# US trade policy and liberalization in the 70s and 80s: Tariffs, inflation, and exchange rates *

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**Abstract**

Employing a novel database of annual U.S. statutory tariffs from 1972 to 1988, we provide the first estimates of the welfare gains from liberalization during the years spanning the Tokyo Round of the GATT. Our analysis highlights the crucial role of understanding sources of variation in ad valorem equivalent (AVE) tariff rates. In the presence of specific tariffs, statutory tariff cuts, inflation, and exchange rate depreciation all reduce AVE tariffs, yet they have opposing effects on prices, imports, and welfare. We present a decomposition of aggregate tariffs to underscore the importance of these channels and document (i) an accidental tariff liberalization due to the inflationary erosion of the tariff schedule–partially offset by U.S. dollar appreciation–coupled with (ii) a four-percentage-point statutory tariff liberalization. After estimating the complete passthrough of these tariff changes into import prices, we generalize an exact-hat framework to incorporate specific tariffs and demonstrate that changes in AVE tariffs alone are insufficient to quantify the welfare effects of tariff policy. During our sample period, inflation caused a greater *tariff liberalization* than the GATT, but the GATT caused a greater *trade liberalization*. Finally, we emphasize how failing to account for this distinction impacts welfare estimates in trade policy studies.

Keywords: Tariffs, Inflation, Exchange Rates, Trade Policy, Tokyo Round, GATT, Plaza Accord, Specific Tariffs

JEL Codes: F13, F16, F62

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# 1 Introduction

The decades of the 1970s and 1980s witnessed a number of momentous events in global trade, including the collapse of the Bretton Woods system, the completion of the Tokyo Round of the General Agreement on Tariffs and Trade (GATT), the Plaza Accord, and the beginning of the modern era of regional trade agreements. In the US context, however, this period remains understudied by trade economists, with substantially more attention devoted to the era of "hyper-globalization" beginning with the Canada-US Free Trade Agreement in 1989. And yet, many of the defining features of the era's trade policy environment seem eerily familiar today: decades of liberalization followed by a period of high inflation and concerns about a growing trade deficit leading to calls for increased protectionism.

In this paper, we shed light on the effects of US trade policy on tariffs, prices, and imports in this important and understudied era. To do so, we construct a novel database covering the universe of US statutory tariffs from 1972-1988, the years spanning the negotiation and implementation of the Tokyo Round of the GATT. After documenting widespread use of specific tariffs, we embed them in a quantitative framework and provide welfare estimates of US trade policy throughout this era.[1] Our analysis underscores the importance of understanding the sources of variation in tariff changes both in this setting and others: despite their ubiquitous use as a measure of liberalization, ad valorem equivalent (AVE) tariff changes are not sufficient to quantify the effects of changes in trade policy on economic outcomes. In the presence of specific tariffs, statutory tariff cuts, inflation, and exchange rate depreciation all cause reductions in AVE tariffs, but have opposing effects on prices, imports, and welfare.

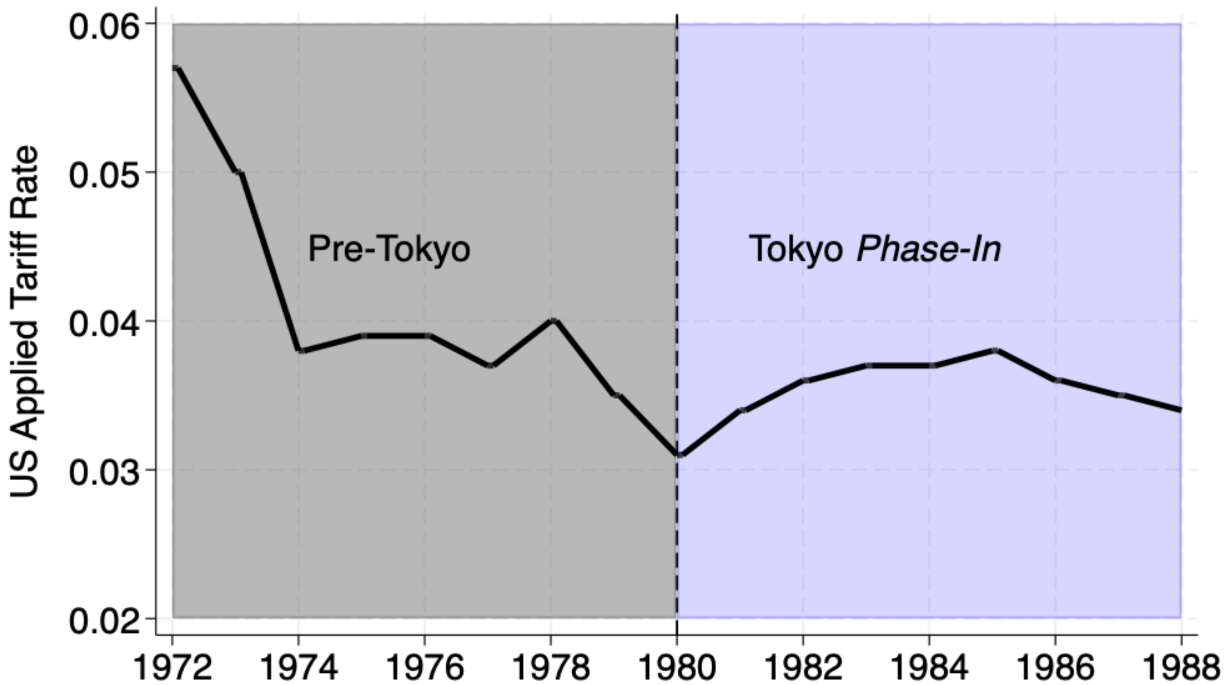
Our analysis begins with a puzzle that is apparent in US aggregate tariff rates during our sample. The Tokyo Round of the GATT was completed in 1979, with negotiated tariff reductions phased in over the following eight years. This represented the first wholesale change in the US tariff code since the tariff reductions mandated by the 1967 Kennedy Round were completed in 1972.[2] One would thus expect relative stability in average US tariffs

[1] Acosta and Cox (2025) have constructed phase-in schedules surrounding the major tariff rounds (including Tokyo), but do not have annual tariff data throughout our sample. Our data not only account for deviations from the planned phase-in schedule, but also capture temporary changes in policy, as well as heterogeneous access to preferential rates including GSP, LDDC, CBERA, IFTA, and shifting Column 2 tariff access. Moreover, our data contribution extends to an improved disaggregated import dataset which are combined with our annual tariff data.

[2] The "Nixon Shock" also altered US tariff rates after the Kennedy Round negotiations had been completed. These tariffs were transitory, however, lasting for only four months in 1971, prior to the start of our sample (Irwin, 2012).

throughout the 1970s and a subsequent decline throughout the 1980s. However, Figure 1 depicts the US aggregate AVE tariff and shows that the *opposite* is true.[3] That is, the average tariff level fell sharply throughout the 1970s despite the absence of meaningful changes to trade policy for most of the decade, and despite the successful completion of the Tokyo Round negotiations in 1979, average tariffs *rose* slightly in its wake.

**Figure 1:** Aggregate US Ad Valorem Equivalent Tariff Rate




**Notes:** US Ad Valorem Equivalent (AVE) Tariff Rate defined as duties collected divided by total imports. Data from USITC. Equivalently, this is an import value-weighted average of tariff rates.

To reconcile these changes in aggregate rates with the common understanding of trade policy in this era, we construct a tariff-line level tariff database which covers more than 97% of imports during this sample and encompasses not only the Tokyo Round liberalization, but also complete coverage of Non-Normal Trade Relations "Column 2" rates, temporary legislative tariff changes, and the introduction of preferential tariff programs.[4] Uniquely, this database details the statutory tariff rates – distinguishing among ad valorem, specific, and

[3] Data taken from the: US International Trade Commission (USITC).

[4] These latter rates include those covered under the Generalized System of Preferences (GSP), Least-Developed and Developing Countries, the Caribbean Basin Economic Recovery Act (CBERA), and the US-Israel Free Trade Agreement

compound tariff rates – rather than relying on the ad-valorem equivalent (AVE) tariff rates used extensively elsewhere throughout the literature.[5] As we will show, knowledge of the statutory (rather than ad valorem equivalent) tariff rates is crucial for correctly calculating the welfare effects of trade policy. We combine these data with information on trade flows from the Census Import Databank (IDB) over the same period and correct several important issues in these data. A primary contribution of this paper is to make this joint import and tariff dataset available to researchers. Given the renewed emphasis on tariffs in modern US trade policy, we view this as an important contribution.

With these data in hand, we detail a decomposition of aggregate tariff rates into changes in tariff-line AVE tariffs and expenditure shares. The decomposition reveals two distinct types of liberalization during our sample. The first is a statutory liberalization implied by the Tokyo Round. This reduced US tariffs by nearly 25% between 1980 and 1987, largely along lines dictated by the so-called "Swiss Formula."[6] Our decomposition highlights, however, that this liberalization is masked in the aggregate by endogenous changes in expenditure shares in response to the tariff cuts. Second, we document a substantial "accidental" liberalization in the years preceding the Tokyo Round liberalization driven by changes in ex-tariff unit values. Rapidly rising prices in the presence of specific tariffs covering one-third of the US tariff code and reduces these tariffs from 7% to 4%. This effect drives the pre-period decline in tariff rates, and were it not for a dramatic appreciation of the US dollar (which lead to a growing trade deficit and ultimately to the Plaza Accord), it would have persisted through the end of our sample. While nearly every sector experiences tariff cuts, raw materials and agriculture are primarily impacted in the 1970s while remaining sectors are primarily affected by Tokyo Round phaseouts throughout the 1980s.

While such inflationary erosion of the tariff schedule has been discussed in various settings previously (Van Cott and Wipf, 1983; Crucini, 1994; Irwin, 1998; Greenland and Lopresti, 2024), welfare calculations of these changes have been sparse or ad hoc. This may be in part due to the nature of specific tariffs themselves; their additive nature clashes with the workhorse multiplicative general equilibrium models in international economics, complicating the use of modern quantitative tools in counterfactual analysis. Indeed, empirical

[5]For example the data developed in Feenstra (1996) reports only AVE tariff rates.

[6]The Tokyo Round was the first use of Swiss Formulas for tariff reduction. The formula, proposed by the Swiss delegation to the GATT in 1976, defines a final tariff $Z$ as $Z = \frac{AX}{A+X}$, where $X$ is the initial tariff and $A$ is a coefficient representing the maximum final tariff rate across all products. In the Tokyo Round negotiations, $A$ was set at 0.14 for the US, though the formula was not followed for all products. For more details, see: https://www.wto.org/english/tratop_e/agric_e/agnegs_swissformula_e.htm.

researchers typically omit data with specific tariffs, convert them to their ad valorem equivalent, or rely on data sources which do this implicitly (Topalova, 2010; Head and Mayer, 2014; Caliendo and Parro, 2015; Hakobyan and McLaren, 2016; Pierce and Schott, 2016; Dix-Carneiro and Kovak, 2017; Handley and Limão, 2017; Boehm et al., 2023; Alessandria et al., 2025). We show that such an approach is neither innocuous nor necessary. Generalizing the CES demand and Armington production structure adopted by Fajgelbaum et al. (2020), we demonstrate that one can employ modern "hat algebra" tools to conduct welfare analysis even in the presence of specific tariffs.

Our analysis highlights a key and perhaps surprising result, not all reductions in AVE tariffs are welfare enhancing. As a consequence, the failure to distinguish the source of AVE tariff changes will lead to to misstated welfare estimates of trade policy. The intuition for this result is as follows: when tariffs are exclusively ad valorem changes in AVE are isomorphic to changes in statutory rates and are thus a sufficient statistic for the change in the importer's price. As AVE tariff rates fall the importer's price falls, and imports rise. However, the presence of specific tariffs breaks this relationship. Inflation in ex-tariff unit values will erode the AVE of specific tariffs, but increase the importers price and lead to falling in imports. Similarly, USD appreciation will increase the AVE of specific tariffs, but lower the importers price and lead to surging imports. As such, an assessment of the import and welfare effects of a AVE tariff change requires knowing the source of the tariff change. As rampant inflation and a stark appreciation of the USD are hallmarks of our sample, we use this opportunity to separate the effects of these channels on AVE tariffs and on imports. Our counterfactuals highlight that inflation caused a greater *tariff liberalization* than the GATT, but the GATT caused a greater *trade liberalization*. While the latter was welfare enhancing, the former was not.

Of course, a quantitative assessment of these channels requires structure and welfare estimates require demand and supply elasticities. For these, we combine the approach of Zoutman et al. (2018) and Fajgelbaum et al. (2020) with an IV based on the "Swiss Formula" that dictated the magnitude of tariff cuts under the Tokyo Round Greenland et al. (2023). The formula mandates a tariff cut based entirely on the pre-Tokyo tariff level. This formula allows us to exploit tariff changes based on intended, rather than observed, tariff cuts to estimate our elasticities. We estimate import demand elasticities ranging from 3-5 and export supply elasticities of zero. These estimates add to a growing list of studies documenting complete passthrough of tariff changes into import prices.[7] In our framework,

[7] In robustness exercises, we also generalize the Feenstra (1994) and Broda and Weinstein (2006) estimator

the so-called "small-open-economy" case of allows for easy implementation of "exact-hat" algebra counterfactuals.

Our work is related to three distinct strands of literature. First, we add to the numerous studies focused on quantifying the effects of trade policy on US domestic economic outcomes. Studies of the 1989 Canada-US Free Trade Agreement (Trefler, 1993; Guadalupe and Wulf, 2010), NAFTA (Caliendo and Parro, 2015; Hakobyan and McLaren, 2016; Choi et al., 2024), the US granting PNTR to China in 2001 (Pierce and Schott, 2016; Handley and Limão, 2017; Greenland et al., 2019), the 2001 Bush steel tariffs (Cox, 2022; Lake and Liu, 2022), and the Trump-era tariffs (Fajgelbaum et al., 2020; Flaaen and Pierce, 2021) all rely on discrete changes in disaggregate tariff data to establish causal links between trade policy and economic outcomes. By contrast, we emphasize the importance of both legislated tariff changes and the inflationary erosion of specific tariffs as sources of liberalization. Further, in hopes of facilitating subsequent research in this era, we also construct the first publicly available dataset of TSUSA legislated tariffs at the annual level and merged Census Import Database. Given the growth in imports, declines in tariffs, and labor market turmoil during this time period, we believe these data and techniques will prove to be a valuable resource for other researchers.

Second, our study contributes to the literature focused on the impacts of additive trade barriers. Hummels and Skiba (2004) and Feenstra and Romalis (2014) emphasize the importance of per-shipment trade costs in determining both trade volume and export quality. Irarrazabal et al. (2015) detail a procedure to estimate additive trade costs, while Sørensen (2014) shows that the gains from trade are larger in the presence of such barriers. Still other studies emphasize the importance of per-unit trade costs in shaping tariff levels and import patterns during the first half of the 20$^{\text{th}}$ century US (Crucini, 1994; Irwin, 1998; Bond et al., 2013; Greenland and Lopresti, 2022). In this paper, we show that per-unit trade costs are quantitatively important for trade flows far more recently than has been previously demonstrated. Specific tariffs cover more than one-third of products in the US tariff code in 1972, and more than 25% of goods on the eve of the transition to the HS system.[8]

Finally, our paper is related to a number of studies analyzing the effects of evolving US trade policy in the 1970s and 1980s. Among these, only Van Cott and Wipf (1983) address

to account for specific tariffs and document the bias generated by ignoring their presence.

[8]As of 2020, specific tariffs are still a highly important form of protection in US agriculture. Moreover, certain countries remain dependent on specific tariffs for protection across the entire tariff schedule. Over 85% of Switzerland's tariff code, for example, consists of specific tariffs.

the role of inflation on tariff levels. The authors provide back of the envelope estimates of the effects of inflation on AVE tariff levels in the pre-Tokyo era, but do not assess impacts on imports or address statutory tariff changes. Deardorff and Stern (1979, 1981) provide prospective analyses of the effects of the Tokyo round before its implementation, while Brown (1988) provides estimates of the effects of GSP implementation in a CGE model. Trefler (1993) focuses on the effects of non-tariff barriers during the 1980's period instead of the tariff changes during the Tokyo Round. Relative to these studies we provide a comprehensive analysis through a structural model of all sources of tariff changes during this era. A number of authors have also emphasized the role US monetary policy in driving the abrupt USD exchange rate appreciation and resulting trade imbalance in the 1980s (Destler, 1991; Frankel, 1994, 2015). While we do not directly model the determination of exchange rates, we use this shock and reversal following the Plaza Accord to highlight the way in which exchange rates interact with tariff policy in this era. Finally, while our analysis adopts the variety set corrections outlined in Feenstra (1994), our emphasis is on the welfare gains due to the evolution of trade policy in this era rather than the expansion of the variety set as in Broda and Weinstein (2006).

The paper proceeds as follows. Section 2 describes our statutory tariff database and details a comparison of coverage with alternative data sources. Section 3 provides a decomposition of aggregate tariff changes into statutory and endogenous components and reconciles variation in aggregate tariffs with conventional wisdom about US tariff policy between the Kennedy and Tokyo Rounds. Section 4 shows that embedding specific tariffs in a CES framework generates incomplete passthrough of price shocks in both hat and exact-hat settings. Here we also outline our identification strategy and estimate the parameters of the model. Section 5 presents a number of counterfactual estimates to quantify the role of statutory, inflationary, and exchange rate driven changes in tariffs. We also highlight the problems with failing to account for specific tariffs in trade policy studies. Section 6 concludes.

## 2 Data

Between 1972 and 1988, the global trading system operated under two GATT regimes. Beginning in 1968, the Kennedy Round was enacted and tariffs were phased in over four years, reaching their negotiated final levels in 1972. Upon completion of the Tokyo Round negotiations in 1979, negotiated tariff cuts were implemented with a phase-in schedule that lasted until 1987. Legislated tariff schedules for the US in this period, including phase-ins, were covered by the Tariff Schedule of the United States Annotated (TSUSA).

Currently, no dataset contains annual product-level US legislated tariffs for these years. As such, work relying on tariff levels in this era has taken an indirect approach: US imports and exports are recorded annually by the US Census in the Annual Import Data Bank (IDB) and have been detailed at length by Feenstra (1996). Product-level AVE rates can be calculated by dividing duties collected by import values. Such an approach, however, ignores the distinction between tariffs specified in percentage (ad valorem) terms and those specified in per-unit (specific) terms. As such, one cannot determine whether changing AVE rates are driven by a actual changes in the legislated tariffs or by price movements in the presence of specific tariffs. As price levels doubled throughout the 1970s and specific tariffs were pervasive, this is a non-trivial concern in this era. To address this concern, we construct a dataset of US tariff rates at the tariff-line level using a novel estimation procedure that captures both the ad valorem and specific components specified by legislation.

Although the data provided by Feenstra (1996) has been the workhorse dataset during this era, it has some serious limitations for our purposes– the data are aggregated to a country-product-year level which aggregates across different tariff rates even within narrowly defined products. Second, these data have no information about tariffs before 1974. Third, the data they do provide on tariffs are ad valorem equivalent and provide no information about the distinction between ad valorem and specific tariff rates. Finally, there are a number of data quality issues outlined in Feenstra (1996) about omitted products or duplicated entries that make disaggregate use infeasible.

To avoid these pitfalls we begin with the raw files directly.[9] We adopt a two-fold approach to mapping from these raw files to our final database. We first conduct an estimation exercise that allows us to recover the statutory tariff rates for a substantial majority of the products. This procedure is detailed in full in Appendix A. We then manually fill in any tariff codes for which we are unable to estimate these rates. This provides near complete coverage of all traded goods at the tariff-line level between 1972 and 1988. Finally, we manually digitize the entire TSUSA schedule in 1972, 1979, and 1987. This serves as a check our estimation routine and also provides complete coverage of Column 2 tariffs and tariff rates for non-traded products. We augment this with country by year information on inclusion in CBERA and LDDC as well as country-product-year access to GSP. Lastly, we also digitize tariff rates for

[9] https://catalog.archives.gov/id/566340

the Israel Free Trade Agreement (IFTA) and monitor changes in country's access to column 1 rates (as opposed to column 2).

The completed database provides information on ad valorem tariff rates, $\tau_{vgt}$, and specific tariff rates, $f_{vgt}$, both of which may differ by country $v$, good $g$, and time $t$. In addition to distinguishing between tariff types, the database offers several improvements relative to the IDB data. First, it includes tariff data in 1972 and 1973, both of which are absent from the IDB. Second, we document multiple substantial errors in the IDB data. We adjust the data to provide time-series-consistent units where possible. We correct such cases.[10] Our final sample covers 97% of the value of imports and more than 5,000 dutiable items per year. Appendix A discusses the dataset construction in detail.

Table 1 presents descriptive statistics from our joint annual database of tariffs and imports from 1972-1988 separately for the seven 1-digit TSUSA sectors. The share of tariff lines in each sector typically varies between 17% and 22% except with the main exceptions being Wood & Paper and Non-metal Minerals & Products with around 6% of tariff lines. In contrast, the share of imports across sectors is more dispersed with 42% of imports in Metals & Metal Products followed by 18% in Chemicals (which includes fuels) and 14% in Agriculture.

**Table 1: Descriptive Statistics by Sector**

| | Sector Level | | | Dutiable Goods | | | |
|---|---|---|---|---|---|---|---|
| | $Sh.Imports_s$ | $Sh.Lines_s$ | $I(DF_g)$ | $AVE_g$ | $I(Spec._g)$ | $\Delta AVE_g^{72,79}$ | $\Delta AVE_g^{79,88}$ |
| Agriculture | 0.140 | 0.221 | 0.229 | 0.088 | 0.614 | −0.043 | −0.024 |
| Wood & Paper | 0.084 | 0.063 | 0.231 | 0.064 | 0.426 | −0.007 | −0.033 |
| Textiles | 0.016 | 0.174 | 0.048 | 0.162 | 0.310 | −0.027 | −0.065 |
| Chemicals | 0.184 | 0.190 | 0.234 | 0.061 | 0.485 | −0.013 | −0.018 |
| Non-Metals/Minerals | 0.041 | 0.064 | 0.242 | 0.105 | 0.434 | −0.014 | −0.058 |
| Metals | 0.420 | 0.168 | 0.119 | 0.079 | 0.340 | −0.007 | −0.034 |
| Misc. | 0.092 | 0.119 | 0.028 | 0.148 | 0.329 | −0.015 | −0.066 |
| Total | 0.157 | 0.165 | 0.157 | 0.104 | 0.423 | −0.021 | −0.041 |

**Notes:** Table presents summary statistics of our combined import and tariff database by sector. The left three columns provide descriptive statistic for all observations while the right three columns provide descriptive statistics for the dutiable goods in each sector. $I(DF_g)$ is a dummy variable taking the value of one for duty free goods. $AVE_g$ is the ad valorem equivalent tariff rate (total duties/imports) aggregated across all observations.

