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 calibrating models. 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 is able to include 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 twenty percent of 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 broader industries or sectors. Economists 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 an 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 a change in the specific tariff rate of a product alters its 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 will not deliver the same revenue if the unit price of garlic increases or decreases.

In this paper, I determine the divergence between counterfactual estimates made with data on specific tariff rates and 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 U.S. 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, or 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 for a selection of agricultural goods for which I do observe domestic unit prices. I then execute the same calibration and solution method for all HTS8 products as a function of domestic price, and calculate the difference between specific tariff counterfactuals and AVE counterfactuals for a spectrum of hypothetical 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, 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.

A larger body of literature, largely from the 1990s and 2000s, discusses the structural differences between specific tariffs and ad valorem tariffs. Chowdhury (2011) argues quantitatively that the specific tariffs levied on agricultural products by the European Union penalize African countries exporting low-price goods, offsetting the benefits of preferential tariff agreements. The vast majority of this literature, however, is theoretical,

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

and uses economic theory to show how specific tariffs and ad valorem tariffs lead to different equilibrium outcomes under imperfect competition.[2] Helpman and Krugman (1989) summarizes this literature prior to the 1990s. Shea and Shea (2006), Kowalczyk and Skeath (1994) and Skeath and Trandel (1994) find that ad valorem tariffs lead to higher welfare outcomes than specific tariffs, while Jorgenson and Schroeder (2005) and Das and Donnenfeld (1987) find that specific tariffs are welfare superior. Lockwood and Wong (2000) argue that in a trade war between two countries, specific tariffs will not yield equivalent outcomes to ad valorem tariffs even if all markets are competitive. My paper complements this work by contrasting the two types of tariffs using a product–specific dataset, rather than a theoretical model.

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 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

[2] Under perfect competition conditions, specific tariffs and ad valorem tariffs generate identical equilibrium outcomes.

substitution σ. Without import tariffs, the consumer demand functions and price index would be

$$\begin{aligned} q_d &= YP^{-\varepsilon}(\frac{P}{p_d})^{\sigma} \\ q_f &= YP^{-\varepsilon}(\frac{P}{p_f})^{\sigma} \\ P^{1-\sigma} &= p_d^{1-\sigma} + p_f^{1-\sigma} \end{aligned} \tag{1}$$

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 I consider 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

$$q_f = YP^{-\varepsilon}(\frac{P}{p_f + \tau_s})^{\sigma} \tag{2}$$

and the price index becomes

$$P^{1-\sigma} = p_d^{1-\sigma} + (p_f + \tau_s)^{1-\sigma} \tag{3}$$

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.

$$p_f q_f \tau_a = q_f \tau_s$$
$$p_f \tau_a = \tau_s$$
$$\Rightarrow \tau_a = \frac{\tau_s}{p_f} \tag{4}$$

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 2022 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 2022. This description applies to 648 products, which is slightly over five percent of all products in HTS two–digit sectors 1–97.[3]

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 have 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 its 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 narrow the sample of elasticities to focus on exports to the United States, and construct a supply elasticity for the aggregated country in the model by computing an average elasticity across all exporting countries, weighted by the customs value of 2022 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

[3]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.

supply elasticity of the HTS4 sector to which the product belongs. Estimations of domestic supply elasticity are not available, and 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 HTS products categoriesl

Equation (4) generates the AVE of a specific tariff, given specific rates and 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 category 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 2022 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 be 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.

