prices.

In addition, future research on this topic can further test the robustness of AVEs by evaluating their performance in situations this paper does not consider. Researchers could evaluate the performance of AVEs when used to represent other types of HTS tariffs, such as tariff codes that incorporate both a specific and ad valorem component.[7] Researchers could also calculate import measurement dispersion using more complex PE models that incorporate an upstream component or include alternative market structures. This paper demonstrates that the AVE computation methodology is simple and works well in straightforward situations, but ideally it should also be robust to further modeling extensions.

[7]Since many of these codes account for a small fraction of HTS8 products, however, this exercise would be useful primarily in analyzing a specific product that happens to fall under that a given tariff schedule.

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