[10]There are a small set of products for which we are not able to provide tariff rates. These range from 2-3% of import values annually. These include products such as watches, which include distinct rates on as many as 5 dimensions, and goods for which the legislated rate depends on the domestic price of the good or the time of year. The final database includes a flag indicating these "complex" products. Finally, a handful of products appear in the import data but have no corresponding tariff entry in the TSUSA. While the source of this problem is unclear, we similarly flag these cases in the database.

There is substantial tariff heterogeneity across sectors. Most sectors have zero tariffs on around 20-25% of tariff lines, Textiles and Miscellaneous Products are notable exceptions with below 5% of tariff-free lines. In this period, specific tariffs are very prevalent. Over 60% of tariff lines in Agriculture have specific tariffs and this number only falls to 30-48% for the other sectors. Now focusing on dutiable goods, the mean AVE tariff at the tariff-line level is 10.4%, reaching 16.2% in Textiles and 14.8% for Miscellaneous Products while falling to 6.4% in Wood & Paper and 6.1% in Chemicals. The combination of large initial tariffs and a large share of specific tariffs in Agriculture and Wood & Paper lead to pre-Tokyo AVE tariff reductions of 4.3% points and 2.7% points respectively. In contrast, the large initial tariffs in Textiles, Non-metal Minerals & Products, and Miscellaneous Products leads to Tokyo round AVE tariff cuts of around 6-6.5% points.

# 3 The Evolution of US Tariff Policy: 1972-1988

We now turn to the behavior of tariff rates during our sample, emphasizing two features of the data. First, we investigate the sharp decline in the aggregate tariff rates in the pre-Tokyo Round period despite the absence of wholesale policy changes. Second, we provide an explanation for the relative stability of the aggregate $AVE$ in the years following the successful agreement.

To begin, we rewrite $AVE$ as the sum across exporters $v$ and port-by-seven-digit TSUSA goods $g$ of total duties collected divided by the sum of import values, also over exporters and goods:

$$\begin{aligned} AVE_t &= \frac{\sum_g \sum_v TD_{vgt}}{\sum_g \sum_v M_{vgt}} \\ &= \frac{\sum_g \sum_v M_{vgt}\left(\tau_{vgt} + \frac{f_{vgt}}{p^*_{vgt}}\right)}{\sum_g \sum_i M_{vgt}} \\ &= \sum_g \sum_v s_{vgt} \underbrace{\left(\tau_{vgt} + \frac{f_{vgt}}{p^*_{vgt}}\right)}_{AVE_{vgt}} \end{aligned} \tag{1}$$

We refer to the exporter-good pair as a "variety". The second line follows from rewriting variety-level duties collected, $TD_{vgt}$, as the multiple of variety-level imports, $M_{vgt}$ and its AVE, $\tau_{vgt} + \frac{f_{vgt}}{p^*_{vgt}}$. Finally, we rewrite as the weighted average of the variety-level $AVE_{vgt}$, with weights equal to is the variety-level import share $s_{vgt}$.

We next define three mutually exclusive sets of imported varieties: continuing varieties $V^C$ between time $t = 0$ andd $t = 1$, exiting varieties $V^X$, and entering varieties $V^N$. We can then decompose changes in $AVE_t$ as follows:

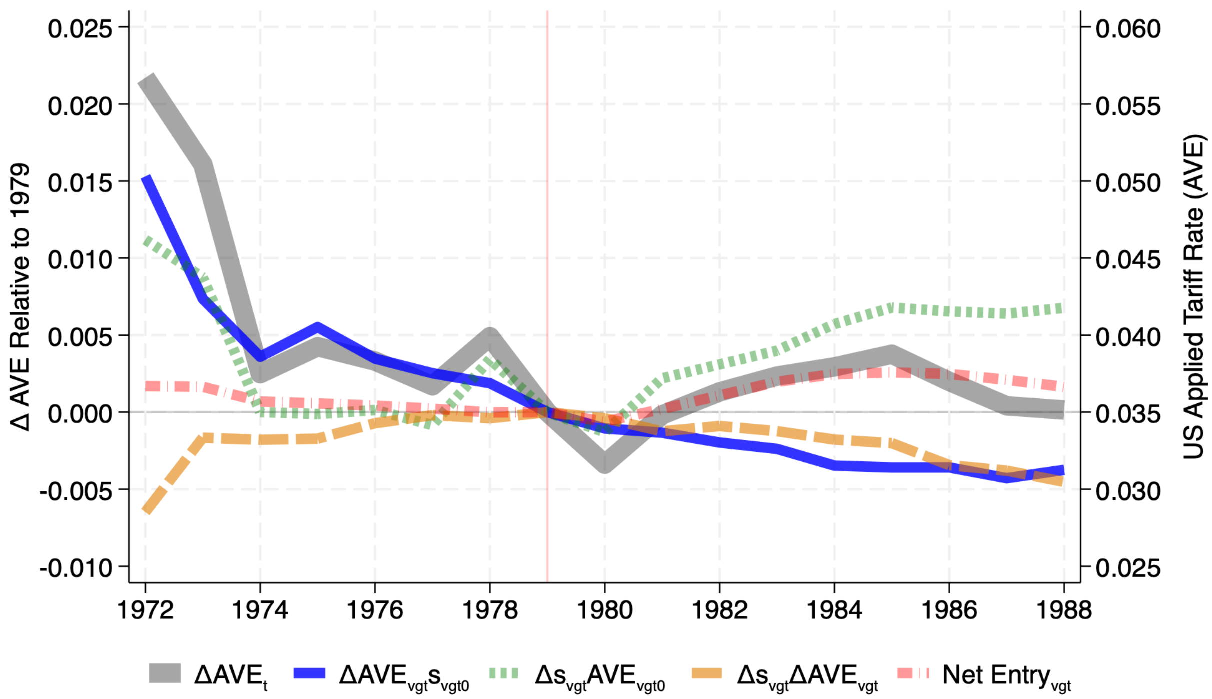
$$\begin{aligned}\Delta AVE_t \equiv & AVE_{t_1} - AVE_{t_0} \\ = & \underbrace{\sum_{v \in V^C} \Delta s_{vgt} AVE_{vgt_0}}_{\substack{\Delta \text{ Import Shares,} \\ \text{Initial Tariffs Fixed}}} + \underbrace{\sum_{v \in V^C} s_{vgt_0} \Delta AVE_{vgt}}_{\substack{\Delta\text{AVE Tariffs,} \\ \text{Initial Shares Fixed}}} + \underbrace{\sum_{v \in V^C} \Delta s_{vgt} \Delta AVE_{vgt}}_{\substack{\Delta \text{ AVE Tariffs,} \\ \Delta \text{ Import Shares}}} \\ & + \underbrace{\sum_{v \in V^N} s_{vgt_1} AVE_{vgt_1} - \sum_{v \in V^X} s_{vgt_0} AVE_{vgt_0}}_{\text{Net Entry}} \end{aligned} \tag{2}$$

Equation (2) shows that changes in the aggregate AVE tariff rate can be separated into the sum of changes in tariffs rates on continuing varieties conditional on initial import shares, changes in shares on continuing varieties condition on initial tariff levels, the covariance of changes in tariffs and import shares, and changes due to net entry of products. Using our tariff database and defining the base year as 1979, we plot this decomposition between 1972 and 1988 in Figure 2.

Here, the solid grey line depicts the change in aggregate $AVE$, as displayed in Figure 1. The other lines represent the respective components of the aggregate change. We focus first on the solid blue line, representing the changes driven by variety-level changes AVE with expenditure shares fixed at their 1979 level. Here, we observe a substantial decrease in tariffs between 1972 and 1974, followed by a modest increase in 1976 before a continuous decline throughout the remainder of our sample. The total decline between 1972 and 1979 – a period in which Normal Trade Relations legislated tariff levels are fixed – amounts to an approximately 1.5 percentage point liberalization. The equivalent liberalization during the Tokyo Round between 1979 and 1988 is approximately one half of a percentage point.

The dashed green line, which depicts variation in aggregate $AVE$ driven by changing import shares conditional on 1979 variety-level $AVE_{vgt}$, shows that a shift in expenditure towards low-AVE varieties reinforces the decline in tariff levels prior to 1979, reducing aggregate AVE by an additional 1 percentage point between 1972 and 1979. In the years after 1979, on the other hand, the pattern reverses itself, with changing expenditure shares masking the effect of the tariff changes of the Tokyo Round. This is consistent with the

**Figure 2:** Decomposition of Changes in Aggregate US AVE Tariff Rate




**Notes:** Plot based on the decomposition of changes in aggregate ad valorem equivalent tariff rates detailed in equation (2) where $t_0 = 1979$. The left-hand axis indicates the change relative to 1979 while the right-hand axis provides the tariff level. The thick grey line plots $\Delta AVE_t$, with each of the other lines being the constituent components of that rate defined in equation (2). See main text for further details.

fact that varieties experiencing greater liberalization in the years after 1979 were those with initially higher tariffs. Similarly, the orange dashed line, depicting the covariance of changes in variety-level AVE rates and expenditure shares, suggests a movement towards varieties with declining tariffs in the years of the Tokyo liberalization. Finally, we find relatively little role for net entry in driving our results.

## 3.1 Variety-Level Tariff Changes

The variation depicted by the solid blue line, driven by changes in variety-level $AVE$ conditional on constant expenditure shares, is worth exploring in more detail, as this is commonly used as a measure of tariff liberalization.[11] However, such variation can stem from multiple

[11] There are numerous ways of detailing intra-good variation. One alternative to the one chosen here would be to first explore differences in tariff rates across exporters (varieties) within a good. For example, one might

sources. Specifically, we write the change in the AVE between periods as

$$\Delta AVE_{gt} = \sum_{v \in V^C} s_{vgt_0} \Delta AVE_{vgt} = \sum_{v \in V^C} s_{vgt_0} \Delta \left( \tau_{vgt} + \frac{f_{vgt}}{p^*_{vgt}} \right). \tag{3}$$

From this, one can see that variety-level $AVE_{vgt}$ can vary for three reasons: changes in ad valorem tariff rates $\tau_{vgt}$, specific tariff rates $f_{vgt}$, or prices $p^*_{vgt}$. As we discuss in detail below, the implications of these three changes on, for e.g., importers prices, imports, and aggregate welfare can be quite different. It is thus important to understand the role of each channel in driving variety-level tariff changes in our sample.[12] In this spirit, we rewrite changes in variety-level AVE tariffs as

$$\begin{aligned}
\Delta AVE_{vgt} &= \left( \tau_{gt_1} + \frac{f_{gt_1}}{p^*_{vgt_1}} \right) - \left( \tau_{vgt_0} + \frac{f_{vgt_0}}{p^*_{vgt_0}} \right) \\
&= \Delta \tau_{vgt} - \frac{\Delta f_{vgt}}{p^*_{vgt_1}} - \frac{\Delta p^*_{vgt}}{p^*_{vgt_1}} \underbrace{\left( \frac{f_{vgt_0}}{p^*_{vgt_0} \tau_{vgt_0} + f_{vgt_0}} \right)}_{STS_{vgt_0}} \underbrace{\left( \tau_{vgt_0} + \frac{f_{vgt_0}}{p^*_{vgt_0}} \right)}_{AVE_{vgt_0}} \\
&= \Delta \tau_{vgt} - \frac{\Delta f_{vgt}}{p^*_{vgt_1}} - \frac{\Delta p^*_{vgt}}{p^*_{vgt_1}} STS_{vgt_0} AVE_{vgt_0}
\end{aligned} \tag{4}$$

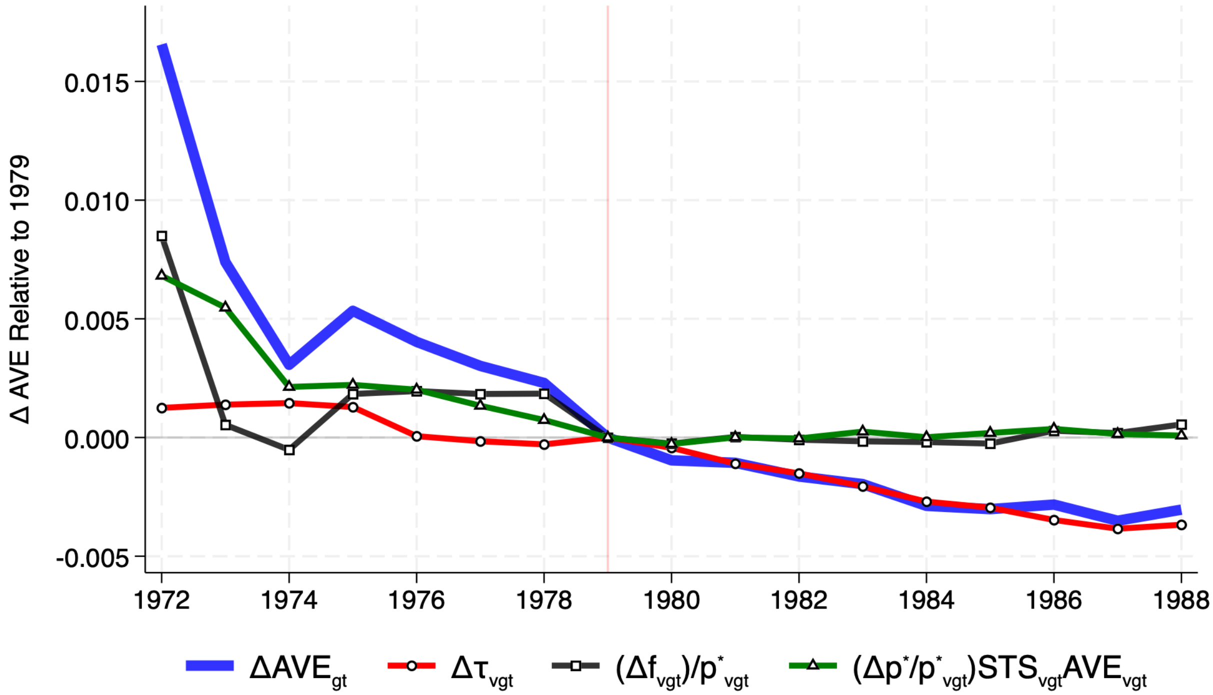
The first term reflects statutory changes in ad valorem rates, $\Delta \tau_{vgt}$, while the second term, $\frac{\Delta f_{vgt}}{p^*_{vgt_1}}$, captures changes in the protection afforded by specific tariffs driven by legislated rate changes under new equilibrium prices. The third term, $\frac{\Delta p^*_{vgt}}{p^*_{vgt_1}} STS_{vgt} AVE_{vgt_0}$, captures changes in tariff protection driven by changes in ex-tariff price levels. This is itself a function of the magnitude of initial tariffs, $AVE_{vgt_0}$, the share of tariff duties specified in per-unit terms – or the specific tariff share, $STS_{vgt} \in [0, 1]$ – and the magnitude of the price change, $\frac{\Delta p^*_{vgt}}{p^*_{vgt_1}}$. This final term implies that changes in ex-tariff prices alter AVE tariff levels by more when initial tariff levels are higher and when tariff duties are generated by specific rather than ad valorem tariffs. Note, that in the ad valorem only case – as is regularly presumed in the literature on studies of trade policy – both $\Delta f_{vgt} = 0$ and $STS_{vgt} = 0$. This would imply that all of the variation in the blue line $\Delta AVE_{vgt}$ should be driven by ad valorem tariff changes. We show the relative importance of these three channels in Figure 3.[13]

consider tariff changes due to changing access to Column 1 tariffs, the introduction of GSP, LDDC, CBERA, IFTA, and other temporary tariff changes. We present this decomposition in figure A.7.

[12] See Appendix C.1 for further details.

[13] An unweighted version of this figure may be found in Appendix figure A.6.

**Figure 3:** Decomposition of Change in Good-level AVE Tariffs




**Notes:** Figure decomposes the time series changes in within good AVE to its components reflecting statutory changes in ad valorem tariffs $\Delta\tau_{vgt}$, specific tariffs $f_{vgt}$, and inflationary erosion of tariffs $\frac{\Delta p^*_{vgt}}{p^*_{vgt_1}}$. Intra-variety changes in tariff rates are weighted by their 1979 import shares as implied by equation 1. An unweighted version of this figure may be found in Appendix Figure A.6.

The figure underscores the importance of observing the legislated tariffs by type: much of the variation in the years prior to 1979 is driven not by changes to legislated rates, but rather by inflationary erosion of the protection afforded by specific tariffs. To the extent that legislated tariffs did change in this period, it was largely specific rather than ad valorem rates that changed.[14] Liberalization in the years after 1979, on the other hand, are driven exclusively by legislated reductions in ad valorem tariffs. Such a finding is itself surprising. Given the prominence of specific tariffs documented in Fable 1, their documented erosion during the 1970's and the stark inflation present in the 1980s, it is surprising that this channel seems not to persist after 1979.[15]

To explore this further we take one additional step. We write the tariff exclusive import

[14]This decline was driven primarily by the suspension of tariffs on petroleum imports in 1973. We discuss the sources of variation in detail in Appendix C.1.

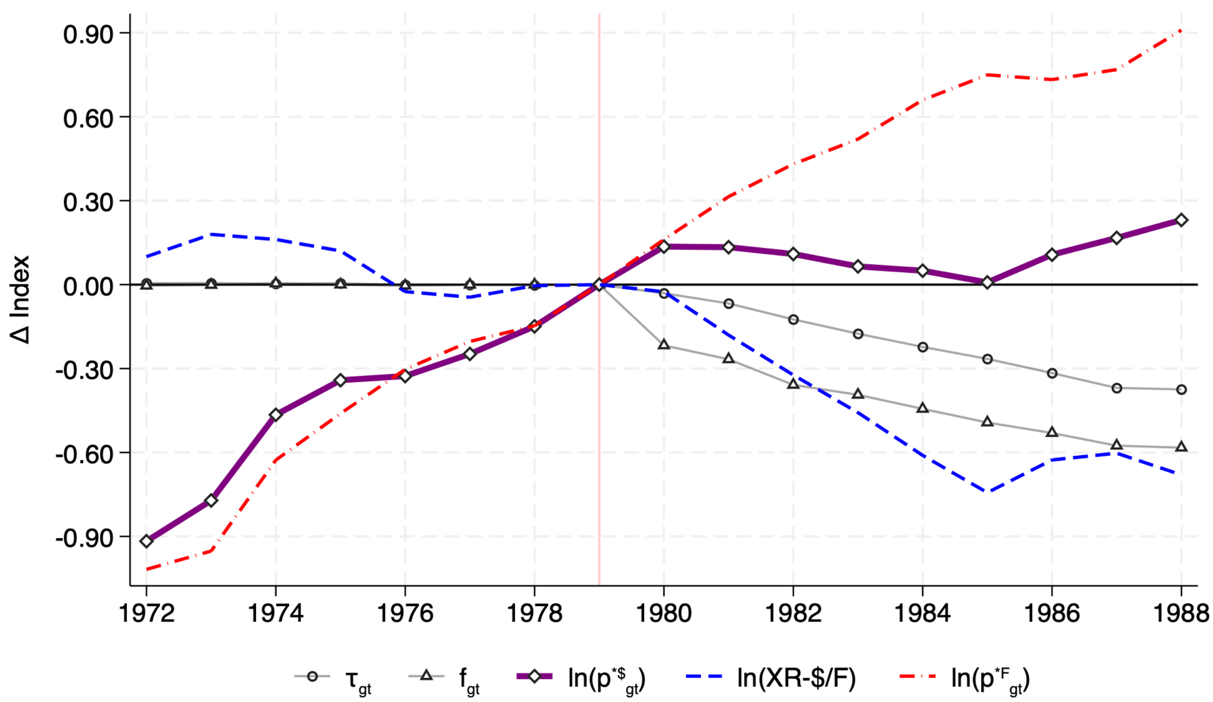
[15]We thank Andy Bernard for his repeated encouragement that we further explore this point.

price $p^*_{vgt}$ in terms of two components and $p^{*,F}_{vgt}$ which denotes the price in the foreign currency and $XR_t^{\frac{\$}{F}}$ which is the bilateral exchange rate between US and the foreign country. For this exercise we focus solely on all varieties subject to the Column 1 rates (where we know that statutory rates are common to all exporters).[16] We index each channel, $c_{vgt}$, through which $AVE_{vgt}$, may be impacted $\tau_{gt}$, $f_{gt}$, $\ln(p^{*,F}_{vgt})$, and $\ln(XR_t^{\$/F_v})$, to its 1979 value and run the following regression:

$$c_{vgt} = \sum_{t=1972}^{1988} \beta_t^c * I(year = t) + \xi_v + \kappa_g + \epsilon_{vgt}. \tag{5}$$

Figure 4 plots the time series shows the evolution the coefficients $\beta_t^c$ which will capture all changes relative to 1979 for each component separately.

**Figure 4:** Statutory and Price Driven Changes in US Column 1 Tariffs




**Notes:** Figure reports time series coefficients on obtained from estimating equation 5 for each component of variety level AVE for column 1 varieties from 1972-1988. Regressions are weighted by 1979 import shares.

[16] See Appendix Figures A.4 and A.3 for tariff revenue and import shares of column 1 imports respectively.

Consistent with the common understanding of US trade policy events during this era, the coefficients on statutory ad valorem and specific tariffs, $\tau_{gt}$ and $f_{gt}$, are static until 1979. Unlike our previous figure, here we can see that both components are falling during the Tokyo Round implementation from 1980-1987. The coefficients on the US dollar denominated tariff exclusive price (indicated in the dark purple, $\ln(p^{*\$}_{gt})$) is indeed increasing between 1972 and 1979 causing an erosion of the specific tariffs. However, this inflationary erosion of specific tariffs didn't continue through 1988 due to the combination of two coincidental offsetting force. Continued global inflation in foreign prices of imported goods (red dashed line) was offset offset by sharp appreciation of the US dollar against many currencies (dashed blue line). In Appendix Figure A.9 we show that this ultimately resulted in a 42% appreciation of the 1979 import-weighted bilateral exchange rate by 1985. Absent this dramatic strengthening of the US dollar, inflation would have continued eroding the AVE of specific tariffs throughout the 1980s which were themselves falling due to Tokyo Round statutory tariff cuts.