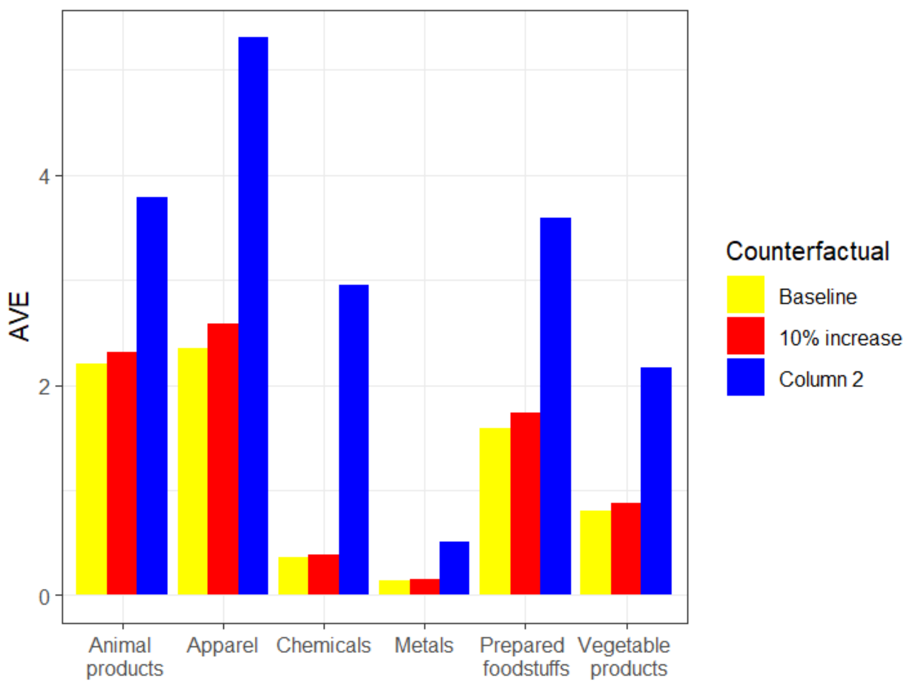


Figure 1: Median ad valorem equivalents for selected sectors, baseline and counterfactual

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 category have the highest column 2 AVE, of 6.41 percent.

3.2 Foreign Supply Shifters

I compute unit import prices p_s in the baseline version of the model by dividing the customs value for each HTS8 product 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 a second foreign country. 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.

$$p_n q_n + p_m q_m = \text{Value}_{2022}$$

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.

$$p_n = \big(\frac{q_m}{q_n}\big)^{\frac{1}{\sigma}}(p_m + \tau_s) - \tau_s$$

$$\Rightarrow \big[\big(\frac{q_m}{q_n}\big)^{\frac{1}{\sigma}}(p_m + \tau_s) - \tau_s\big]q_n + p_m q_m = \text{Value}_{2022}$$

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 or domestic price data for most HTS8 products, which makes calibrating domestic supply shifters a_d difficult.[4] 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 observe domestic price data, and then I perform estimations for all HTS8 products as a function of domestic price while making only limited assumptions on the potential values of those domestic prices. The following two subsections go through each product subset in turn, explaining calibrations for a_d and how to solve the model to generate counterfactual equilibria.

[4] 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.

3.3 Calibration and Solution Method for Agricultural Products

The Food and Agriculture Organization (FAO) provides 2022 U.S. producer 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 data 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 categories 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

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 price than vegetables. Meat products also display the highest discrepancy between domestic unit prices and import unit prices, with the median import 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 (2). I solve for it in the baseline version of the model by inputting data on import quantities, specific tariffs, and unit import prices into (2):

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

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 (3), 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, an analysis of agricultural products may not provide a complete account of how accurately AVEs represent specific tariffs. However, I do not observe unit prices or domestic production for non-agricultural products. Even though domestic price data is available for agricultural products, this data does not exactly correspond with its counterpart p_d in the model, because producer prices represent prices received by farmers at the point of sale rather than prices paid by consumers.

To obtain a broader measure of AVE reliability, I calibrate and solve the model using the same method as detailed in Section 3.3, but since p_d is unknown I obtain all solution quantities as a function of p_d rather than as values. I then compute precise numerical values under a spectrum of potential domestic prices, and can thereby ascertain the robustness of my counterfactual measures with respect to domestic prices.

Category	Minimum	Median	Maximum
All products	8.92×10^{-3}	.707	2.02
Meat	.159	.728	2.02
Dairy	.657	.983	2.02
Fruits	.364	.762	1.75
Vegetables	.286	.743	1.57
Cereals	.0787	.759	.923

Table 3: Ratio of domestic agricultural prices to foreign agricultural prices

I calculate potential values for domestic prices using information from agricultural goods on the ratio of domestic prices to import prices, and then multiplying observed import prices by these ratios. Among the 124 agricultural products, the median ratio of domestic prices to import prices was .707, with a minimum under .001 and a maximum of 2.02. Table 3 shows that this median is largely consistent across categories, with products in the dairy industry having slightly higher domestic prices relative to import prices. While non-agricultural products may not exhibit the same price behavior as agricultural products, I argue that this spectrum represents a reasonable range under which price ratios could fall.

Since the entire distribution of price ratios is unknown for the larger sample of goods, I calculate equilibria under several alternatives. I first assume a single domestic–to–import price ratio across all products and observe how trade outcomes vary based on this price ratio. I then re–calculate equilibria for a set of domestic prices generated using a random normal distribution of ratios with the same median and standard deviation as those of agricultural prices.

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 measure, total imports, across both counterfactual situations.