Through the remainder of this paper we take the view that the USD appreciation (and post Plaza Accord depreciation) was not due to the Tokyo Round of the GATT, but was instead due to a surge in demand for US government bonds whose yields peaked at over 15% in the first half of 1980s (Destler, 1991; Frankel, 1994, 2015).[17] The rising demand for the US dollar lead to a substantial appreciation in USD bilateral exchange rate and ultimately a substantial trade imbalance.[18] This in turn was met by calls for increased protectionist measures and ultimately resulted in the Plaza Accord, where, in 1985, countries were encouraged to appreciate their currency relative to the USD to help close this gap (Frankel, 2015). While one might then be tempted to think that this appreciation is unrelated to U.S. tariff policy, it is not. Because specific tariffs are not applied uniformly across countries or goods, this shift in exchange rates led to an increase in AVE tariff rates by exerting downward pressure on U.S. dollar-denominated import prices and shifting imports away from goods and varieties which, ceteris paribus, relied differentially on specific tariffs for protection (had a higher STS).

Having documented that AVE tariffs move for a variety of reasons during this sample, we turn to a simple descriptive table to highlight the fact that in the presence of specific tariffs, changes in AVE tariff rates are not sufficient to quantify the effects of trade policy on a number of important economic outcomes. In particular, not all AVE tariff reductions

[17] https://fred.stlouisfed.org/series/DGS10

[18] We plot the unweighted, import weighted, and RGDP weighted exchange rates during this time in appendix figure A.9.

lead to higher imports and welfare, and not all AVE tariff increases lead to lower imports or welfare. Table 2 illustrates this point. We detail the mapping between each possible determinant of tariff levels, $\tau, f, p^{*f}_{vgt}$, & $XR^{\frac{\$}{f}}_{t}$ in a unique row. We highlight the direction of change required to lower $AVE$ tariff levels in column 1. The adjacent columns indicate the effects on prices, tariff levels, imports, price indices and welfare.

**Table 2: Sources of Lower AVE Tariffs and Link to Prices, Imports, and Welfare**

| | Change On | | | | | |
|---|---|---|---|---|---|---|
| Change in | $p^{*\$}_{vgt}$ | $AVE_{vgt}$ | $p_{vgt}$ | Imports$_{vgt}$ | $P_t$ | $W_t$ |
| Statutory Tariffs | | | | | | |
| $\Delta\tau < 0$ | + | - | - | + | - | + |
| $\Delta f < 0$ | + | - | - | + | - | + |
| USD Prices ($p^{*\$}_{vgt}$) | | | | | | |
| $\Delta p^{*F}_{vgt} > 0$ | + | - | + | ? | ? | ? |
| $\Delta XR^{\frac{\$}{f}}_{t} > 0$ | + | - | + | - | + | - |

**Notes:** Table displays the direction of the change required for a reduction in AVE tariffs for each source (in rows) and the effect of those changes on equilibrium objects.

Rows one and two show two well-known facts in the literature. Reductions in statutory tariffs remove the wedge between tariff inclusive and tariff exclusive prices allowing both $p^{*f}_{vgt}$ to rise and $p^{*\$}_{vgt}$ to fall. These allow imports to rise, lower price indices, and lead to increased welfare.[19]

However, the story is more nuanced when thinking about the impact of AVE tariff decreases due to changes in ex-tariff prices. Increases in the foreign-denominated ex-tariff price inflate away specific tariffs and lower the AVE tariff rate, but lead to rising tariff inclusive prices. The effect on imports and welfare will depend entirely on whether these supply-driven price increases are correlated with changing demand in the home market. If uncorrelated, imports would fall as tariff inclusive prices rise and so would welfare. If positively correlated (if the higher ex-tariff prices were due to higher costs associated with the production of higher quality goods) then imports may rise and welfare with it. For exchange rates, however, the case is a bit more clear. A depreciation of the US dollar (which is the opposite of what the US experienced during the 1980s) would lead to higher dollar-denominated prices, lower AVE tariffs, but higher tariff inclusive prices. This, in turn, would lead to lower imports, higher price indices, and lower welfare.

[19] This assumes an upward sloping export supply curve. Strictly speaking we would typically expect the effects on tariff exclusive prices to be greater than or equal to zero.

To summarize the findings of this table, changes in $AVE$ tariffs are not a sufficient statistic for the welfare effects of trade policy. In the absence of specific tariffs, changes in AVE tariffs are isomorphic to changes in $\tau$ and thus map directly to tariff inclusive prices (and welfare). However, in their presence, the $AVE$ tariff rate is an equilibrium object whose relationship to prices, imports, and welfare depends on the source of the price change. We now turn to a model to formally quantify these effects.

# 4 Quantifying the Welfare Effects of Trade Policy in the Presence of Specific Tariffs

The above implies that a complete understanding of the evolution of tariff levels in the 1970s and 1980s requires one to distinguish between various sources of changes in $AVE$ rates. In this section, we show that this distinction matters both for welfare calculations and for the interpretation of counterfactual results. To quantify the aggregate importance of various types of tariff liberalization during our sample period, in Section 4.1 we embed specific tariffs in a standard CES framework and extend existing hat algebra techniques to this setting. We discuss the channels through which our analysis differs from the standard approach in Section 4.2 before turning to a full exact hat representation of our model in Section 4.3.

## 4.1 A CES Model with Specific Tariffs

On the demand side, a representative consumer has a three-tier utility function with time-varying expenditure $E_t$ allocated at the upper tier across a domestic composite good $q_{Dt}$ and a importable composite good $q_{Mt}$. To focus our analysis on the the distinction between specific and ad valorem tariffs and the implications for consumer welfare, we do not model the domestic production side of the economy, but assume a Cobb-Douglass upper nest of utility with expenditure shares $\alpha$ and $1 - \alpha$:

$$u\left(q_{Dt}, q_{Mt}\right) = q_{Dt}^{\alpha} + q_{Mt}^{1-\alpha}. \tag{6}$$

The middle tier defines consumption of the importable composite good $q_{Mt}$ as a CES aggregator of a set of composite sectors $S$ with an elasticity of substitution $\gamma > 1$:

$$q_{Mt} = \left[ \sum_{s \in S} q_{st}^{(\gamma-1)/\gamma} \right]^{\gamma/(\gamma-1)}. \tag{7}$$

Finally, the lower tier defines consumption of a composite importable sector $q_{st}$ as a CES aggregate of Armington varieties $q_{vgt}$ of good $g$ within sector $s$ with an elasticity of substitution $\sigma > 1$ and time-varying, variety-specific taste shock $b_{vgt}$:

$$q_{st} = \left[ \sum_{vg \in s} b_{vgt}^{1/\sigma} q_{vgt}^{(\sigma-1)/\sigma} \right]^{\sigma/(\sigma-1)}. \tag{8}$$

Export supply is given by

$$p_{vgt}^{*} = \exp\left(\eta_{vgt}\right) q_{vgt}^{\omega}, \tag{9}$$

where $\eta_{gvt}$ is a time-varying, variety-specific technology shock and $\omega \geq 0$ is the inverse export supply elasticity.

Import tariffs create a wedge between the tariff-exclusive price received by the foreign exporter, $p_{vgt}^{*}$, and the tariff-inclusive price paid by domestic consumers, $p_{vgt}$ :

$$p_{vgt} = p_{vgt}^{*} \left(1 + AVE_{vgt}\right). \tag{10}$$

where $AVE_{vgt}$ is the ad valorem equivalent tariff

$$AVE_{vgt} \equiv \tau_{gt} + \frac{f_{gt}}{p_{vgt}^{*}}. \tag{11}$$

For simplicity, we refer to the tariff-exclusive and tariff-inclusive prices as the “foreign” and “domestic” prices, respectively.

Equilibrium variety-level prices equate the quantity of import demand and export supply. After a log transformation, the variety-level import demand curve and inverse export supply curves are

$$\ln q_{vgt} = -\sigma \ln p_{vgt} + \gamma_{gt} + u_{D,vgt} \tag{12}$$

$$\ln p_{vgt}^{*} = -\omega \ln q_{vgt} + u_{S,vgt} \tag{13}$$

where $\gamma_{gt} = \ln E_{gt} + (\sigma - 1)\ln P_{gt}$ combines the good-level expenditure and price index and $u_{D,vgt} = \ln b_{vgt}$ and $u_{S,vgt} = \eta_{vgt}$ represent the structural import demand and export supply shocks, respectively.[20] Equilibrium prices and quantity are then

$$\ln p^{*}_{vgt} = -\frac{\sigma\omega}{1+\sigma\omega}\ln\left(1 + AVE_{vgt}\right) + \varphi_{gt} + u_{vgt} \tag{14}$$

$$\ln p_{vgt} = \frac{1}{1+\sigma\omega}\ln\left(1 + AVE_{vgt}\right) + \varphi_{gt} + u_{vgt} \tag{15}$$

$$\ln q_{vgt} = -\frac{\sigma}{1+\sigma\omega}\ln\left(1 + AVE_{vgt}\right) + \gamma_{gt} + u_{vgt} \tag{16}$$

where $\varphi_{vgt}$ combines the good-level expenditure and price index while $u_{vgt}$ combines the structural import demand and export supply shocks. Our elasticity estimation strategy below will employ equations (12)-(16).

## 4.2 Specific Tariffs and Incomplete Pass-through

To emphasize the channel through which our analysis differs from a model without specific tariffs, we adopt the hat algebra notation common in the literature on the welfare effects of trade policy. While postpone the full "exact hat" version of the model to section 4.3, here we highlight the crucial feature: the mapping of price shocks to tariff-inclusive prices. We demonstrate this using the first-order approximation to the system adopted by Fajgelbaum et al. (2020) in their analysis of the US-China trade war.[21]

We begin by log-linearizing the tariff-inclusive price domestic price in equation (10):

$$\ln(p_{vgt}) = \ln(1 + AVE_{vgt}) + \ln(p^{*}_{vgt}). \tag{17}$$

For any variable $x$, denote the proportional change as $\hat{x} \equiv \frac{d\ln(x)}{dx} = \frac{dx}{x}$. One can then write the equilibrium change in the tariff-inclusive price with and without specific tariffs as follows.

**Case 1: No Specific Tariffs**

The domestic price reduces to

$$\ln(p_{vgt}) = \ln(1 + \tau_{vgt}) + \ln(p^{*}_{vgt}).$$

[20] The good-level price index is $P_{gt} = \left(\sum_{v=1}^{V_g} b_{vgt} p_{vgt}^{1-\sigma_g}\right)^{1/(1-\sigma_g)}$.

[21] The appendix presents a full description of the first order solution to the system, with relevant proofs.

and the proportional change in the domestic price is

$$
\begin{aligned}
\hat{p}_{vgt} &= \widehat{(1+\tau_{vgt})} + \hat{p}^*_{vgt} && (18)\\
&= \widehat{(1+\tau_{vgt})} + \overbrace{\left(-\frac{\sigma\omega}{1+\sigma\omega}\widehat{(1+\tau_{vgt})}\right) + \hat{\Gamma}}^{\hat{p}^*_{vgt}} \\
&= \left(\frac{d\tau_{vgt}}{1+\tau_{vgt}}\right) + \left(-\frac{\sigma\omega}{1+\sigma\omega}\left(\frac{d\tau_{vgt}}{1+\tau_{vgt}}\right)\right) + \hat{\Gamma} \\
&= \left(\frac{d\tau_{vgt}}{1+\tau_{vgt}}\right)\left(1-\frac{\sigma\omega}{1+\sigma\omega}\right) + \hat{\Gamma} && (19)
\end{aligned}
$$

where $\hat{\Gamma}$ captures proportional changes in supply shocks, demand shocks, price indices and expenditure shares.[22]

One can see the two ways that changes in ad valorem tariffs, $d\tau_{vgt}$, affect domestic prices. The first term, $\left(\frac{d\tau_{vgt}}{1+AVE_{vgt}}\right)$, captures the magnitude of the direct effect of changes in statutory tariffs, while the second term, $\left(1-\frac{\sigma\omega}{1+\sigma\omega}\right)$, captures tariff pass-through. Taken together, the two terms trace out the incidence of the tariff on exporters relative to domestic consumers. When supply is perfectly elastic and $\omega = 0$, tariff changes are passed completely into domestic prices. Conversely, as export supply elasticity rises, a greater share of the tariff change is borne by foreign suppliers.

A significant benefit of this first-order hat algebra system is that it yields a linear system of equations through which one can express changes in equilibrium objects in terms of initial levels, demand and supply elasticities, and statutory tariff changes $d\tau$. This allows counterfactual analysis to be conducted through a simple matrix inversion problem. Here one could quantify changes in welfare through the change in, for example, consumer prices by feeding in a set of tariff changes that reverse an observed policy. Indeed if the tariff schedule is entirely ad valorem, one can write this in terms of the empirical ad valorem equivalent tariff as

$$
\hat{p}^*_{vgt} = \left(\frac{dAVE_{vgt}}{1+AVE_{vgt}}\right)\left(1-\frac{\sigma\omega}{1+\sigma\omega}\right) + \hat{\Gamma} \qquad (20)
$$

[22]Here we use $\hat{\Gamma}$ to capture changes in supply shocks, demand shocks, price indices and expenditures: $\hat{p}^*_{vgt} = -\frac{\sigma\omega}{1+\sigma\omega}\left(\frac{d\tau}{1+\tau_{vgt_0}}\right) + \underbrace{\frac{\omega}{1+\sigma\omega}\left[\hat{E}_t + (\kappa-1)\hat{P}_t + (\gamma-\kappa)\hat{P}_{Mt} + (\sigma-\gamma)\hat{P}_{gt}\right] + \frac{1}{1+\sigma\omega}\left(\omega\hat{b}_{vgt} + \hat{\eta}_{vgt}\right)}_{\hat{\Gamma}}$

However, as our previous analysis highlighted, the presence of specific tariffs implies changes in the AVE are not exclusively driven by statutory tariffs – even when expenditure shares are fixed (as in a hat algebra system or appropriately conducted empirical analysis). Thus, counterfactuals which fail to account for the presence of specific tariffs are fundamentally incorrectly implemented as they are unknowingly manipulating an *equilibrium object* rather than an *exogenous* policy variable. To see this, we now explicitly consider specific tariffs.

**Case 2: Specific Tariffs**

In this case, the log-linearized domestic price is

$$\ln(p_{vgt}) = \ln(1 + \tau + \frac{f}{p^*_{vgt}}) + \ln(p^*_{vgt}). \tag{21}$$

In the online appendix, we show the proportional change in the domestic price is

$$\hat{p}_{vgt} = \frac{\overbrace{d\tau_{vgt} + \frac{df_{vgt}}{p^*_{vgt}}}^{Statutory}}{1 + AVE} + \underbrace{\rho_{vgt}}_{Passthrough} \times \overbrace{\left( -\frac{\sigma\omega}{1+\sigma\omega} \left( \frac{d\tau_{vgt} + \frac{df_{vgt}}{p^*_{vgt}}}{1 + AVE} \right) + \hat{\Gamma} \right)}^{\hat{p}^*_{vgt}}$$

Simplifying as before, we obtain an expression analogous to equation (19):

$$\hat{p}_{vgt} = \left( \frac{d\tau_{vgt} + \frac{df_{vgt}}{p^*_{vgt}}}{1 + AVE} \right) \left( 1 - \left( \frac{\sigma\omega}{1+\sigma\omega} \right) \rho_{vgt} \right) + \rho_{vgt}\hat{\Gamma}. \tag{22}$$

The pass-through coefficient generated by the presence of specific tariffs is

$$\rho_{vgt} = \frac{1 - STS_{vgt} \frac{AVE_{vgt}}{1+AVE_{vgt}}}{1 - \left(\frac{\sigma\omega}{1+\sigma\omega}\right) STS_{vgt} \frac{AVE_{vgt}}{1+AVE_{vgt}}} \tag{23}$$

where

$$STS_{vgt} \equiv \frac{f_{vgt}}{p^*_{vgt}\tau_{vgt} + f_{vgt}} \tag{24}$$

is the proportion of total tariffs levied on a variety accounted for by specific tariffs. The numerator of the pass-through coefficient $\rho_{vgt}$ captures the incomplete pass-through of *any* foreign price shock into domestic prices, while the denominator captures the dampening effect of shocks on the tariff-exclusive price.

Specific tariffs alter the proportional change in the domestic price in two key ways. First, of course, statutory tariff changes now include changes in the ad valorem equivalent of legislated specific tariffs, $\frac{df_{vgt}}{p^*_{vgt}}$. Second, specific tariffs moderate the pass-through of both the tariff changes themselves, $1-\left(\frac{\sigma\omega}{1+\sigma\omega}\right)\rho_{vgt}$, and non-tariff effects $\rho_{vgt}\hat{\Gamma}$. That is, the presence of specific tariffs protection implies that price shocks do not pass through fully to the domestic economy.[23]

### 4.3 Exact hat algebra

A limitation of the hat algebra methodology outlined in the previous section is that it relies on a linear approximation of the model. This is undesirable when analyzing, for example, relatively large tariff or export supply shocks. To avoid this limitation, exact hat algebra techniques define $\hat{x} \equiv \frac{x'}{x}$ where $x'$ and $x$ are the counterfactual and observed values, respectively.[24]

While the inherent non-linearity in the model complicates the functional form taken by price changes, the intuition from the previous section generalizes to the exact hat algebra setting. In particular, as we show in the appendix, the elasticity of the tariff-inclusive price with respect to tariff or non-tariff shocks to the foreign price is nearly identical to that in the previous section, save for the fact that the pass-through coefficient $\rho_{vgt}$ takes the form:

$$\rho_{vgt} = \left(1 - \frac{STS_{vgt}AVE_{vgt}}{1+AVE_{vgt}}\right)\frac{(\widehat{1+\tau_{vgt}})}{(\widehat{1+AVE_{vgt}})}\left[1 - \frac{\sigma\omega}{1+\sigma\omega}\frac{STS_{vgt}AVE_{vgt}}{1+AVE_{vgt}}\frac{\hat{f}_{vgt}/\hat{p}^*_{vgt}}{(\widehat{1+AVE_{vgt}})}\right]^{-1}. \tag{25}$$

The change in welfare resulting from changes in exogenous variables is proportional to the change in the aggregate price index. As a result, our counterfactual analysis requires an expression of the relationship between such shocks and tariff-inclusive prices. The variety-level change in the tariff-inclusive price is the product of the change in the tariff-exclusive price and the AVE tariff,

$$\hat{p}_{vgt} = \hat{p}^*_{vgt}(\widehat{1+AVE_{vgt}}), \tag{26}$$

[23] In ongoing work we are exploring the implications of this for volatility and risk in the US

[24] The elasticity of $\hat{x}$ with respect to a shock $\hat{z}$ is then $\frac{\partial\hat{x}}{\partial\hat{z}}\frac{\hat{z}}{\hat{x}}$.

where $(1+\widehat{AVE}_{vgt})$ is a weighted average of the change in the ad valorem tariff and the ad valorem equivalent of the specific tariff, with weights corresponding to the importance of specific tariffs:

$$(1+\widehat{AVE}_{vgt}) = (\widehat{1+\tau_{vgt}})\left(1 - \frac{STS_{vgt}AVE_{vgt}}{1+AVE_{vgt}}\right) + \frac{\hat{f}_{vgt}}{\hat{p}^*_{vgt}}\frac{STS_{vgt}AVE_{vgt}}{1+AVE_{vgt}} \tag{27}$$

The change in the tariff-exclusive price can be written

$$\hat{p}^*_{vgt} = (1+\widehat{AVE}_{vgt})^{-\frac{\sigma\omega}{1+\sigma\omega}}\left[\hat{E}_t\hat{P}^{\gamma-1}_{Mt}\hat{P}^{\sigma-\gamma}_{gt}\hat{b}_{vgt}\hat{\eta}^{\frac{1}{\omega}}_{vgt}\right]^{\frac{\omega}{1+\sigma\omega}}. \tag{28}$$

where $\hat{\eta}_{vgt} \equiv \frac{\exp\left(\eta'_{vgt}\right)}{\exp(\eta_{vgt})}$.

Equations (26)-(28) demonstrate that the change in the AVE includes both statutory tariff changes and the price-driven changes in the ad valorem equivalent of specific tariffs, and that the effect of changes in AVE on the domestic price is non-linear and non-separable. After solving for the equilibrium change in variety-level tariff-inclusive prices, we aggregate to construct changes in the price indices. Holding unobserved unobserved demand shocks $\hat{b}_{vgt}$ fixed, the exact change in the good-level and importable price indices can be written

$$\hat{P}_{gt} = \prod_{v\in V_g}\hat{p}^{w_{vgt}}_{vgt}. \tag{29}$$

$$\hat{P}_{Mt} = \prod_{g\in G}\hat{P}^{w_{gt}}_{gt}. \tag{30}$$

The weights can be written

$$w_{vgt} = \frac{s_{vgt}\left(\hat{s}_{vgt}-1\right)/\ln\hat{s}_{vgt}}{\sum_g s_{vgt}\left(\hat{s}_{vgt}-1\right)/\ln\hat{s}_{vgt}} \tag{31}$$

$$w_{gt} = \frac{s_{gt}\left(\hat{s}_{gt}-1\right)/\ln\hat{s}_{gt}}{\sum_g s_{gt}\left(\hat{s}_{gt}-1\right)/\ln\hat{s}_{gt}}, \tag{32}$$

where the changes in tariff-inclusive expenditure shares are

$$\hat{s}_{vgt} = \frac{(1+\widehat{AVE}_{vgt})^{1-\sigma}\hat{p}^{*1-\sigma}_{vgt}}{\sum_{v=1}^{V_g} s_{vgt}(1+\widehat{AVE}_{vgt})^{1-\sigma}\hat{p}^{*1-\sigma}_{vgt}} \tag{33}$$

$$\hat{s}_{gt} = \frac{\hat{P}^{1-\gamma}_{gt}}{\sum_{g=1}^{G} s_{gt}\hat{P}^{1-\gamma}_{gt}}. \tag{34}$$

The change in the aggregate price index is then

$$\hat{P}_t = \hat{P}_M^{s_M}\hat{P}_D^{1-s_M} \tag{35}$$

where $s_M$ is the model-implied share of expenditure allocated to importables.

The presence of $\hat{p}^*_{vgt}$ inside $(1+\widehat{AVE}_{vgt})$ on the right hand side of equation (28) creates non-linearity in the model, substantially increasing the computational burden to solve it. However, an important special case avoids this complication: an infinitely elastic supply, faced by a small open economy. In this case, $\omega = 0$ and equation (28) reduces to $\hat{p}^*_{vgt} = \hat{\eta}_{vgt}$. As a result, simple manipulations of the data deliver equilibrium changes in $(1+\widehat{AVE}_{vgt})$ via (27), variety-level tariff inclusive prices $\hat{p}_{vgt}$ via (26), and price indices using (29)-(35). We return to this case in detail below. First, however, we estimate import demand and export supply elasticities needed to conduct counterfactuals.

## 4.4 Import Demand and Export Supply Elasticities

Our elasticity estimation strategy is based on the method developed by Zoutman et al. (2018), and employed in a trade context by Fajgelbaum et al. (2020).[25] Zoutman et al. (2018) show that one can recover supply and demand elasticities using exogenous changes in a tax as a single instrument. In our context, exogenous changes in the AVE tariff will trace out the wedge between the tariff-inclusive and tariff-exclusive prices. The relationship between the tariff-inclusive price and import quantity demanded reveals the import demand elasticity. Simultaneously, the relationship between the tariff-exclusive price and lower export quantity reveals the export supply elasticity.

Following Fajgelbaum et al. (2020), we first-difference equations (12) and (13) and recover

[25] As an alternative strategy we generalize the Feenstra (1994) estimator to our setting. Details may be found in Appendix E

import demand and export supply elasticities $\sigma$ and $\omega$ by using exogenous tariff changes to instrument for tariff-inclusive price changes in the import demand equation (12) and for import quantity in the export supply equation (13). In particular, our estimating equations are

$$\Delta \text{ln} q_{vgt} = -\sigma \Delta \text{ln} p_{vgt} + \gamma_{st} + \gamma_{vs} + \gamma_{vt} + \varepsilon_{vgt} \tag{36}$$

$$\Delta \text{ln} p^*_{vgt} = \omega \Delta \text{ln} q_{vgt} + \gamma_{st} + \gamma_{vs} + \gamma_{vt} + \varepsilon_{vgt}. \tag{37}$$

where the $\gamma$ terms are fixed effects, with $s$ denoting a sector, and the $\varepsilon_{vgt}$ terms are the error terms. We use two-way clustered standard errors, clustering by exporter and tariff-line level products.

Strictly speaking, first-differencing equations (12)-(13) only implies a limited fixed effect structure. It would only include $\gamma_{gt}$ in equation (36) to control for the the price index and expenditure at the tariff-line good level. However, like Fajgelbaum et al. (2020), we view the resulting first-differenced error terms as consisting of various fixed effects which lead to the above estimating equations. For example, $\gamma_{vs}$ include factors such as exporter sector-specific comparative advantage while $\gamma_{vt}$ include factors such as bilateral exchange rate movements with the US. Moreover, unlike Fajgelbaum et al. (2020), the largely MFN nature of US tariffs in our sample period implies we have little tariff line-level tariff variation in tariffs at a point in time across exporters. Thus, fixed fixed effects $\gamma_{st}$ at the sector-year level rather than the tariff line good by year level. This reflects the idea that the lower nest of utility is defined across varieties within a sector, e.g. 2-digit or 3-digit TSUSA goods, rather than varieties of a tariff-line good. [26]

Using tariffs as an instrument to recover demand and supply elasticities requires exogenous change in tariff levels. However, the observed tariff cuts following the Tokyo Round negotiations likely reflect, among other things, industry political influence. As a result, the extent of tariff cuts will depend on product- or industry-level characteristics, and thus cannot be considered as good as random.

To deal with this potential endogeneity, we construct an instrument based on the nature of the Tokyo Round negotiations. Specifically, we exploit the fact that the so-called "Swiss Formula", proposed by the Swiss delegation to the GATT, was the starting point for tariff cuts in the Tokyo Round. This formula compressed the distribution of post-Tokyo tariffs by

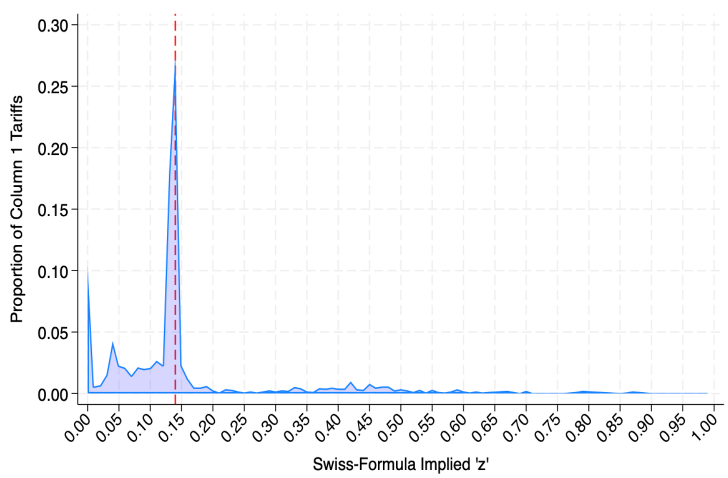
[26] From a practical standpoint demonstrate robustness to fixed effects at various levels of aggregation, but in our baseline estimates below we use 3-digit TSUSA goods.

imposing an upper bound on final tariff rates and dictating larger tariff cuts for goods that with larger pre-Tokyo tariffs. Countries generally phased in these tariff cuts over time beginning in 1980, with the US doing so linearly and finishing the phase-in by 1987. Specifically, the post-Tokyo AVE tariff for good $g$ dictated by the Swiss Formula is

$$AVE_{g,87}^{Swiss} = \frac{z \times AVE_{g,79}}{z + AVE_{g,79}} \tag{38}$$

where the parameter $z$ represents the the maximum allowed post-Tokyo tariff. Because the parameter $z$ is the same for all sectors – equal to 0.14 for the US – the only source of variation in the extent of liberalization under the Swiss Formula is differing pre-Tokyo tariff levels. Given observed statutory tariffs for 1979 and 1987, we can then back out the "z" used for each good. We display the density in Figure 5 where we see that the US largely adopted z = 0.14 as expected.

**Figure 5:** Variety-specific implied $z$ using Swiss formula




**Notes:** Figure displays the z implied by the observed statutory tariff change at the good-level. GATT documents indicate that the US used a value of 0.14 for its application of the Swiss Formula.

This, of course, raises questions regarding the exogeneity of pre-Tokyo tariff levels. Themselves being products of prior GATT rounds, statutory 1979 tariffs are themselves likely non-random. Further, in the presence of specific tariffs, differing price levels across products will generate differing AVE levels, even for goods facing the same statutory tariffs. Lower priced goods will have higher AVE levels and thus be assigned a larger tariff cut through our instrument. If lower price levels are associated with differential import growth, our estimates would be biased. We address each issue in turn.

To address the potential endogeneity of pre-Tokyo statutory tariff rates, we use 1979 column 2 tariffs in the Swiss formula rather than MFN tariffs. Column 2 tariffs in this era are applied almost exclusively to communist countries. They were determined largely by the Tariff Act of 1930 – the "Smoot-Hawley" tariff – and reflect the tariffs set on all trade partners prior to liberalization first under the Reciprocal Tariff Act of 1934 and subsequently under various GATT rounds. As such, column 2 tariffs are highly correlated with their MFN counterparts, but having been set 50 years prior to the Tokyo Round are less subject to the political economy concerns outlined above. Finally, to address concerns related to pre-Tokyo prices and their effect on AVE levels, we document the robustness of our estimates to inclusions of lagged price growth. We also separately construct estimates using only ad valorem goods, where such a concern is not relevant.

Formally, our instrument for $\Delta \ln\left(1 + AVE_{vgt}\right)$ is

$$\Delta \ln\left(1 + AVE_{vgt}^{IV}\right) \tag{39}$$

where $AVE_{vgt}^{IV}$ in 1979 is equal to the column 2 tariff, $AVE_{g,79}^{col2}$, and $AVE_{vgt}^{IV}$ in 1987, after the Tokyo Round is completed, is

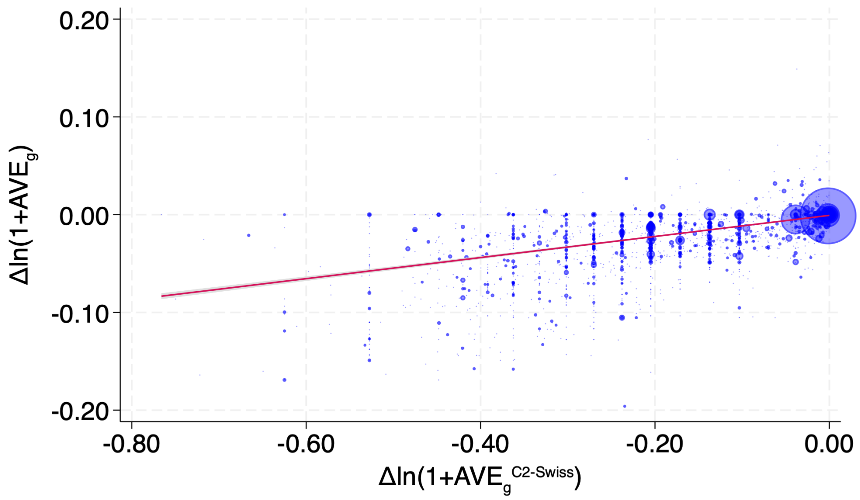
$$AVE_{g,87}^{IV} = \frac{0.14 \times AVE_{g,79}^{col2}}{0.14 + AVE_{g,79}^{col2}}. \tag{40}$$

$AVE_{vgt}^{IV}$ for years in between 1979 and 1987 is assumed to follow with a linear phase in. For varieties not subject to MFN tariffs – i.e., countries facing column 2 tariffs or varieties subject to preferential zero tariff treatment – $AVE_{vgt}^{IV}$ is set to zero.

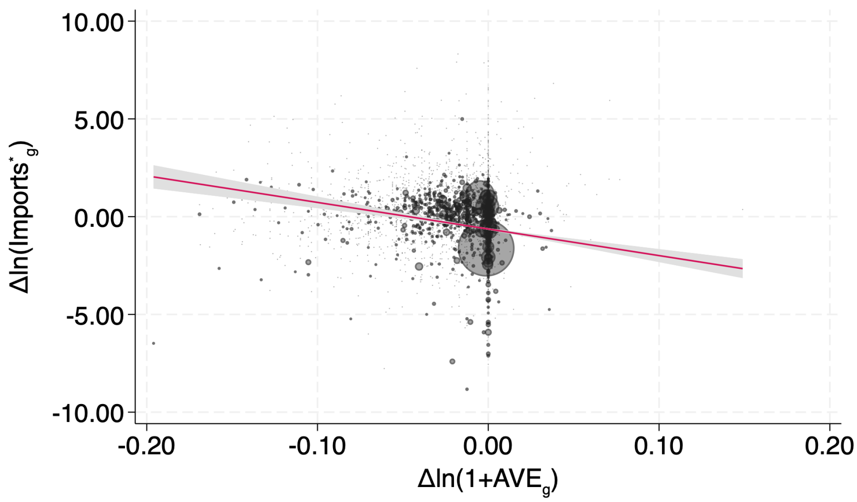
The strength of the instrument depends on the extent to which the US followed the Swiss Formula in practice. Figure 6 plots the relationship between the the Tokyo tariff cuts implied by our IV and the observed Tokyo tariff cuts in panel (a), and it also plots the relationship between the potentially endogenous observed Tokyo tariff cuts and import growth in panel (b).We see a clear correlation between our IV and our endogenous variable.

We now estimate the effect of instrumented tariff cuts on imports and on tariff inclusive prices and quantities to recover demand and supply elasticities. We restrict our estimation period to 1979-1987 and construct an unbalanced panel in annual first differences. Table 3 presents our results. Panels A regresses tariff-exclusive import values on $\Delta \ln\left(1 + AVE_{vgt}\right)$,

**Figure 6:** Imports, Tariffs, and the Swiss IV




**(a)** Tariff Changes: Observed and Instrument




**(b)** Import Growth and Tariff Changes

**Notes:** Figure displays good-level log import growth from 1979-1988 against the observed change in log ad valorem equivalent tariffs in panel A. Panel B presents the observed change in log ad valorem tariffs against the IV implied by the Column 2 rates and the swiss formula.

instrumenting with (39).[27]. Panel B and C report estimates of $\sigma$ and $\omega$ from equations (36)-(37). Column 1 is our baseline specification, which includes exporter-by-year fixed effects,

[27]The full specification is $\Delta\ln(Imports^*_{vgt}) = \beta_1\Delta\ln(1+AVE_{vgt}) + \beta_2\Delta\ln(p^*_{vgt}) + \gamma_{st} + \gamma_{vs} + \gamma_{vt} + \varepsilon_{vgt}$

exporter-by-3-digit TSUSA sector, and year-by-3-digit TSUSA sector.[28][29]

**Table 3: The Effect of Tariff Cuts on Imports, Prices, and Quantities**

| | Panel A: Dep. Var. $\Delta\ln(Imports_{vgt})$ | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| $\Delta\ln(1+\widehat{AVE}_{vgt})$ | -9.098*** | -9.595*** | -7.973*** | -4.961** |
| | (2.121) | (2.140) | (2.694) | (1.966) |
| $\Delta\ln(p^*_{vgt})$ | -0.073*** | -0.073*** | -0.072*** | -0.090*** |
| | (0.015) | (0.015) | (0.016) | (0.016) |
| $1^{st}$-stage $\beta$ | 0.12 | 0.12 | 0.11 | 0.11 |
| p-value | 0.000 | 0.000 | 0.000 | 0.000 |
| KP-Weak-f | 63.0 | 62.0 | 44.4 | 37.3 |
| AR-Weak-p | 0.000 | 0.000 | 0.004 | 0.005 |
| | Panel B: Dep. Var. $\Delta\ln(q_{vgt})$ (estimates of $\sigma$) | | | |
| | (1) | (2) | (3) | (4) |
| $\Delta\ln\widehat{(p_{vgt})}$ | -4.346** | -4.442** | -3.043** | -2.593* |
| | (2.076) | (2.129) | (1.532) | (1.394) |
| $1^{st}$-stage $\beta$ | 0.30 | 0.31 | 0.40 | 0.28 |
| p-value | 0.130 | 0.123 | 0.152 | 0.285 |
| KP-Weak-f | 3.2 | 3.3 | 2.6 | 1.6 |
| AR-Weak-p | 0.000 | 0.000 | 0.001 | 0.020 |
| | Panel C: Dep. Var. $\Delta\ln(p^*_{vgt})$ (estimates of $\omega$) | | | |
| | (1) | (2) | (3) | (4) |
| $\Delta\ln\widehat{(q_{vgt})}$ | -0.136 | -0.137 | -0.234 | -0.234 |
| | (0.120) | (0.116) | (0.171) | (0.246) |
| $1^{st}$-stage $\beta$ | -1.31 | -1.36 | -1.21 | -0.72 |
| p-value | 0.003 | 0.002 | 0.009 | 0.085 |
| KP-Weak-f | 18.4 | 20.5 | 10.4 | 5.3 |
| AR-Weak-p | 0.303 | 0.276 | 0.239 | 0.457 |
| Obs. | 240678 | 240678 | 140830 | 185315 |
| Sample | Full | Full | Full | Col 1 |
| Controls | Baseline | $STS_{vgt} * \frac{AVE}{1+AVE_{vgt}}$ | $\Delta\ln(p^*_{vgt-1})$ | Baseline |
| Country $\times$ Year FE | Y | Y | Y | Y |
| Sector $\times$ Country FE | Y | Y | Y | Y |
| Sector $\times$ Year FE | Y | Y | Y | Y |

**Notes:** Table estimates of instrumented tariff cuts on import growth in (Panel A), tariff inclusive prices (Panel B), and import quantities (Panel C). All specifications include 3-digit TSUSA x country fixed effects and 3-digit TSUSA x year fixed effects and country x year fixed effects. Column 1 includes no additional controls. Column 2 includes a control for inflationary erosion of the tariff schedule, Column 3 includes a control for lagged price growth. Column 4 returns to the baseline specification but restricts the sample to varieties subject to column 1 rates only. All standard errors are clustered by 5-digit TSUSA (goods)and country.

We begin with Panel A where we estimate an elasticity of approximately -9. The first

[28] To give an example of the level of aggregation used in our analysis, these 3 digit sectors differentiate among Apples d& Bananas (146xx), Citrus Fruits (147xx), Melons (148xx), Plums (149xx)

[29] We report alternative sector aggregations in the online appendix. Our results are robust to these specifications.

stage coefficient or 0.12 indicates that our for every 1% tariff cut implied by the application of the Swiss-Formula to the 1979 Column 2 rates is associated with a 0.12% observed tariff cut. Both the KP Weak-f statistic and AR-Weak instrument P-values provide support that our IV can reliably identify these effects. In column 2 we account for potential inflationary erosion, that is concurrent with but unrelated to statutory tariff cuts. Specifically, we include $\frac{STS_{vg,79}AVE_{vg,79}}{1+AVE_{vg,79}}$ which captures the amount of tariff protection susceptible to inflationary changes. This increases the magnitude of our estimate slightly. In column 3 we address the concern that goods with lower prices will be assigned higher potential tariff cuts through our IV, but may be on differential import growth trends (relative to goods with higher prices). To do so we include lagged price growth in column 3 as a control. This reduces the magnitude of our elasticity and suggests that differential import growth trends may be important.

Finally, column 4 estimates this relationship using column 1 goods only. During our estimation sample the US applied non-MFN tariffs for various reasons including column 2 tariffs on many communist countries, reduced tariff access to various developing countries under the Generalized System of Preference, full Tokyo Round cuts to LDDC countries immediately in 1980 (rather than phasing these cuts in), tariff-free access to various Central American countries in the mid-1980s under CBERA, and Free Trade Agreement preferential tariffs to Israel starting in 1986. Although these programs account for a relatively small share of US imports, this is an important set of observations with zero tariff changes and a zero instrument value.[30] Thus, column 4 restricts the sample to the set of varieties subject to US MFN tariffs. While the point estimate reduces this is to be expected as there is less tariff variation across exporters and this sample restriction eliminates many very close substitutes which face lower tariff burdens.

Column 1 of panel B reports a baseline import demand elasticity of $\sigma = 4.3$, well within the range found in existing work. While the Kleibergen-Paap weak instrument $F$-statistic is around 3, below the rule of thumb value of 10, the Anderson-Rubin weak-instrument robust p-value strongly supports a statistically significant import demand elasticity. The effects of the additional controls and sample restrictions in columns 2-4 mirror those of Panel A but do little to alter our takeaway. Even the estimate of $\sigma$ in column 4 is statistically indistinguishable from the estimate found in Column 1.

In Panel C we report estimates of our export supply elasticity $\omega$. Our baseline result is statistically indistinguishable from zero. These estimates imply a perfectly elastic world

[30]See figure A.5 for tariff and import shares impacted.

export supply curve. If anything there is weak (statistically insignificant) evidence of a fall in ex-tariff prices. Perhaps surprising, this finding is similar to Fajgelbaum et al. (2020) who also document that US tariff changes during the first US-China trade war have no impact on world prices. Columns 2 through 4 of the table incorporate the same robustness tests of these baseline results. None of these meaningfully change our understanding of the effects of the Tokyo Round Tariff Cuts. As the US cuts tariffs, tariff inclusive prices fall, imported quantities rise and there is no effect on world prices – the gains from these tariff reductions pass entirely through to importers.

# 5 Counterfactual Estimates of Statutory, Inflationary, and Exchange Rate Driven Tariff Liberalizations.

With estimates in hand we turn to a series of counterfactual exercises aimed at quantifying the effect of US tariff policy during this period. We conduct two primary exercises. Our first set of exercises will decompose the effect of changes AVE tariffs on US import prices into their statutory, inflationary, and exchange rate driven components. We then highlight sectoral heterogeneity in these channels. Our second exercise will highlight how these changes in AVE are not – as they are in the ad-valorem-only-case– sufficient statistic for changes in welfare. Notably, because we fail to reject a perfectly horizontal world export supply curve, we are able to adopt the exact-hat variant of our model. The highly nonlinear system simplifies substantially in the special case of $\omega = 0$.

## 5.1 Decomposing the Effects of $\Delta AVE$ on Import Prices into Statutory, Inflationary, and Exchange Rate Components

To assess how each channel contributed to import price indices through their effects on the AVE tariff we consider three counterfactuals. First, we reset variety-level AVE tariffs in every year to their 1972 levels. Intuitively, this can be interpreted as assuming all tariffs were ad valorem and there was no tariff liberalization from 1972 onward. As we have emphasized earlier, the equilibrium change in the tariff-exclusive price generally depends on whether tariffs are ad valorem or specific. However, this equilibrium change is zero when $\omega = 0$ regardless of whether tariffs are ad valorem or specific. As such, the counterfactual change in the equilibrium tariff-inclusive price is given by equation (26) where $\hat{p}^*_{vgt} = 0$ and the counterfactual change in the AVE is $(1+\widehat{AVE}_{vgt}) = \frac{1+AVE_{vg,72}}{1+AVE_{vgt}}$. In the pre-Tokyo period, $AVE_{vgt}$ essentially only differs from $AVE_{vg,72}$ due to inflation erosion of specific tariffs. Thus, the pre-Tokyo period counterfactual results quantify the effect of inflation erosion on prices and welfare.