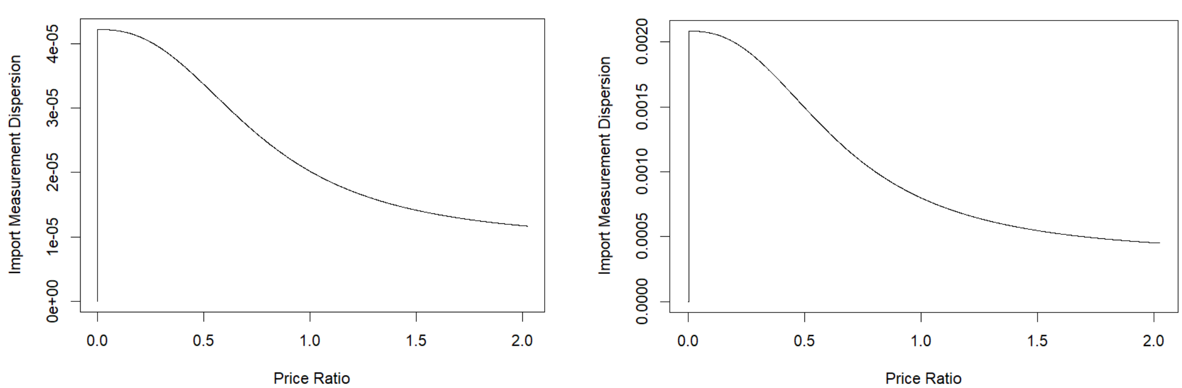
4.1 Example: Garlic

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 that the new specific tariff will be precisely .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 using a spectrum of potential domestic prices.

With a domestic price of \$1.67/kg, import quantities of garlic calculated using AVEs are 2.4×10^{-5}% higher in the counterfactual where specific rates increase by ten percent 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.



(a) Ten percent increase

(b) Removal of PNTR status

Figure 2: Increase in AVEs vs. import measurement dispersion

Figure 2 presents import measurement dispersion results for garlic as a function of the ratio between domestic and import prices, which is known for garlic but not known for most products. Dispersion rates continue to be negligible regardless of the price ratio, indicating that AVEs are a reliable measure for garlic even if the domestic price data contains measurement issues.

4.2 Results for Agricultural Products, Estimated using Domestic Price Data

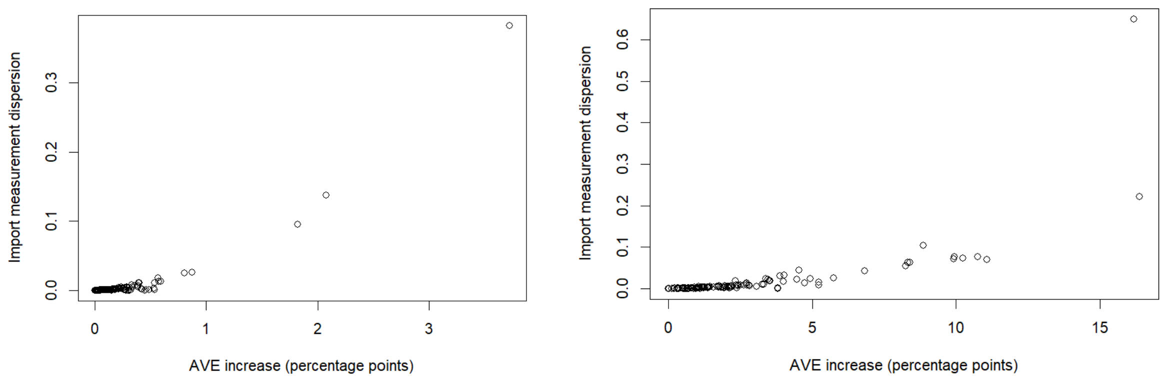
	Ten percent increase		Removal of PNTR status	
Sector	Median	Max	Median	Max
All products	5.62×10^{-4}	4.87	2.75×10^{-3}	0.650
Meat	7.97×10^{-5}	8.30×10^{-4}	2.19×10^{-3}	4.48×10^{-3}
Dairy	0.0513	4.87	0.0149	0.650
Fruits	5.62×10^{-4}	.0252	3.63×10^{-3}	.221
Vegetables	1.01×10^{-3}	5.08×10^{-3}	3.38×10^{-4}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

Table 4: Percent differences between import quantities calculated with AVEs and import quantities calculated with observed specific tariffs

The main result of Table 4 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 very much in the counterfactual.

For all 124 HTS8 products analyzed in Table 4, 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, since the majority of column 2 tariffs exceed their PNTR counterparts by more than ten percent

Table 4 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

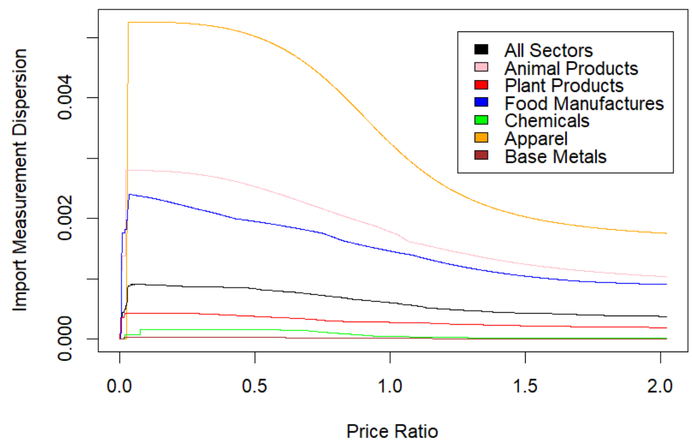
Figure 3: Increase in AVEs vs. import measurement dispersion

Figure 3 plots counterfactual percentage point changes in ad valorem equivalent tariff measures against import measurement dispersion. As shown in Figure 3, products with higher tariff upticks also display a greater degree of dispersion in counterfactual import measurements; the most likely explanation for this observation is that greater changes in AVEs correspond with greater changes in unit prices, and hence greater losses in precision in how those AVEs represent specific tariffs. Researchers should be more careful when using AVEs to evaluate the effects of a large tariff hike compared to a smaller one.

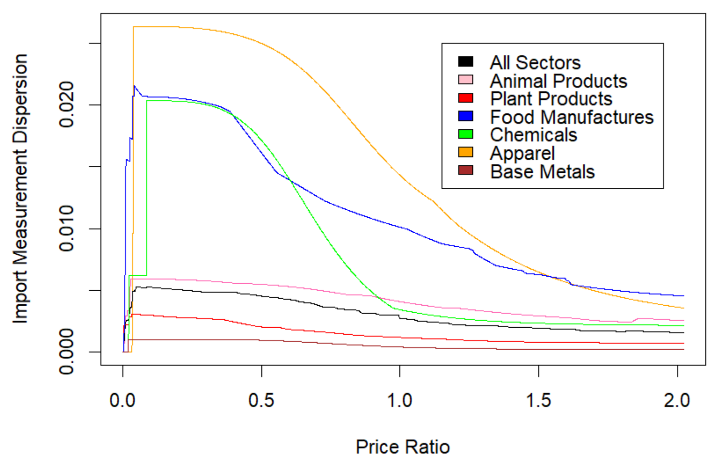
4.3 Results for All Products

In this subsection, I discuss the results of running simulations on all 648 HTS8 goods with nonzero imports and specific tariff rates. Figure 3 plots the median import measurement dispersion across sectors as a function of an (assumed) common price ratio.

Import measurement dispersion rates continue to be small when considering all products. The median dispersion rate under a ten percent tariff increase is between 0 and .1 percent and the median dispersion rate under the post–PNTR counterfactual is between .002 percent and .005 percent, with all median dispersion rates falling below .05 percent. Dispersion rates are generally higher under the post–PNTR simulation,



(a) Ten percent increase



(b) Removal of PNTR status

Figure 4: Change in AVE vs import measurement dispersion

especially for manufactured goods, because the increase in specific rates in column 2 compared to column 1 is often more than ten percent. As in Table 4, import measurement dispersion rates are uniformly positive, suggesting that unit prices fall when tariffs rise.

Among manufactured goods, food manufactures and apparel display higher rates of dispersion than plant products, as well as the median dispersion among all sectors. Base metals, however, have the lowest dispersion rate of any sector. Chemical products display low rates of dispersion in Figure 4a) but higher rates of dispersion in Figure 4b); as shown in Figure 1, chemical tariffs barely change in the first counterfactual but go up by a factor of Y in the second.