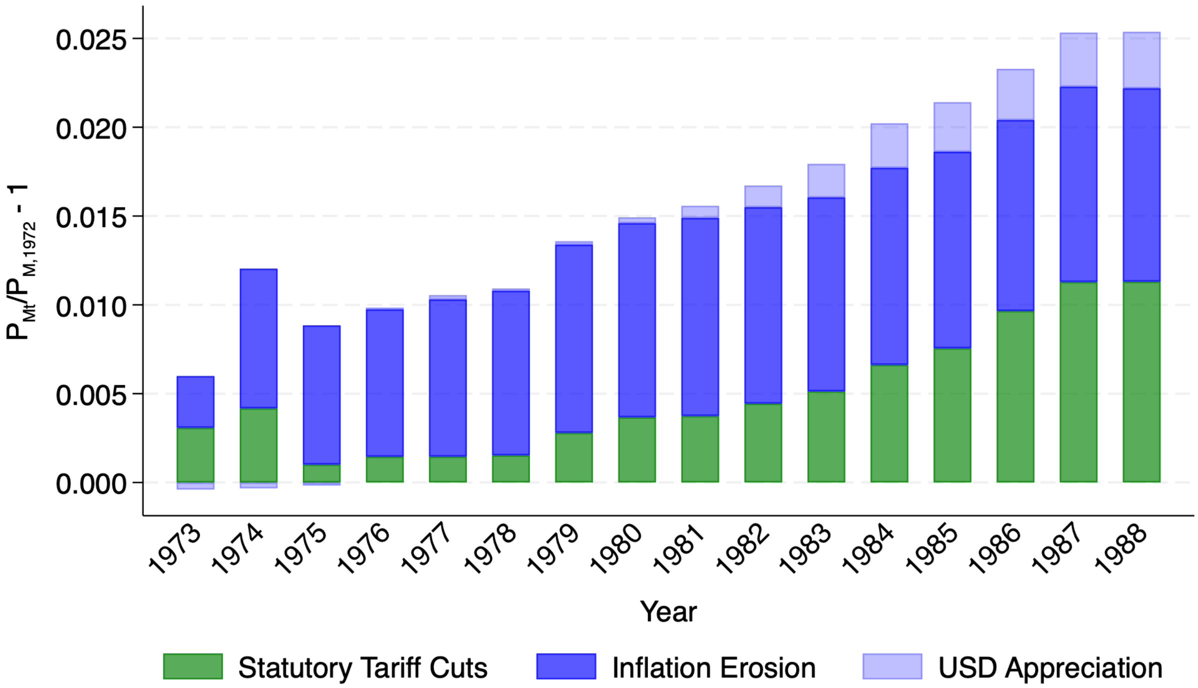
Second, we conduct a second counterfactual which differs from the first counterfactual by reducing the AVE tariff due to statutory changes from temporary legislation (which impacted fuel throughout the 1970's for example) and due to the Tokyo-Round phase in's from 1980 onward.[31] Finally, we also conduct a third counterfactual which also removes the USD appreciation observed in the data. This leaves changes in the foreign local currency denominated ex-tariff price as the only source of variation in US dollar denominated ex-tariff prices.

Figure 7 shows the results from these three counterfactuals. The combined height of the blue and green bars, which comes from the first counterfactual, show how much higher the importable price index would have been in the absence of contemporaneous changes in AVE tariffs. The height of the green bar before 1980 reflects two changes. First, the US implemented a variety of temporary changes in legislation surrounding Fuel. Second, more modest changes to tariffs occured due to the introduction of GSP. The bulk of the pre-Tokyo AVE changes are indeed driven by inflationary erosion. Indeed, the height of the blue bar in 1974 following the first oil crisis shows the importable price index would have been about 0.9 percentage points higher if rising tariff-exclusive prices had not eroded specific tariffs. This magnitude rises through the 1970s and peaks at about 1.2 percentage points following the second oil crisis in the early 1980s. Apart from temporary tariff suspensions on oil, essentially all the effects on the importable price index during the 1970s are driven from shutting down inflationary erosion of specific tariffs.

However, Tokyo Round statutory tariff cuts also matter after 1980 in terms of the lower importable price index relative to the counterfactual of no post-1972 liberalization. The height of the green bars show how much higher the importable price index would have been if the only post-1972 tariff cuts were the statutory tariff cuts following the Tokyo Round. As expected given the linear phase-in of Tokyo Round tariff cuts starting in 1980 and ending in 1987, these green bars grow steadily and reach a peak of around 1.1 percentage points by 1987. Finally, if ultimately, by the end of the phase-in of Tokyo Round tariff cuts,

[31] That is, the counterfactual change in the AVE is now $(1+\widehat{AVE}_{vgt}) = \frac{1+AVE_{vg,72}-1(t\geq 1980)\left(AVE_{vg,79}-AVE_{vgt}|_{p^*_{vgt}=p^*_{vg,79}}\right)}{1+AVE_{vgt}}$.

**Figure 7:** Increase in Importable Price Index Removing Sources of AVE Decline




**Notes:** Figure presents exact-hat counterfactual estimates of the effect of changes in AVE tariffs on the importable price index. Bars represent the increase in the importable price index if a particular form of AVE liberalization were undone. Green bars indicate an increase in statutory tariffs, blue bars eliminate the effects of inflationary erosion, and the light blue bars are due to reversals in US exchange rates.

the liberalization embodied through inflation erosion of specific tariffs and Tokyo Round statutory tariff cuts lowered the importable price index by about 2.2 percentage points and was roughly equally split between the two types of tariff cuts.

Finally, the height of the light purple bars in the 1980s show the additional declines in the importable price index if the US had not experienced the sharp US dollar appreciation. In this case, inflation erosion of specific tariffs would have continued rising through the 1980s due to inflation in foreign local currency ex-tariff prices. By 1988, this would have contributed about 0.3 percentage points to the decline in the importable price index.

Table 4 details how these counterfactual effects differ across TSUSA 1-digit sector. The first set of columns do so using counterfactual results that allow observed changes in bilateral US exchange rates while the second set of columns do so using counterfactual results that hold bilateral US exchange rates fixed. In each set of columns, the first column shows results removing all changes in AVE tariffs while the second and third columns do so by, respectively, only removing statutory or inflationary AVE tariff changes.

Table 4: **Counterfactual Changes in Importable Price Index by Sector**

| | Observed XR | | | Fixed XR | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| TSUSA Sector | All Sources | Statutory | Inflationary | All Sources | Statutory | Inflationary |
| 1-Agriculture | 0.025 | 0.006 | 0.018 | 0.064 | 0.005 | 0.057 |
| 2-Wood & Paper | 0.010 | 0.009 | 0.000 | 0.010 | 0.009 | 0.000 |
| 3-Textiles | 0.066 | 0.035 | 0.030 | 0.069 | 0.035 | 0.033 |
| 4-Chemicals | 0.022 | 0.010 | 0.012 | 0.025 | 0.010 | 0.015 |
| 5-Minerals & Manuf. | 0.026 | 0.023 | 0.002 | 0.026 | 0.023 | 0.003 |
| 6-Metals & Manuf. | 0.012 | 0.009 | 0.003 | 0.014 | 0.009 | 0.003 |
| 7-Misc. | 0.005 | 0.017 | -0.012 | 0.004 | 0.017 | -0.013 |

**Notes:** Table presents estimates of counterfactual changes in sector-level price indices due to the removal of AVE tariff changes separately for statutory changes and inflationary changes.

Here we see sectoral heterogeneity in sources of liberalization. Considering columns 1-3 where exchange rates vary, roughly three-quarters of the decline in tariff protection in agriculture was inflationary, rather than statutory changes in tariff protection. By contrast, Textile liberalization was approximately evenly split. Whereas TSUSA-5 Non-metallic Minerals and Manufactures experienced an almost entirely statutory (rather than inflationary) liberalization.

Turning to the role of exchange rates, we can see the industry heterogeneity is even more stark. Consider again, agriculture, which would have experienced a 5.7 percentage point increase in the import price index if not for the erosion of specific tariffs and the appreciation of the USD. The effect of exchange rates is important, but not nearly as large in other sectors.

While these counterfactuals can tell us how much liberalization occurs *relative* to an entirely ad-valorem tariff schedule, it is important to recognize that this is not the same as concluding that such tariff cuts were associated with welfare improvements. Consider that, column 3 essentially characterizes the amount AVE tariff rates fell due to ex-tariff price *rises*. And while these tariff reductions are beneficial vis-a-vis an all ad valorem tariff schedule (under which tariff rates wouldn't have been eroded and would have thus been higher), it doesn't address the fact that the only reason these tariffs fell is because equilibrium ex-tariff prices rose. If, as we have estimated, the rise in prices is due to foreign market productivity shocks, the welfare effects of these price hikes cannot be associated with welfare improvements.[32] Studies that fail to distinguish the source of change in the AVE tariff rates and instead "reset" the counterfactual tariffs to some pre-period AVE level may be, as they

[32] As discussed previously, this depends on the assumption that there is no correlation between demand and supply shocks, i.e. import price shocks do not reflect changes in quality.

would in this case, manipulating an equilibrium object – not an exogenous policy variable. Such a counterfactual does not capture the effect of a policy change.

## 5.2 Interpreting Changes in AVE

Table 5 illustrates this issue by providing estimates of changes in AVE tariffs on model-implied changes in import shares. Specifically we estimate

$$\Delta s_{vgt} = \beta \Delta \ln(1 + AVE_{vgt}) + \nu_{gt} + \epsilon_{vgt}, \tag{41}$$

where import shares $s_{vgt}$ are constructed at the 5-digit TSUSA good level while $\nu_{gt}$ are good x time fixed effects. Standard errors are clustered by variety and 5-digit TSUSA good.

In column 1, we begin by shocking the model with statutory ad valorem tariff cuts equivalent to the size of observed AVE tariff changes in the data. The remaining columns consider the change in AVE tariffs due to observed changes in US dollar denominated ex-tariff prices, foreign local currency denominated ex-tariff prices, and a general bilateral appreciation of the US dollar. In a small open economy (where $\omega = 0$), as we have estimated, $\beta$ should recover the demand elasticity $\sigma$. However, we will see this is not generally the case.

Consider Panel A. With ad valorem tariff changes, we mechanically recover the imposed elasticity of $\sigma = 4.75$ without controlling for US dollar denominated ex-tariff prices. This is because this is the "true" effect of an AVE tariff change on prices given $\sigma = 4.75$ and $\omega = 0$. As ad-valorem tariffs fall, tariff inclusive prices fall and imports rise. By contrast, when we exploit changes in the tariff driven by rising tariff exclusive prices in USD, not only do we recover the incorrect demand elasticity, but it is also the wrong sign and is highly statistically significant. This is simply due to the fact that the falling tariffs are driven by rising prices and the tariff inclusive price – what importers actually care about – is actually rising despite the fact that tariffs are falling. Thus, falling tariffs are met with falling imports and we estimate a strongly positive effect. Similarly, when we exploit changes in AVE due to inflation in foreign unit values (denominated in foreign currency) we similarly recover the incorrect sign and the welfare effects of associated with these tariff cuts are negative. When we exploit changes in AVE due to exchange rates in column 4, the story is a bit more subtle. Exchange rate appreciation leads to falling US denominated import prices which leads to rising AVE and rising imports. Here again, we recover the wrong sign, though the welfare effects of these tariff increases are positive.

**Table 5: Counterfactual Changes in Import Shares by Source of Change in $AVE$**

| Dependent Variable | Counterfactual Change in Variety Import Share | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| | Panel A: No Ex-tariff Price Control | | | |
| $\Delta\ln(1 + AVE_{vgt})$ | -4.750*** | 21.322*** | 9.684*** | 3.636 |
| | (0.000) | (2.978) | (1.772) | (4.128) |
| Observations | 596,666 | 596,666 | 596,666 | 596,666 |
| $R^2$ | 1.000 | 0.495 | 0.490 | 0.486 |
| | Panel B: Controlling for Ex-Tariff Price Changes | | | |
| $\Delta\ln(1 + AVE_{vgt})$ | -4.750*** | -4.750*** | -4.750*** | -4.750*** |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| $\Delta\ln(p^*_{vgt})$ | 0.000 | -3.750*** | -3.750*** | -3.750*** |
| | - | (0.000) | (0.000) | (0.000) |
| $\Delta AVE_{vgt}$ Due To: | Ad Valorem Tariff | $p^{*,USD}_{vgt}$ | $p^{*F}_{vgt}$ | $XR^{\frac{USD}{F}}$ |
| Observations | 596,666 | 596,666 | 596,666 | 596666 |
| $R^2$ | 1.000 | 1.000 | 1.000 | 1.000 |
| Good x Time FE | Y | Y | Y | Y |

**Notes:** Table presents estimates of equation 41. Dependent variable is model implied change in import shares. Each column uses a different source of variation to induce a change in $AVE_{vgt}$ tariff rates indicated in footer of table. Panel A includes only good x time fixed effects while Panel B incorporates the change in tariff exclusive export price.

From an econometric standpoint it is straightforward to show that this is a simple endogeneity issue arising from the presence of specific tariffs. Namely,

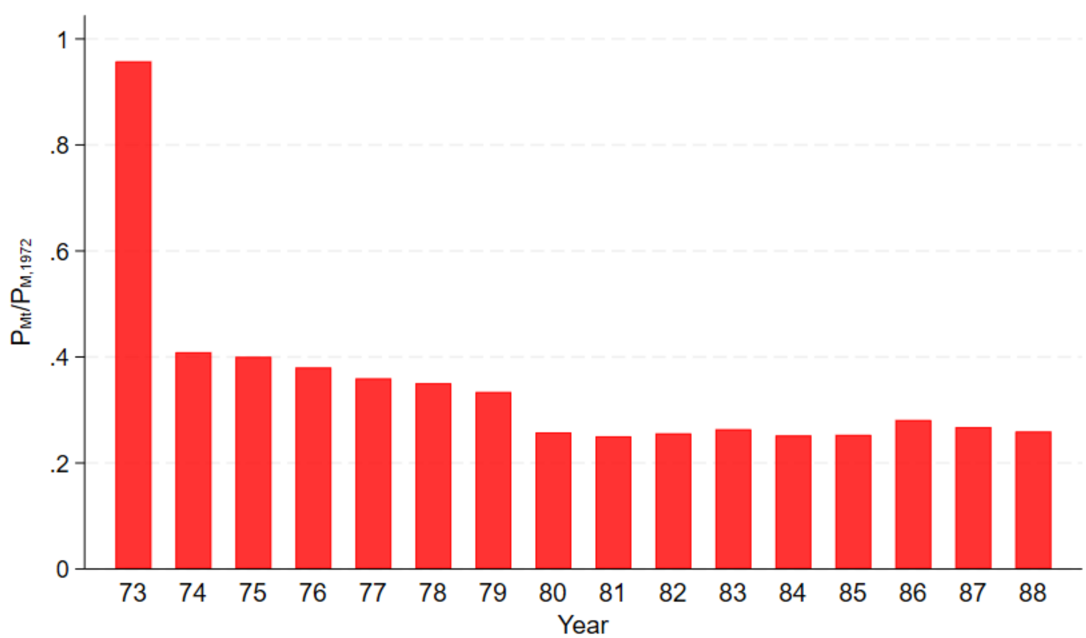
$$E(\widehat{\beta}) = -\sigma \iff E(\epsilon_{vgt}|\Delta\ln(\underbrace{1 + \tau_{gt} + \frac{f_{gt}}{p^*_{vgt}}}_{AVE_{vgt}})) = 0$$

But because, $\epsilon_{vgt}$ includes $p^*_{vgt}$ (and its components $p^{*f}_{vgt}$ & $XR_t^{\frac{\$}{f}}$), this will necessarily be violated in the presence of specific tariffs even if the tariffs have no direct effect on the world price (i.e. $\omega = 0$). To see this, Panel (b) shows that one again recovers this true value of $\sigma$ upon controlling for contemporaneous changes in the US dollar denominated ex-tariff price. That is, conditional on the rising price (which has a direct effect on import shares), we can then recover the correct effect of tariff changes.

This result has important implications for how we measure exposure to trade liberalizations. The literature has largely uniformly adopted $\Delta\ln(1+AVE_{gt})$ as the preferred measure of liberalization, and it is easy to see why. In a small open economy (where $\omega = 0$) if the tariff schedule is ad valorem only, then $\Delta\ln(1 + AVE_{gt})$ are isomorphic to changes in ad valorem tariffs and therefore a sufficient statistic for the change in the domestic price $p_{vgt}$. But the presence of specific tariffs breaks this relationship. There are some tariff liberalizations which do not result in trade liberalizations and some increases in AVE tariff protection which do. If specific tariffs are present during any liberalization, changes in observed $AVE$ tariff rates do not capture the correct effect on domestic prices. The challenge is that without relying on statutory data to differentiate what changes in AVE tariffs are driven by policy, rather than inflation or exchange rates, one cannot know whether the variation in AVE they are exploiting correctly identifies the parameters of interest.

Our final counterfactual addresses this issue from a slightly different perspective: imagining what would have happened if inflationary erosion of specific tariffs did not occur is imagining what would have happened if the export supply shocks driving the inflationary environment of the 1970s did not happen. To this end, our last counterfactual sets $\hat{\eta}_{vgt} = -\hat{p}^*_{vgt}$. Figure 8 shows the results.

**Figure 8:** Proportional change in importable price index: No inflationary erosion




Mirroring the intuition behind the inflation erosion channel in Figure 7, the importable price index would have been nearly 60% lower in 1974 absent the model-implied export supply shocks from 1973 and, especially, the oil-crisis related shocks from 1974. These effects continue growing and by the finish of the second oil crisis in the early 1980s, the importable price index would have been nearly 75% lower if the 1970s and early 1980s export supply shocks had not happened. In turn, imports and welfare would have been much higher if the shocks driving observed inflation erosion did not happen.

Overall, quantifying the effect of specific tariffs during our sample period is somewhat nuanced. On one hand, the presence of specific tariffs allowed inflation to erode away the distortionary effect of tariffs on the economy and created lower prices, higher trade volumes, and higher welfare than if all tariffs were ad valorem. However, the underlying shock that was driving prices higher during the 1970s and early 1980s was export supply shocks. The counterfactual that imagines inflation erosion did not happen is one that imagines these export supply shocks did not happen. And, the lower prices that would have eventuated far outweigh the gains from inflation eroding specific tariffs.

# 6 Conclusion

Despite having a tariff liberalization larger in magnitude than all combined liberalization that followed, the decades immediately before and after the Tokyo Round of the GATT have received relatively little empirical attention. In this paper, we quantify the effects of US tariff policy from 1972-1988. To do so we construct the first dataset on annual legislated tariffs, which differentiate among ad valorem, specific, and compound tariffs, between 1972 and 1988. We combine these tariff data with a cleaned version of the IDB import data at a highly disaggregate level. Given the salience of understanding the role of tariffs in the modern policy environment, we anticipate this will prove a valuable resource for subsequent research.

With this new tariff-line level data we document the prevalence of specific tariffs in our sample accounting approximately 35% of tariff lines at the star of our sample and 25% at the eve of the transition to the HS system in 1988. Our analysis underscores the importance of accounting for the source of variation in AVE tariff rates – the standard measure of liberalization in the literature. In the presence of specific tariffs, statutory reductions in tariffs, inflationary erosion, and exchange rate depreciation all lower AVE tariff rates but have opposing effects on prices, imports, and welfare. Thus, failure to account for the source of variation in AVE rates can lead to misstated welfare effects and parameter estimates.

After detailing a decomposition of aggregate tariff rates which highlights these channels, we show that the US underwent an *accidental* liberalization over the period 1972-1979 immediately prior to implementing agreed upon tariff reductions under the Tokyo Round of the

GATT. Inflation, exchange rate appreciation, and statutory tariff cuts implemented during the Tokyo round all play an important role in explaining variation in tariff rates during this era.

To quantify these distinct effects we embed specific and ad valorem tariffs into an otherwise standard CES structure and derive a novel exact hat representation which accommodates specific tariffs. After estimating complete passthrough of tariff changes into import prices during this era, we conduct a number of counterfactual exercises. Our counterfactuals show the inflationary erosion of specific tariffs induced greater reductions in import price indices than the legislated Tokyo Round tariff cuts, but that this was driven by net increases in exporter prices. As such, while tariff rates fell, tariff inclusive prices were rising. This ultimately lead to reduced welfare. By contrast the Tokyo round cuts lowered imported prices leading to a welfare enhancing import surge.

Our analysis thus far leaves many avenues for subsequent research. During our sample the dramatic "accidental" liberalization of US ad valorem equivalent tariffs through inflationary foreign price shocks should have notable impacts on US import growth, US output, and US labor markets. Additionally, as more modern and historical tariff schedules come online, we hope the methods developed here will improve welfare quantification of trade policy. Finally, we believe the the per unit nature of specific tariffs and existing literature linking quality to per unit trade costs leads may yield interesting insights related to endogenous quality. We are also currently exploring the effect that changes in the use of specific tariffs over time has on import price volatility.

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# A Data Appendix

## A.1 Estimating Tariffs 1972-1988

The import data we use to estimate tariffs are taken from the IDB.[33] These data include total duties collected as well as import values, dutiable values, and (up to) two measures of quantity. The data are highly disaggregate: each observation represents exports by an exporting country of a TSUSA seven-digit product to a US port in a year $t$ subject to tariffs defined by "rate provision code" $r$. Since tariffs are applied at the five-digit good level $g$, the rate provision code $r$ applies to all seven-digit imports within the five-digit good and indicates whether the duty is ad valorem, specific, or compound – i.e., a combination of ad valorem and specific duties.

Table 6 describes the two-digit rate provision codes in the data. A first digit of values 1-4 describes whether the tariff is duty free, specific, ad valorem, or compound. For non-duty-free products, a second digit of 1 or 2 indicates that the tariff is the MFN normal trade relations (NTR) tariff from column 1 of the US tariff schedule or the non-NTR tariff from column 2, respectively. The vast majority of imports fall under one of the seven potential combinations of these rate provision codes. For example, rate provision code 22 indicates a non-NTR specific tariff, while rate provision code 31 indicates an NTR ad valorem tariff. The codes 5*, 7*, *3, *4 and *8 capture various infrequently used types of tariffs.

**Table 6:** Rate provision codes ($r$)

| First Digit | Duty Type | Second Digit | Rate |
|---|---|---|---|
| 1* | Duty Free | *1 | Col 1 |
| 2* | Specific Duty | *2 | Col 2 |
| 3* | Ad Valorem | *3 | Col. 1 Exceptions |
| 4* | Compound | *4 | Col. 2 Exceptions |
| 5* | Minimum | *8 | Cuba Special |
| 7* | Special | | |

In general, the total duties collected on variety $v$ (defined in the data as an exporter by

[33] Feenstra (1996) reports these data at the country-product-year level by aggregating over (i) dutiable and non-dutiable imports and (ii) ports. Thus, we use the raw ASCII files to access the most disaggregate data.

seven-digit product by port triple) of good $g$ under rate provision $r$ at time $t$ are

$$TD_{vgrt} = \tau_{grt} DV_{vgrt} + f_{grt} Q_{vgrt}. \tag{A.1}$$

Here, $\tau_{grt}$ and $f_{grt}$ are, respectively, the unknown ad valorem and specific tariffs, while $DV_{vgrt}$ and $Q_{vgrt}$ represent dutiable import value and the quantity of imports. We again note that the data in the IDB are reported at the variety-level while legislated tariffs are specified at the more aggegate five-digit level $g$.

Absent measurement error, one would need at most two non-collinear variety-level observations of a good in a given year to calculate its tariff(s).[34] For five-digit product $g$ facing rate provision code $r$ in year $t$, one would calculate

$$f_{grt} = \frac{TD_{vgrt}}{Q_{vgrt}} \text{ for } r = 2^* \tag{A.2}$$

$$\tau_{grt} = \frac{TD_{vgrt}}{DV_{vgrt}} \text{ for } r = 3^* \tag{A.3}$$

$$TD_{vgrt} = \tau_{grt} DV_{vgrt} + f_{grt} Q_{vgrt} \text{ for } r = 4^*. \tag{A.4}$$

For ad valorem and specific tariffs, only a single variety-level observation would be needed using (A.2) and (A.3). But two variety-level observations would be needed to calculate $\tau_{grt}$ and $f_{grt}$ for compound tariffs since (A.4) is a single equation with two unknowns $\tau_{grt}$ and $f_{grt}$.[35]

However, multiple forms of measurement error make direct calculation infeasible. First, the IDB data round import values and quantities to the nearest integer. Second, database entry error may occur – occasionally, for instance, the units of quantity may be recorded inconsistently within a rate code. Third, countries may be moved from Column 2 to Column 1 status within a year and hence face different tariffs during the year.[36] This creates problems because the IDB only records imports annually.

An additional complication is that many products with specific tariffs report two distinct quantity values for a given observation, each corresponding to a different unit of measure-

[34] This standard is easily met in the data – it fails for a mere 0.2% of observations covering 0.1% of imports by value.

[35] One would obtain identical $\tau_{grt}$ and $f_{grt}$ for any chosen variety in equations (A.2)-(A.3) and any two varities in equation (A.4). Additionally, the two versions of equation (A.4) defined by the two varities must be linearly independent – that is, they must define two non-parallel lines in $\tau_{vgt}$-$f_{vgt}$ space.

[36] One such is example is China gaining NTR status with the US in March of 1980.

ment. Without information on which unit is used in assigning duties, there are thus two possible values for the specific tariff.[37] In such cases, one needs two varieties to calculate the correct $f_{grt}$. One would then calculate a value of $f_{grt}$ using (A.3) for each of the two units of quantity and identify the correct $f_{grt}$ as the one that is constant across the two varieties.[38] Similarly, one would need two sets of variety pairs to calculate the correct $\tau_{grt}$ and $f_{grt}$ for products with compound tariffs. In this case, one would separately solve the simultaneous equations given by (A.4) for each unit of quantity. Only one unit of quantity would yield a constant $\tau_{grt}$ and $f_{grt}$ across the two sets of variety pairs. These would be the correct $\tau_{grt}$ and $f_{grt}$.

Ultimately, we can only estimate the five-digit MFN tariffs $\tau_{grt}$ and $f_{grt}$ with noise. However, Section A.2 will show the resulting estimation error is negligible for the vast majority of imported goods. Our estimations strategy employs a three-step iterative estimation process. The first step provides initial estimates of the annual tariffs. The second step refines the estimates by removing observations that exhibit inconsistencies plausibly related to the data entry and rate-switching measurement error discussed above. The third step further improves these estimates by jointly re-estimating the tariffs with data pooled across multiple years. To do so, we jointly estimate the tariffs of a five-digit good over "spells" of consecutively observed years where the variation in the good's tariff is sufficiently small. This final step allows us to smooth estimation error at the annual frequency that could otherwise lead us to mistakenly infer minor fluctuations in legislated tariffs.

In step one, we estimate the following equation separately by product, rate provision code, and year between 1974 and 1988:

$$TD_{vgrt} = \tau_{grt} DV_{vgrt} + f_{grt} Q_{vgrt} + \epsilon_{vgrt}. \tag{A.5}$$

Naturally, we impose we impose $\tau_{grt} = 0$ for goods only facing specific tariffs and $f_{grt}$=0 for goods only facing ad valorem tariffs. If two units of quantity are provided, we estimate equation (A.5) separately for each quantity. If estimated tariffs under each of these quantities

[37] For example, TSUSA product 37315 covers non-ornamented, wool neckties for men and boys. In 1978, the rate for this was 10.5% ad valorem plus $0.375 per pound. The IDB data report two different quantities for each observation of this product. According to the TSUSA schedule, the quantities reflect dozens of ties as well as pounds of imports. However, the IDB does not indicate which value of quantity measures dozens of ties and which measures pounds of ties.

[38] This additionally requires that the percentage difference in the quantity amount across the two exporter-port observations is different for each of the two units of quantity. This is satisfied in general as long as the units in the data are not scalars of each other – e.g., pounds and ounces.

provide valid estimates – i.e. $\hat{f}_{grt}, \hat{\tau}_{grt} > 0$ – we use the estimates that give with the lower $R^2$.[39]

After obtaining initial tariff estimates $\hat{\tau}_{grt}$ and $\hat{f}_{grt}$ for all five-digit rate provision codes, we proceed to the second estimation step. Measurement error for individual observations is occasionally quite large, such as when countries shift from Column 2 to Column 1 tariffs during the year. We can thus improve the accuracy of our tariff estimates by iteratively removing observations with substantial measurement error.

To this end, we begin by defining ad valorem equivalent tariffs in the data, $AVE_{vgrt}$, and our estimates of these, $\widehat{AVE}_{vgrt}$:

$$AVE_{vgrt} \equiv \frac{TD_{vgrt}}{DV_{vgrt}} \text{ and } \widehat{AVE}_{vgrt} \equiv \hat{\tau}_{grt} + \frac{\hat{f}_{grt}}{p^*_{vgrt}} \tag{A.6}$$

where $p^*_{vgrt} = \frac{V_{vgrt}}{Q_{vgrt}}$ is the unit value on the total value of imports $V_{vgrt}$. For small ad valorem equivalent tariffs, the log estimation error

$$\varepsilon^{Est}_{vgrt} \equiv \ln\left[p^*_{vgrt}\left(1 + AVE_{vgrt}\right)\right] - \ln\left[p^*_{vgrt}\left(1 + \widehat{AVE}_{vgrt}\right)\right] \tag{A.7}$$

approximates the percentage difference between the tariff-inclusive price in the raw data and the value implied by our estimates of the underlying legislated tariffs. In this step we remove variety-level ($v$) observations with the largest estimation error within each cluster of good-by-rate-provision-by-year ($grt$) observations. For products where the mean absolute error $|\varepsilon^{Est}_{vgrt}|$ exceeds 0.001, we identify the single observation with the largest standardized error and drop it from our estimating sample.

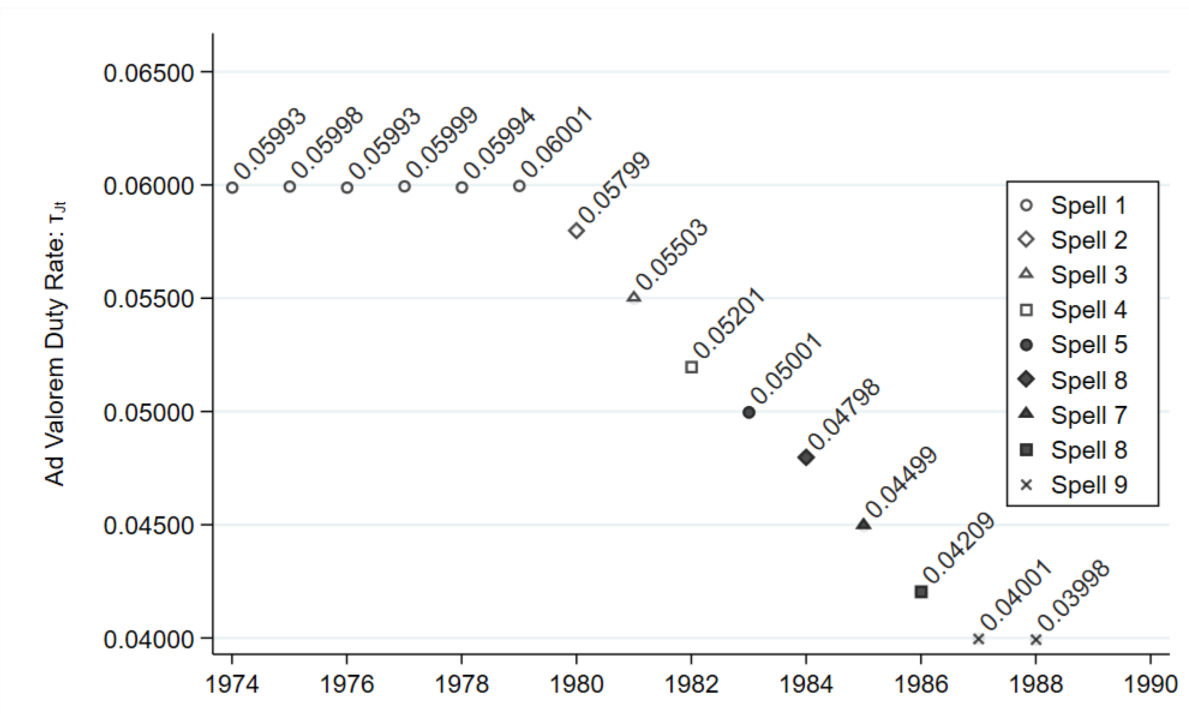
Using the resulting reduced sample, we repeat the above two steps, again estimating tariffs and removing observations with the largest error within clusters. We repeat this iterative process ten times. If there are still products for which observations exhibit substantial estimation error, we assume that this may be driven by individual countries which have changed MFN status during the year. This would result in systematically high errors in all observations from this country and potentially impact all products exported by the country. Consequently, we drop the set of exporters in a given year for which the mean absolute

[39] In some infrequent cases goods receive numerous specific duties on components of the individual good. Because the IDB measures at most two distinct quantities, neither digitization nor estimation can recover the true tariff on such goods. Due to the infrequency of this type of good and a concern of over-fitting, we do not estimate equation (A.5) with two units of quantity simultaneously.

error $|\varepsilon_{vt}|$ across all variety-by-rate-provision observations within a cluster of export-year observations exceeds 0.001. Finally, we re-estimate the tariffs on the resulting sub-sample to yield our final estimates and iterate on this process up to 10 additional times.

Due to estimation error, our annual estimates often exhibit minor fluctuations around a common mean, suggesting that rates were in fact static during this period. For example, in Figure A.1 we can see that TSUSA 11137 had nine distinct tariff rates between 1974 and 1988. The rate was static from 1974 to 1979, was reduced annually from 1980 to 1987, and was constant again between 1987 and 1988. We capture this relationship by identifying spells in the data in which estimated tariffs change by less than 0.015 log points in any two years.

**Figure A.1:** Identifying Tariff Spells from Annual Estimates



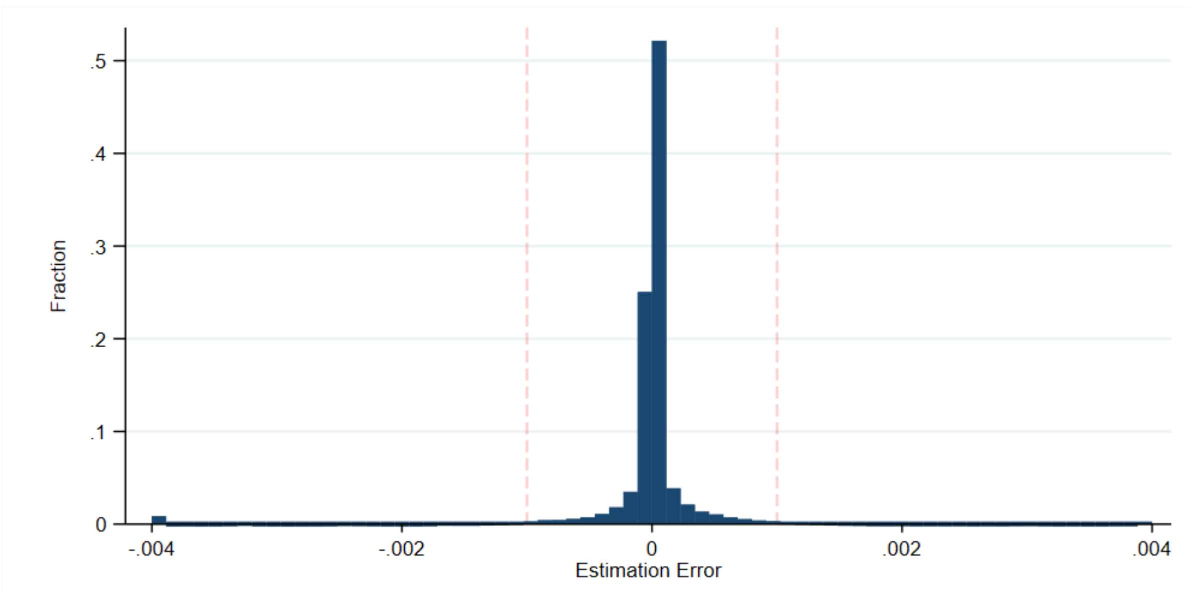

**Notes:** Figure displays annual estimates of ad valorem tariff rates for TSUSA 11137 (Herring, salted or pickled, but not otherwise preserved, and not in airtight containers with weight of no more than 15 lbs) after completing the first two steps of our tariff estimation procedure.

We then repeat steps one and two in our tariff estimation algorithm, pooling observations across time within spells. Again, we eliminate variety-by-rate provision-by-year observations sequentially if they exhibit substantial estimation error and re-estimate tariffs on the reduced sample, and further refine our estimates by eliminating exporter-year pairs which similarly exhibit high average error rates.

## A.2 Accuracy and Coverage of Estimated Tariffs

In general, we expect that estimation error will drive a wedge between our tariff estimates and the true legislated values. To assess the extent of this error, we begin by displaying the estimation error $\varepsilon_{vgrt}$, as described in (A.7), in Figure A.2. The dashed red lines indicate thresholds of $|\varepsilon_{vgrt}| = 0.001$, which represents an estimation error of approximately 0.1% of the tariff-inclusive price. Less than 3.8% of observations lie outside of these thresholds. That is, import prices implied by our estimates very closely match those in the data.

**Figure A.2:** Distribution of Estimation Error




**Notes:** Estimation error defined in equation (A.7) at exporter-port-TSUSA 7 digit-rate provision code-year level as log difference between tariff inclusive price and our estimated tariff inclusive price using our tariff estimates from Section A.1. See main text for further details.

Despite iteratively dropping observations and countries from our sample during tariff estimation, this process yields a database of 7366 unique five-digit TSUSA goods. We restrict our attention to imports for which $|\varepsilon_{vrgt}| < .001$. Our final sample covers nearly 97% of the value of US imports annually. Moreover, we are able to provide disaggregate tariff rates for goods in 1972 and 1973, years in which the IDB does not report duties collected, using our estimated tariff rates from 1974. The notable exception to the high accuracy and coverage of our approach is 1980 where coverage falls to 82%. This is due to two intra-year trade policy changes that render tariff rates incalculable. First, China receives NTR status which means that the country's import and tariff data are subject to both Column I and Column II rates in an indistinguishable manner. Second, tariff changes introduced under the Tokyo round of the GATT are introduced mid-year for some products in this year. Tariff rates for these products tariff rates are similarly incalculable.

Our second method for assessing the accuracy of our estimation strategy is more direct: we digitize all 1978 tariffs using the 1978 TSUSA and compare it with our 1978 estimated tariffs. Collapsing over all varieties, we then calculate log tariff-inclusive price in the data $\ln(1+AVE^{Data}_{gr,1978})$, using our estimated tariffs, $\ln(1+AVE^{Est.}_{gr,1978})$, and using digitized tariffs $\ln(1+AVE^{Dig.}_{gr,1978})$ This yields a sample of 9422 good-by-rate provision observations. Table 7 reports the correlation between these measures and shows a near-perfect correlation between our estimated tariffs and either those in the data or the digitized tariffs.[40]

**Table 7:** Sample of Estimated vs Digitized Tariffs

| | $\ln(1+AVE^{Data}_{rg,1978})$ | $\ln(1+AVE^{Est.}_{rg,1978})$ | $\ln(1+AVE^{Dig.}_{rg,1978})$ |
|---|---|---|---|
| $\ln(1+AVE^{Data}_{rg,1978})$ | 1.0000 | - | - |
| $\ln(1+AVE^{Est.}_{rg,1978})$ | 0.9994 | 1.0000 | - |
| $\ln(1+AVE^{Dig.}_{rg,1978})$ | 0.9990 | 0.9997 | 1.0000 |

**Notes:** Table presents an import weighted pairwise correlation matrix of good-by-rate level tariffs taken from the data, estimated via the algorithm detailed above, and digitized in 1978.

[40]This figure omits the 83 observations (0.8% of our sample in 1978) which exhibit nontrivial discrepancies between data and estimation related to units of quantity in the underlying IDB data.

# B Additional Figures

**Figure A.3:** Share of Annual Imports Accounted for by Rate Type

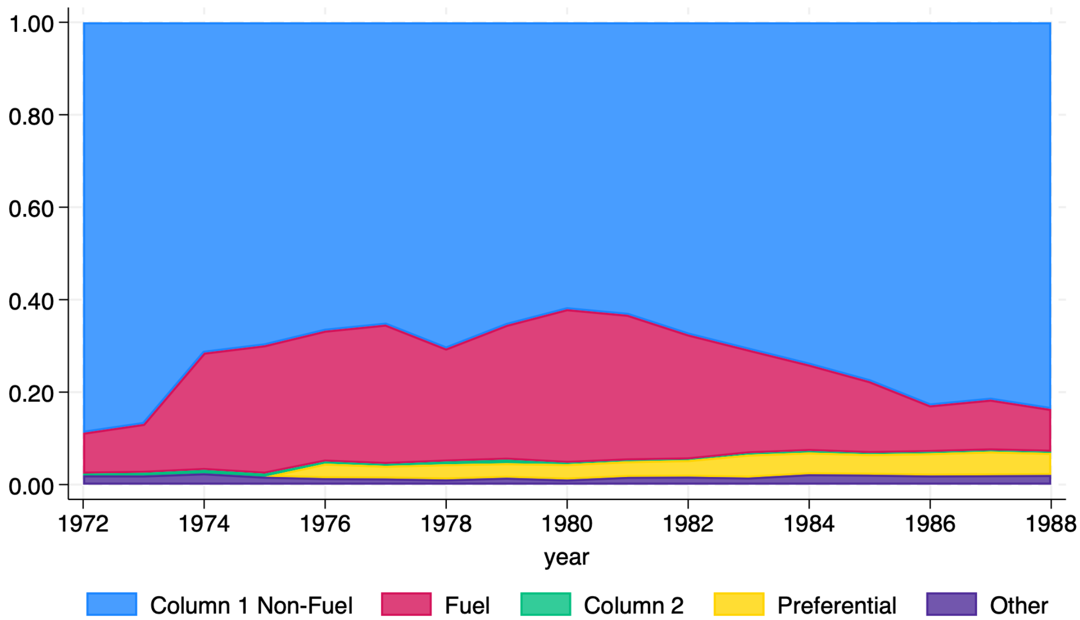


**Figure A.4:** Share of Annual Tariff Revenue Accounted for by Rate Type

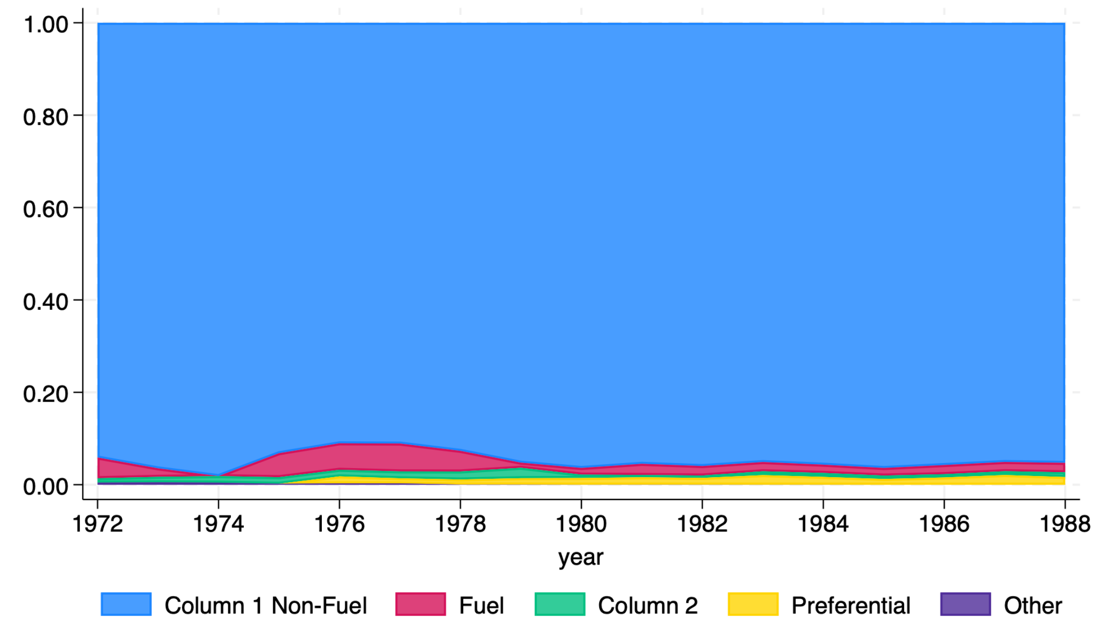
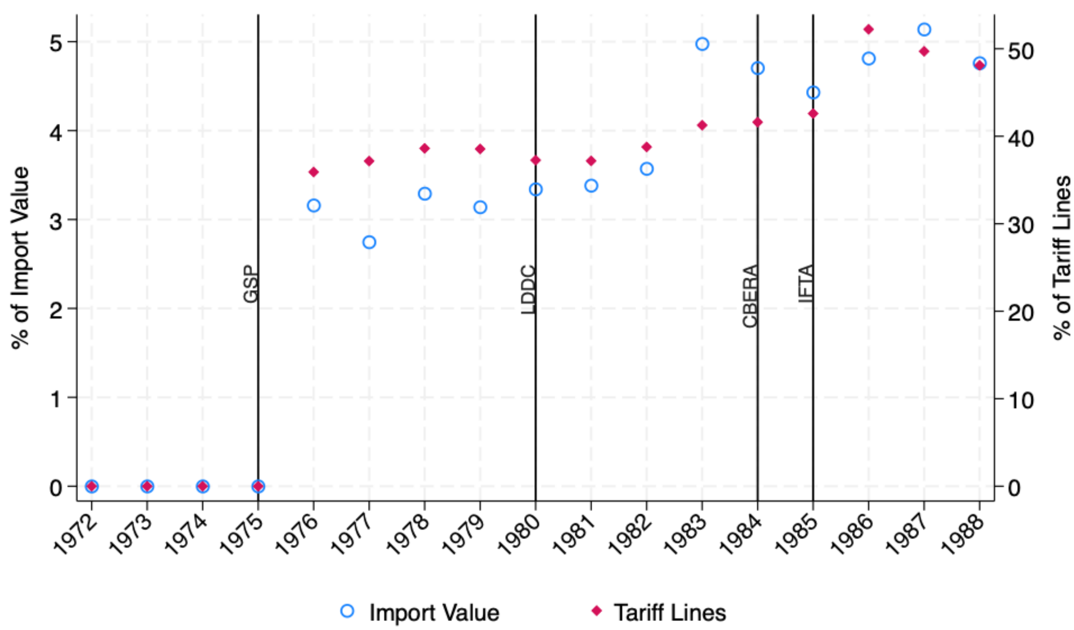