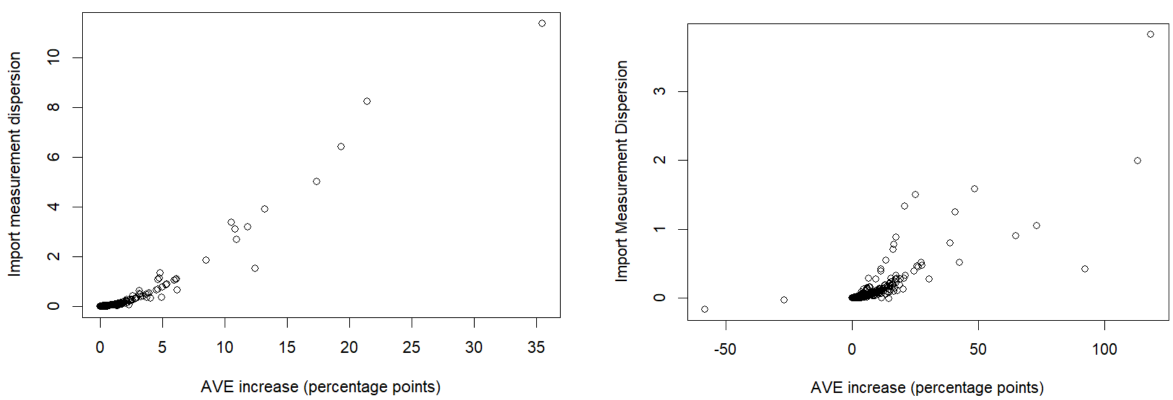
Finally, results in Figure 4 indicate that the difference between AVE–generated counterfactuals and specific rate–generated counterfactuals monotonically decreases as domestic production becomes more expensive relative to imports, with the exception of when domestic prices are close to zero. Median dispersion rates in Figure 4b) are around .005 when domestic prices are around .1% of import prices and fall to about .001 when domestic prices are twice as high as import prices. A higher domestic price means that agents cannot easily substitute away from foreign imports when tariffs rise, and thus the unit import price net of specific tariffs will not decline as much relative to its baseline value. Since counterfactual AVEs are based on that baseline value, a lesser change in import prices implies a counterfactual AVE that more closely resembles its specific counterpart, and so import measurement dispersion decreases as domestic prices rise and increases as they fall. If domestic prices are especially close to 0, though, agents' expenditure on imports will also approach zero, and an increase in trade barriers cannot significantly alter that result regardless of what type of tariff represents that increase in trade.

	10% increase		Removal of PNTR Status	
Price Ratios	Median	Max	Median	Max
$p_d = .7p_s$	7.46×10^{-4}	11.6	3.77×10^{-3}	4.90
Normal Distribution	6.03×10^{-4}	11.4	2.74×10^{-3}	3.83
Uniform Distribution	5.67×10^{-4}	11.7	2.92×10^{-3}	1.85

Table 5: Import measurement dispersion under various price distributions

In Table 5, I show the results of calculating equilibria and import measurement dispersion rates under various distributions of the price ratio between domestic and unit import prices, which I then multiply by observed import prices to get a series of potential domestic prices. I first consider a simulation where all domestic prices are equal to import prices multiplied by .706542, the median domestic–to–foreign price ratio for agricultural products. I then consider a simulation where price ratios are normally distributed around this median with a standard deviation equal to that of the agricultural price ratios, and a simulation where price ratios follow a uniform distribution between 8.92×10^{-4}, the observed lowest price ratio for agricultural products, and 2.02, the maximum observed price ratio. Results in Table 5 indicate that the assumed price distribution has very little effect on import measurement dispersions, and that these dispersions continue to be quite small.

Around one to two percent of products in each simulation have import measurement dispersion rates above one percent; products with higher dispersion rates tend to belong to the animal products or food manufacturing categories.[5] Individual products with import penetration rates above one percent in both counterfactuals include sour cream, tobacco refuse, and watch movements.



(a) Ten percent increase

(b) Removal of PNTR status

Figure 5: Change in AVE vs import measurement dispersion

Figure 5 juxtaposes changes in AVEs against import measurement dispersion for all 648 HTS8 products with a specific tariff, generated using a random normal distribution of price ratios.[6] As with Figure 3, a higher increase in tariffs results in higher levels of import measurement dispersion.

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

[5]Dispersion rates are generally higher for products in the dairy industry, as Section 4.2 demonstrates as well.

[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.

to evaluate the performance of AVEs under two counterfactuals: one in which all specific tariffs increase by ten percent and another in which twenty percent of US imports become subject to column 2 tariff rates instead of the lower PNTR 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 reliably AVEs represent 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 above one percent 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 does demonstrate, though, that changes in domestic price do not strongly affect the precision of AVE measures, and so any assumptions made in imputing domestic prices should not strongly influence these results.

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, 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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