**Figure A.5:** Introduction of Preferential Access



# C Additional Figures

## C.1 Tariff Decomposition

In the main text we provide a decomposition of the changes in tariff rates between times $t$ and $t_0$. Here we detail the decomposition of intra-variety changes in AVE tariffs. Remembering that the good-level change in tariffs is simply a value weighted average of the variety level tariffs:

$$\Delta AVE_{gt} = \sum_{v} s_{vgt_0} \left( \tau_{vgt} + \frac{f_{vgt}}{p^*_{vgt}} \right) \tag{A.8}$$

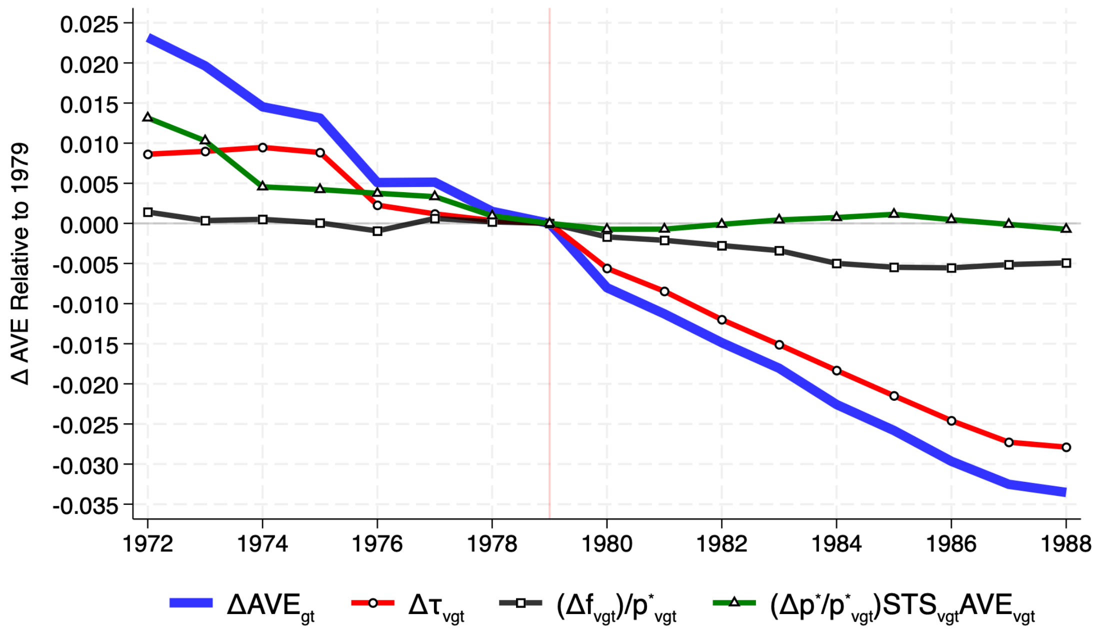
we can see that it can vary for only three reasons. Changes in ad valorem tariff rates $\tau_{gt}$, specific tariff rates $f_{gt}$, or prices $p^*_{vgt}$. Differencing this between t and $t_0$ we can obtain:

$$
\begin{aligned}
\Delta AVE_{vgt} &= AVE_{vgt_1} - AVE_{vgt_0} \\
&= \left(\tau_{gt_1} + \frac{f_{gt_1}}{p^*_{vgt_1}}\right) - \left(\tau_{vgt_0} + \frac{f_{vgt_0}}{p^*_{vgt_0}}\right) \\
&= \Delta\tau_{vgt} - \frac{f_{vgt_1} * p^*_{vgt_0} - f_{vgt_0} * p^*_{vgt_1}}{p^*_{vgt_1} p^*_{vgt_0}} \\
&= \Delta\tau_{vgt} - \frac{(f_{vgt_0} + \Delta f_{vgt}) * p^*_{vgt_0} - f_{vgt_0} * (p^*_{vgt_0} + \Delta p^*_{vgt})}{p^*_{vgt_1} p^*_{vgt_0}} \\
&= \Delta\tau_{vgt} - \frac{f_{vgt_0} p^*_{vgt_0} + \Delta f_{vgt} * p^*_{vgt_0} - f_{vgt_0} p^*_{vgt_0} - f_{vgt_0} \Delta p^*_{vgt}}{p^*_{vgt_1} p^*_{vgt_0}} \\
&= \Delta\tau_{vgt} - \frac{\Delta f_{vgt} * p^*_{vgt_0} - f_{vgt_0} \Delta p^*_{vgt}}{p^*_{vgt_1} p^*_{vgt_0}} \\
&= \Delta\tau_{vgt} - \frac{\Delta f_{vgt}}{p^*_{vgt_1}} - \frac{\Delta p^*_{vgt}}{p^*_{vgt_1}} \frac{f_{vgt_0}}{p^*_{vgt_0}} \\
&= \Delta\tau_{vgt} - \frac{\Delta f_{vgt}}{p^*_{vgt_1}} - \left(\frac{\Delta p^*_{vgt}}{p^*_{vgt_1}} \frac{f_{vgt_0}}{p^*_{vgt_0}}\right) \left(\frac{\tau_{vgt_0} + \frac{f_{vgt_0}}{p^*_{vgt_0}}}{\tau_{vgt_0} + \frac{f_{vgt_0}}{p^*_{vgt_0}}}\right) \\
&= \Delta\tau_{vgt} - \frac{\Delta f_{vgt}}{p^*_{vgt_1}} - \frac{\Delta p^*_{vgt}}{p^*_{vgt_1}} \left(\frac{f_{vgt_0}}{p^*_{vgt_0}(\tau_{vgt_0} + \frac{f_{vgt_0}}{p^*_{vgt_0}})}\right) \left(\tau_{vgt_0} + \frac{f_{vgt_0}}{p^*_{vgt_0}}\right) \\
&= \Delta\tau_{vgt} - \frac{\Delta f_{vgt}}{p^*_{vgt_1}} - \frac{\Delta p^*_{vgt}}{p^*_{vgt_1}} \underbrace{\left(\frac{f_{vgt_0}}{p^*_{vgt_0}\tau_{vgt_0} + f_{vgt_0}}\right)}_{STS_{vgt_0}} \underbrace{\left(\tau_{vgt_0} + \frac{f_{vgt_0}}{p^*_{vgt_0}}\right)}_{AVE_{vgt_0}} \\
&= \Delta\tau_{vgt} - \frac{\Delta f_{vgt}}{p^*_{vgt_1}} - \frac{\Delta p^*_{vgt}}{p^*_{vgt_1}} STS_{vgt} AVE_{vgt_0} \qquad \text{(A.9)}
\end{aligned}
$$

While some countries have access to column 1 rates, others are subject to column 2, while others still have changing access to preferential tariff rates like GSP and LDDC. The former, introduced in 1976 and the latter in 1980. Such changes in statutory tariffs could be driving the within period changes in AVE, rather than the inflationary story we proposed. We also break out one additional group – fuel which experienced both inflationary and temporary tariff changes during our sample.[41] While variation due to fuel is clearly an important

[41]Both due to the evolving government demand for fuel through the end of the Vietnam War and the OPEC driven oil crises, the dutiable status of oil changed throughout our sample. At the onset of our sample it was protected by specific tariffs, and alternated between duty free status and a reinstatement of specific tariffs and was duty free in 1979. Thus the rise in tariffs going back to 1972 will reflect both

**Figure A.6:** Unweighted decomposition of changes in variety-Level $AVE_{vgt}$




**Notes:** Figure presents an equally weighted decomposition of AVE tariff rates to components driven by changes in statutory ad valorem tariffs, specific tariffs, price levels and the inflationary erosion of the tariff schedule. The figure which provides an exact decomposition of aggregate tariffs and is thus weighted by 1979 import expenditure shares can be found in the main text in Figure 3. Data from author's calculations and US Census IDB.

component, we note that the column 1 rate changes are still substantial an in contrast with the notion of static tariffs following the completion of the Kennedy round.

As the final definitive step, we look within the column 1 rates over time. Denoting the AVE tariff within column 1 as:

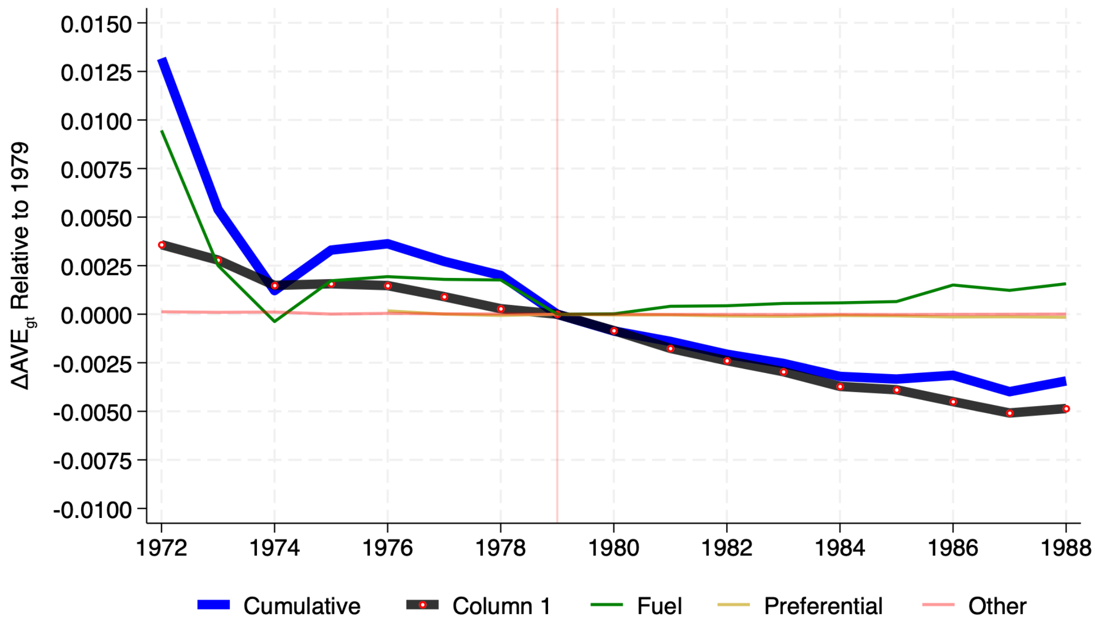
$$AVE_{vgt} = \left( \tau_{gt} + \frac{f_{gt}}{p^*_{vgt}} \right) \tag{A.10}$$

we can see that it can vary for only three reasons. Changes in ad valorem tariff rates $\tau_{gt}$, specific tariff rates $f_{gt}$, or prices $p^*_{vgt}$. Indexing these components to their value in 1979 (and using log prices rather than level), we plot all three components in figure A.8.

The pattern is stark. As expected, before 1980 there are no meaningful changes in statutory column 1 tariff rates $\tau_{vgt}$ or $f_{vgt}$. There is however an near doubling of price levels

inflationary and statutory changes. Nonetheless, for conservatism, we remove this.

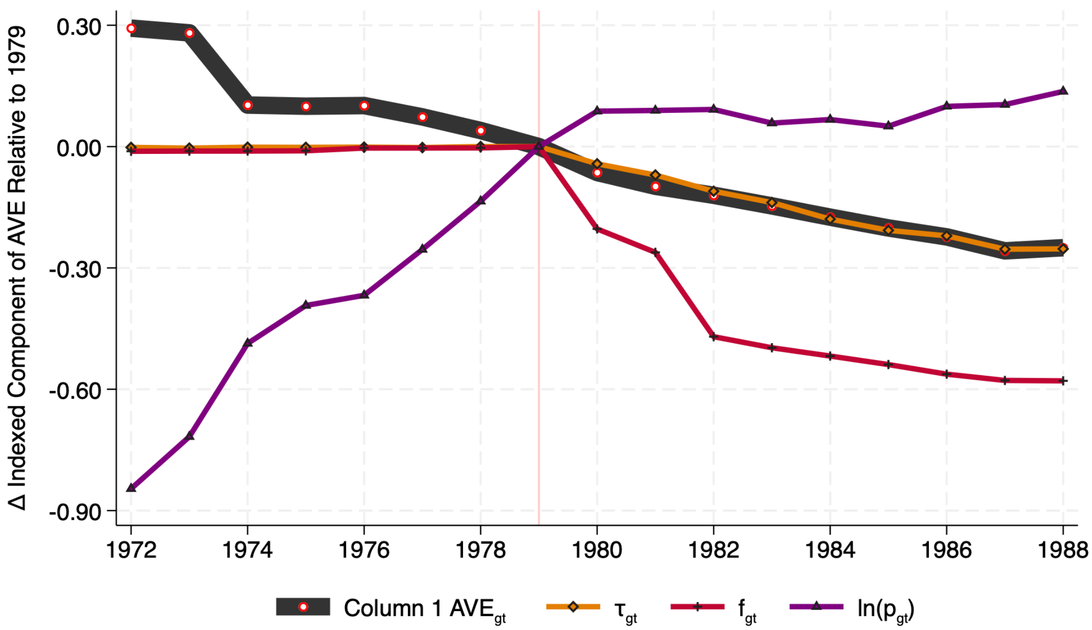
**Figure A.7:** Decomposing Tariff Changes by Rate Type




Notes: Figure decomposes the time series changes in within good AVE to its constituent rate types: Column 1, Column 2, Preferential Agreements (GSP, LDDC, IFTA), and Other Rates. Fuel has been added as a separate category as well. See text for details.

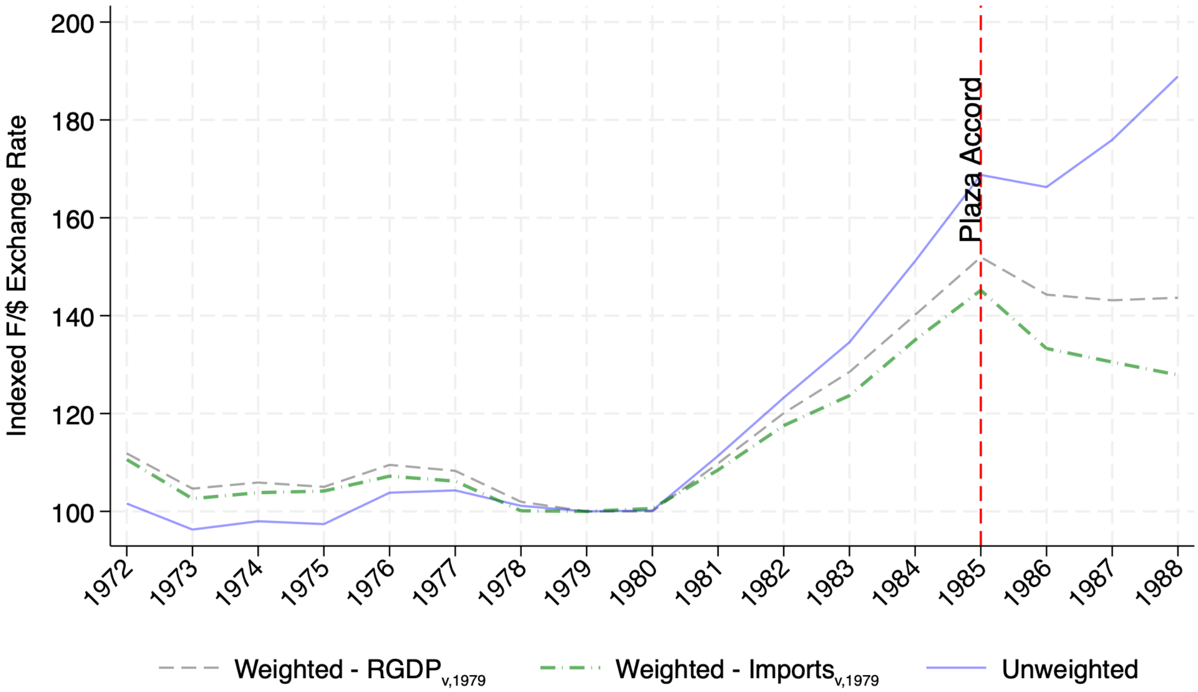
between 1972 and 1979 which, will mechanically lower the AVE. By contrast, the post period features both changing price levels (though more modest) coupled with statutory declines in tariff rates.

**Figure A.8:** Sources of Variation in the Column 1 Rate




Notes: Figure display of sources of variation within column 1 AVE tariff rates 1972-1988.

**Figure A.9:** F/USD Exchange Rates Indexed to 1979.




**Notes:** Figure reports unweighted, import weighted, and RGDP weighted bilateral exchange rates indexed to 100 in 1979.

# D Counterfactual Analysis

## D.1 Solving the Model in Levels

Two computational issues prove challenging for solving our model in levels. The first issue is that the system of equations characterizing the equilibrium of our model – described in Section **??** – is both high-dimensional and highly non-linear. The second issue is recovering the unobserved variety-level structural demand shocks $b_{vgt}$ and structural supply shocks $\eta_{vgt}$ so that one can not only hold them constant in the counterfactuals but also so one can compute the price indices $P_{gt}$ which depend on the demand shocks $b_{vgt}$). While recovering the supply shocks is straightforward, reliably recovering the demand shocks is challenging.

These issues motivate our use of hat algebra to derive proportional changes in equilibrium variables under our counterfactual analysis rather than solving for the level of the counterfactual equilibrium variables. Nevertheless, Appendices D.1.1 and D.1.2 show how to solve these two issues.

### D.1.1 An Algorithm for Solving the Model in Levels

Throughout this subsection, suppose that we have recovered the unobserved structural import demand and export supply shocks (Appendix D.1.2 details how they can be recovered). The algorithm then has an inner, middle and upper nest corresponding to the different nests of the utility function.

**Inner Nest**

1. Take values of $b_{vgt}$ for $v = 1, ..., V_g$ and $g = 1, ..., G$ and $\sigma_g$ for $g = 1, ..., G$ as given. Pick initial values for good-level expenditures $E_{gt}$ for $g = 1, ..., G$ and tariff-exclusive prices $p^*_{vgt}$ for $v = 1, ..., V_g$ and $g = 1, ..., G$.

2. Calculate good-level price indices $P_{gt}$ for $g = 1, ..., G$ using (**??**).

3. Calculate variety-level demand-side and supply-side expenditure shares $\ln s^*_{vgt}$ for $v = 1, ..., V_g$ and $g = 1, ..., G$ using (**??**) and (**??**).

4. If excess supply (demand) for variety $v$ of good $g$ in year $t$ then scale $p^*_{vgt}$ down (up) by a factor of $1 - x$ $(1 + x)$ where $x \in (0, 1)$.

5. Repeat steps 2-4 of the inner nest until convergence.

### Middle Nest

1. Take value of $\gamma$ as given. Pick initial value of importable expenditure $E_{Mt}$. Combining $E_{Mt}$ with the initial values of good-level expenditures $E_{gt}$ in step 1 of the inner nest gives initial log values of good-level tariff-inclusive expenditure shares $\ln s_{gt} = \ln \frac{E_{gt}}{E_{Mt}}$ for $g = 1, ..., G$.

2. Calculate aggregate importable price index $P_{Mt}$ using (**??**) and the good-level price indices $P_{gt}$ from the inner nest.

3. Calculate good-level expenditure shares $\ln s_{gt}$ using of (**??**): $\ln s_{gt} = \ln \left( \frac{P_{gt}}{P_{Mt}}^{(\gamma-1)} \right)$

4. If calculated good-level expenditure share $\ln s_{gt}$ from step 3 is higher (lower) than its initial value from step 1 then scale calculated expenditure share $\ln s_{gt}$ down (up) by a factor of $1 - e$ $(1 + e)$ where $e \in (0, 1)$.

5. Given scaled values of $\ln s_{vgt}$ for $g = 1, ..., G$ and given value of $E_{Mt}$, use implied values of $E_{gt}$ for $g = 1, ..., G$ as initial values in step 1 of the inner nest.

6. Repeat steps 1-4 of the middle nest.

7. Repeat steps 5-6 of the middle nest until convergence.

### Upper Nest

1. Take values of $E_t$, $P_{Dt}$, and $\kappa$ as given. Combining $E_t$ with the initial value of $E_{Mt}$ in step 1 of the middle nest gives an initial value of the aggregate importable expenditure share $s_{Mt} = \frac{E_{Mt}}{E_t}$.

2. Calculate aggregate price index $P_t$ using (**??**) and $P_{Mt}$ from the middle nest.

3. Calculate expenditure share $s_{Mt}$ using (**??**): $s_{Mt} = \frac{P_{Mt}}{P_t}^{(\kappa-1)}$

4. If calculated aggregate importable expenditure share $s_{Mt}$ from step 3 is higher (lower) than its initial value from step 1 then scale calculated expenditure share down (up) by a factor of $1 - z$ $(1 + z)$ where $z \in (0, 1)$.

5. Given the scaled value of $s_{Mt}$ and the value of $E_{Mt}$, use implied value of $E_{Mt}$ as initial values in step 1 of the middle nest.

6. Repeat steps 1-4 of the upper nest.

7. Repeat steps 5-6 of the upper nest until convergence.

#### D.1.2 Recovering Unobserved Structural Demand and Supply Shocks

The key challenge to counterfactual analysis using our model in levels is recovering the unobserved import demand and export supply shocks. On one hand, recovering the unobserved structural supply shocks is straightforward. Manipulating the export supply equation (**??**) reveals

$$\eta_{vgt} = -\omega_g \text{ln} s^*_{vgt} + (1+\omega_g) \text{ln} p^*_{vgt} - \omega_g \text{ln} E_{gt} \tag{A.11}$$

where all of the variables on the right hand side are either observed ($\text{ln} s^*_{vgt}$, $\text{ln} p^*_{vgt}$, and $\text{ln} E_{vgt}$) or estimated ($\omega_{vgt}$).

On the other hand, recovering the unobserved variety-level demand shock for a given variety $v$ of good $g$ in time $t$ is significantly complicated by the fact that these demand shocks affect import demand not only directly but also through the good-level price index and hence on all variety-level prices and all variety-level demand shocks of good $g$ in time $t$. That is, the following highly non-linear system of $V_g$ simultaneous equations defines the unobserved demand shocks $b_{vgt}$ for good $g$ in time $t$ as a function of variables that are either observed ($\text{ln} s_{vgt}$ and $\text{ln} p_{vgt}$) or estimated ($\sigma_g$):

$$\text{ln} s_{vgt} + (\sigma_g - 1) \text{ln} p_{vgt} = (\sigma_g - 1) \text{ln} P_{gt} + \text{ln} b_{vgt} \tag{A.12}$$

$$\text{ln} P_{gt} = \frac{1}{1-\sigma_g} \text{ln} \left( \sum_{v=1}^{V_g} b_{vgt} p_{vgt}^{1-\sigma_g} \right). \tag{A.13}$$

Solving this system of non-linear equations is not straightforward.

While still not straightforward, a simpler approach is to focus on recovering relative unobserved demand shocks. Starting at the lower level of utility and using (**??**), the unobserved demand shock for good $g$ in time $t$ of variety $v$ relative to a *reference variety* $k \neq v$ is

$$\frac{b_{vgt}}{b_{kgt}} = \frac{s_{vgt}}{s_{kgt}} \left(\frac{p_{kgt}}{p_{vgt}}\right)^{\sigma_g - 1} \equiv \alpha_{vgt} \tag{A.14}$$

where $\alpha_{vgt}$ consists of either variables that are either observed ($s_{vgt}$, $s_{kgt}$, $p_{vgt}$ and $p_{kgt}$) or estimated ($\sigma_g$). Because CES prices are homogeneous of degree one, the good-level price index is proportional to the unobserved demand shock of the good's reference variety and a psuedo-price index $\tilde{P}_{gt}$ that only depends on variables either observed ($\alpha_{vgt}$ and $p_{vgt}$) or estimated ($\sigma_{vgt}$):

$$P_{gt} = b_{kgt} \left( \sum_{v=1}^{V_g} \alpha_{vgt} p_{vgt}^{1-\sigma_g} \right)^{\frac{1}{1-\sigma_g}} \equiv b_{kgt} \tilde{P}_{gt} \tag{A.15}$$

Moving to the middle level of utility, we can now recover the unobserved demand shock for the reference variety $k$ of good $g$ in time $t$ relative to the *reference variety* $l$ of a *reference good* $h$ in time $t$. Using (**??**) and (A.15), we have

$$\frac{b_{kgt}}{b_{lht}} = \left(\frac{s_{ht}}{s_{gt}}\right)^{\frac{1}{\gamma-1}} \frac{\tilde{P}_{ht}}{\tilde{P}_{gt}} \equiv \alpha_{gt} \tag{A.16}$$

where $\alpha_{gt}$ consists of variables that only depend on observed or estimated variables. And the price index for the aggregate importable composite good is proportional to the unobserved demand shock of the reference variety $l$ of the reference good $h$ and a psuedo-price index $\tilde{P}_{Mt}$ for the aggregate importable composite good that only depends on variables either observed or estimated:

$$P_{Mt} = b_{lht} \left[ \sum_{g} \alpha_{gt} \left( \left( \sum_{v=1}^{V_g} \alpha_{vgt} p_{vgt}^{1-\sigma_g} \right)^{\frac{1}{1-\sigma_g}} \right)^{1-\gamma} \right]^{1/(1-\gamma)} \equiv b_{lht} \tilde{P}_{Mt}. \tag{A.17}$$

Moving to the upper level of utility, we can now recover the unobserved demand shock for the reference variety $l$ of the reference good $h$ as a function of expenditure shares and price indices for the aggregate importable and aggregate domestic composite goods. Using

(**??**) and (A.17), we have

$$b_{lht} = \left(\frac{s_{Dt}}{s_{Mt}}\right)^{\frac{1}{\kappa-1}} \frac{P_{Dt}}{\tilde{P}_{Mt}} \equiv \alpha_t \tag{A.18}$$

where $\alpha_{gt}$ consists of variables that only depend on observed or estimated variables. While we have focused on relative unobserved demand shocks, solving $b_{lht}$ using (A.18) would then determine the level of the unobserved demand shock for the reference variety $k$ of each good $g$ using (A.16) and in turn the level of the unobserved demand shock for any variety of good $g$ using (A.14). The problem is finding suitable data for the *level* of the price index for the domestic composite good in any given year.

Nevertheless, suppose we know there exists a good $h$ and year $y$ in which the unobserved demand shock for variety $l$ is $b_{lht} \approx 1$ (i.e. a "zero" demand shock given $b_{lht}$ enters utility multiplicatively). For example, perhaps we can manually identify a particular good in a particular year where the non-linear system of equations (A.12)-(A.13) is easy to solve. As just described, we could then use (A.16) and (A.14) to recover the level of the unobserved demand shocks of all varieties of all goods in year $y$. Moreover, we could also apply a two-step approach to recover the level of the domestic price index $P_{Dt}$ in every year. First, manipulating (A.18) reveals

$$P_{Dy} \approx \left(\frac{s_{My}}{s_{Dy}}\right)^{\frac{1}{\kappa-1}} \tilde{P}_{My}. \tag{A.19}$$

Second, combining this price index level $P_{Dy}$ in the reference year $y$ with data such as a Producer Price Index from a national statistical agency would deliver price index levels $P_{Dt}$ in all years $t \neq y$. Thus, we could then use (A.16) and (A.14) to recover the level of the unobserved demand shocks of all varieties of all goods in all years.

While we have just outlined two alternative procedures to recover the unobserved demand shocks, recovering all of these shocks reliably is not straightforward. Moreover, even if we could recover them reliably, one is still left with solving a high-dimensional and highly non-linear system of equations.

## D.2 Solving the Model using Hat Algebra

Following Fajgelbaum et al. (2020), this section uses hat algebra (as opposed to *exact* hat algebra) to characterize the first order approximation of the equilibrum. Thus, the endogenous variables are log changes $\hat{x} \equiv d\ln x = \frac{1}{x}dx$. Specifically the model's endogenous variables are the proportional changes in (i) the equilibrium price indices $\hat{P}_t$, $\hat{P}_{Mt}$, and $\hat{P}_{gt}$, (ii) the equilibrium tariff-exclusive variety-level prices $\hat{p}^*_{vgt}$, and (iii) the equilibrium expenditure levels $\hat{E}_{Mt}$ and $\hat{E}_{gt}$. These endogenous variables depend on the following proportional changes in exogenous variables: (i) aggregate expenditure $\hat{E}_t$ (this could be endogenized to include tariff revenue) and the price index for the aggregate domestic composite good $\hat{P}_{Dt}$, (ii) legislated tariffs $\hat{\tau}_{vgt}$ and $\hat{f}_{vgt}$, and (iii) structural import demand and export supply shocks $\hat{b}_{vgt}$ and $\tilde{\eta}_{vgt}$.

A couple of modeling features deserve attention. First, we abstract from how tariffs affect domestic production and, in turn, interact with the importable side of consumer demand to affect the price index for the aggregate domestic composite good. Second, we abstract the impact of changes in tariff revenue on aggregate expenditure. Together, these two abstractions imply $\hat{E}_t$ and $\hat{P}_{Dt}$ are exogenous.

We begin deriving the hat form of the price indices. For the price index of good $g$ at time $t$, differentiating the CES price index $P_{gt}$ and using the result that the expenditure share $s_{vgt} \equiv \frac{p_{vgt}q_{vgt}}{E_{gt}} = b_{vgt}\left(\frac{P_{gt}}{p_{vgt}}\right)^{\sigma_g - 1}$ reveals

$$\hat{P}_{gt} = \sum_{v=1}^{V_g} s_{vgt}\hat{p}_{vgt}. \tag{A.20}$$

Similar derivations reveal

$$\hat{P}_{Mt} = \sum_{g=1}^{G} s_{gt}\hat{P}_{gt} \tag{A.21}$$

$$\hat{P}_t = s_{Mt}\hat{P}_{Mt} + s_{Dt}\hat{P}_{Dt}. \tag{A.22}$$

To find $\hat{p}^*_{vgt}$, we rely on the equilibrium tariff-exclusive price in equation (13). Since the equilibrium variety-level price depends on good-level expenditure $E_{gt}$, we first use the fact that $E_{gt} = \alpha E_{Mt}\left(\frac{P_{gt}}{P_{Mt}}\right)^{1-\gamma}$ and $E_{Mt} = \alpha E_t = s_{Mt}E_t$ to see that

$$\hat{E}_{gt} = \hat{E}_t - (\gamma - 1)\left(\hat{P}_{gt} - \hat{P}_{Mt}\right). \tag{A.23}$$

Using (A.23) after taking the log and differentiating the equilibrium tariff-exclusive price in

(13), we have

$$\hat{p}^*_{vgt} = -\frac{\sigma_g\omega_g}{1+\sigma_g\omega_g}\frac{1}{1+AVE_{vgt}}dAVE_{vgt} + \frac{\omega_g}{1+\sigma_g\omega_g}\hat{b}_{vgt} + \frac{1}{1+\sigma_g\omega_g}\tilde{\eta}_{vgt} + \frac{\omega_g}{1+\sigma_g\omega_g}\left[\hat{E}_t + (\gamma-1)\hat{P}_{Mt} + (\sigma_g-\gamma)\hat{P}_{gt}\right] \tag{A.24}$$

where $\tilde{\eta}_{vgt} = d\eta_{vgt}$. Unlike when only considering advalorem tariffs, $AVE_{vgt} = \tau_{gt} + \frac{f_{gt}}{p^*_{vgt}}$ is endogenous in the presence of specific tariffs because it depends on $p^*_{vgt}$. Nevertheless, we can substitute $AVE_{vgt} = \tau_{gt} + \frac{f_{gt}}{p^*_{vgt}}$ in (A.24) to yield

$$\hat{p}^*_{vgt} = -\frac{\sigma_g\omega_g\varphi^{-1}_{vgt}}{1+\sigma_g\omega_g}\widetilde{AVE}_{vgt} + \frac{\omega_g\varphi^{-1}_{vgt}}{1+\sigma_g\omega_g}\hat{b}_{vgt} + \frac{\varphi^{-1}_{vgt}}{1+\sigma_g\omega_g}\tilde{\eta}_{vgt} + \frac{\omega_g\varphi^{-1}_{vgt}}{1+\sigma_g\omega_g}\left[\hat{E}_t + (\gamma-1)\hat{P}_{Mt} + (\sigma_g-\gamma)\hat{P}_{gt}\right] \tag{A.25}$$

where $\widetilde{AVE}_{vgt} \equiv (1+\widehat{AVE}_{vgt})\big|_{\hat{p}^*_{vgt}=0}$ which is simply $\frac{d\tau_{vgt}+\frac{df_{vgt}}{p^*_{vgt}}}{1+AVE_{vgt}}$ and $\varphi_{vgt}$ is the denminator of (23). Note that $\varphi^{-1}_{vgt} = 1$ in the special case of $f_{vgt} = 0$ but $\varphi^{-1}_{vgt} < 1$ when $f_{vgt} > 0$.

We now have the simultaneous equation system of endogenous variables $\left\{\hat{P}_t, \hat{P}_{Mt}, \hat{P}_{gt}, \hat{p}^*_{vgt}\right\}$ and exoegnous variables $\left\{\widetilde{AVE}_{vgt}, \hat{b}_{vgt}, \tilde{\eta}_{vgt}, \hat{P}_{Dt}, \hat{E}_t\right\}$ governed by equations (A.20), (A.21), (A.22), and (A.25). Note that there are $G$ price indices and associated equations for $\hat{P}_g$ for $g = 1, ..., G$ and $V = \sum_{g=1}^{G} V_g$ prices and associated equations for $\hat{p}_{vgt}$ for $v = 1, ..., V_g$ and $g = 1, ..., G$.

The system of equations characterizing the equilibrium is:

$$
\begin{bmatrix} \hat{P}_t \\ \hat{P}_{Mt} \\ \left[\hat{P}_g\right]_{G\times 1} \\ \left[\hat{p}^*_{v,g,t}\right]_{V\times 1} \end{bmatrix} = [A_{yt} \vdots A_{xt}] \begin{bmatrix} \hat{P}_t \\ \hat{P}_{Mt} \\ \left[\hat{P}_g\right]_{G\times 1} \\ \left[\hat{p}^*_{vgt}\right]_{V\times 1} \\ \left[\widetilde{AVE}_{vgt}\right]_{V\times 1} \\ \left[\hat{b}_{vgt}\right]_{V\times 1} \\ \left[\tilde{\eta}_{vgt}\right]_{V\times 1} \\ \hat{P}_{Dt} \\ \hat{E}_t \end{bmatrix} \tag{A.26}
$$

where

$$
A_{yt} = \begin{bmatrix} 0 & s_{Mt} & 0_{1\times G} & 0_{1\times V} \\ 0 & 0 & \left[s_{gt}\right]_{1\times G} & 0_{1\times V} \\ 0_{G\times 1} & 0_{G\times 1} & 0_{G\times G} & \left[\beta_{0vgt} s_{vgt}\right]_{G\times V} \\ 0_{V\times 1} & \left[\beta_{2vgt}\right]_{V\times 1} & \left[\beta_{3vgt}\right]_{V\times G} & 0_{V\times V} \end{bmatrix}
$$

$$
A_{xt} = \begin{bmatrix} 0_{1\times V} & 0_{1\times V} & 0_{1\times V} & s_{Dt} & 0 \\ 0_{1\times V} & 0_{1\times V} & 0_{1\times V} & 0 & 0 \\ \left[s_{vgt}\right]_{G\times V} & 0_{G\times V} & 0_{G\times V} & 0_{G\times 1} & 0_{G\times 1} \\ \left[\beta_{4vgt}\right]_{V\times V} & \left[\beta_{5vgt}\right]_{V\times V} & \left[\beta_{6vgt}\right]_{V\times V} & 0_{V\times 1} & \left[\beta_{5vgt}\right]_{V\times 1} \end{bmatrix}
$$

and $\beta_{0vgt} = \left(1 - STS_{vgt}\frac{AVE_{vgt}}{1+AVE_{vgt}}\right)$, $\beta_{2vgt} = (\gamma - 1)\,\psi_{vgt}$, $\beta_{3vgt} = (\sigma_g - \gamma)\,\psi_{vgt}$, $\beta_{4vgt} = -\sigma_g \psi_{vgt}$, $\beta_{5vgt} = \psi_{vgt}$, $\beta_{6vgt} = \frac{1}{\omega_g}\psi_{vgt}$, and $\psi_{vgt} = \frac{\omega_g \varphi_{vgt}^{-1}}{1+\sigma_g \omega_g}$.

Letting $A_t = [A_{yt} \vdots A_{xt}]$, $y_t = \begin{bmatrix} \hat{P}_t & \hat{P}_{Mt} & \left[\hat{P}_g\right]_{1\times G} & \left[\hat{p}^*_{v,g,t}\right]_{1\times V} \end{bmatrix}'$, and $x_t = \begin{bmatrix} \left[\widetilde{AVE}_{vgt}\right]_{1\times V} & \left[\hat{b}_{vgt}\right]_{1\times V} & \left[\tilde{\eta}_{vgt}\right]_{1\times V} & \hat{P}_{Dt} & \hat{E}_t \end{bmatrix}'$, we can simply write the system of equations (A.26) as

$$
\begin{aligned}
y_t &= A_t \begin{bmatrix} y_t \\ x_t \end{bmatrix} \\
y_t &= (I - A_{yt})^{-1} A_{xt} x_t
\end{aligned} \tag{A.27}
$$

which defines the the endogenous variables $y_t = \begin{bmatrix} \hat{P}_t & \hat{P}_{Mt} & \left[\hat{P}_g\right]_{1\times G} & \left[\hat{p}^*_{v,g,t}\right]_{1\times V} \end{bmatrix}'$ in terms of the exogenous variables $x_t = \begin{bmatrix} \left[\widetilde{AVE}_{vgt}\right]_{1\times V} & \left[\hat{b}_{vgt}\right]_{1\times V} & \left[\tilde{\eta}_{vgt}\right]_{1\times V} & \hat{P}_{Dt} & \hat{E}_t \end{bmatrix}'$ and the parameters in $A_t$. Even though the system (A.27) uses very large matrices with our data and requires matrix inversion, MATLAB solves the system with relatively little computational burden.

## D.3 Solving the Model using Exact Hat Algebra

To carry out our exact hat algebra analysis, we redefine our hat notation so that $\hat{z} \equiv \frac{z'}{z}$ where $z'$ is the counterfactual value and $z$ is the initial value of a variable $z$. We will characterize the endogenous variables $\hat{y}$ as a function of the exogenous variables $\hat{x}$.

We start by deriving the exact hat form of the price indices. Using the formula for a Cobb-Douglass price index and well-known results in the literature due to Sato (1976) and Vartia (1976), we have

$$\hat{P}_t = \hat{P}_{Mt}^{s_{Mt}} \hat{P}_{Dt}^{s_{Dt}} \tag{A.28}$$

$$\hat{P}_{Mt} = \prod_{g\in G} \hat{P}_{gt}^{w_{gt}} \tag{A.29}$$

$$\hat{P}_{gt} = \prod_{v\in V_g} \hat{p}_{vgt}^{w_{vgt}}. \tag{A.30}$$

where the exact weights are

$$w_{vgt} = \frac{s_{vgt}\left(\hat{s}_{vgt} - 1\right)/\ln \hat{s}_{vgt}}{\sum_g s_{vgt}\left(\hat{s}_{vgt} - 1\right)/\ln \hat{s}_{vgt}} \tag{A.31}$$

$$w_{gt} = \frac{s_{gt}\left(\hat{s}_{gt} - 1\right)/\ln \hat{s}_{gt}}{\sum_g s_{gt}\left(\hat{s}_{gt} - 1\right)/\ln \hat{s}_{gt}} \tag{A.32}$$

and the exact hat tariff-inclusive expenditure shares are

$$\hat{s}_{vgt} = \frac{(1+\widehat{AVE}_{vgt})^{1-\sigma}\hat{p}^{*1-\sigma}_{vgt}}{\sum_{v=1}^{V_g} s_{vgt}(1+\widehat{AVE}_{vgt})^{1-\sigma}\hat{p}^{*1-\sigma}_{vgt}} \tag{A.33}$$

$$\hat{s}_{gt} = \frac{\hat{P}^{1-\sigma}_{gt}}{\sum_{g=1}^{G} s_{gt}\hat{P}^{1-\sigma}_{gt}}. \tag{A.34}$$

Using (10), the exact hat form for variety-level tariff-inclusive prices is

$$\hat{p}_{vgt} = \hat{p}^{*}_{vgt}(1+\widehat{AVE}_{vgt}). \tag{A.35}$$

For the exact hat form of tariff-exclusive variety-level prices, we first derive an exact hat form for good-level equilibrium expediture $E_{gt}$. Using the fact that $E_{gt} = E_{Mt}\left(\frac{P_{gt}}{P_{Mt}}\right)^{1-\gamma}$ and $E_{Mt} = \alpha E_t$, observed expenditure $E_{gt}$ is

$$E_{gt} = \alpha E_t P^{\gamma-1}_{Mt} P^{1-\gamma}_{gt} \tag{A.36}$$

and in exact hat form

$$\hat{E}_{gt} = \hat{E}_t \hat{P}^{\gamma-1}_{Mt} \hat{P}^{1-\gamma}_{gt}. \tag{A.37}$$

Imposing $b'_{vgt} = b_{vgt}$ and $\eta'_{vgt} = \eta_{vgt}$ and using (13), the exact hat form for variety-level tariff-exclusive prices is

$$\hat{p}^{*}_{vgt} = (1+\widehat{AVE}_{vgt})^{-\frac{\sigma_g\omega_g}{1+\sigma_g\omega_g}}\left(\hat{E}_t\hat{P}^{\gamma-1}_{Mt}\hat{P}^{\sigma_g-\gamma}_{gt}\right)^{\frac{\omega_g}{1+\sigma_g\omega_g}}. \tag{A.38}$$

Importantly, as noted in Appendix D.2, $AVE_{vgt}$ depends on the endogenous variable $p^{*}_{vgt}$. In turn,

$$(1+\widehat{AVE}_{vgt}) = (\widehat{1+\tau_{gt}})\left(1 - STS_{vgt}\frac{AVE_{vgt}}{1+AVE_{vgt}}\right) + \frac{\hat{f}_{gt}}{\hat{p}^{*}_{vgt}} STS_{vgt}\frac{AVE_{vgt}}{1+AVE_{vgt}}. \tag{A.39}$$

We now have an exact hat algebra system of equations that characterizes the counterfactual equilibrium. The endogenous variables are (i) the price indices $\hat{P}_t$, $\hat{P}_{Mt}$, $\left[\hat{P}_{gt}\right]_{G\times 1}$ and, using (A.35), the tariff-exclusive prices $\left[\hat{p}^{*}_{vgt}\right]_{V\times 1}$ characterized by (A.28)-(A.30) and (A.38), (ii) using (31)-(32), the expenditure shares $[\hat{s}_{gt}]_{G\times 1}$ and and $[\hat{s}_{vgt}]_{V\times 1}$ characterized by equations (A.33)-(A.34), and (iii) the AVEs $\left[(1+\widehat{AVE}_{vgt})\right]_{V\times 1}$ characterized by equation (A.39). These endogenous variables depend on the following exogenous variables: (i) initial expenditure shares $s_{Mt}$, $s_{Dt}$, $[s_{gt}]_{G\times 1}$, $[s_{vgt}]_{V\times 1}$, (ii) initial values $[AVE_{vgt}]_{V\times 1}$ and $[STS_{vgt}]_{V\times 1}$, (iii) changes in legislated tariffs $\left[\widehat{(1+\tau_{gt})}\right]_{V\times 1}$ and $\left[\hat{f}_{gt}\right]_{V\times 1}$, and (iv) changes in aggregate expenditure and the domestic price index $\hat{E}_t$ and $\hat{P}_{Dt}$.

The exact hat algebra system is substantially more complicated to solve than the hat algebra system. Not only is it highly non-linear compared to the linear hat algebra system, it also has roughly twice as many endogenous variables as the hat algebra system which was already a high-dimensional system. This is because the exact hat algebra system not only has the endogenous prices $\hat{P}_{gt}$ and $\hat{p}^*_{vgt}$ but also endogenous shares $\hat{s}_{gt}$ and $\hat{s}_{vgt}$ whereas the hat algebra system only has endogenous prices $\hat{P}_{gt}$ and $\hat{p}^*_{vgt}$. While the exact hat algebra change in price indices and prices require knowing the counterfactual change in expenditure shares, the hat algebra (i.e. first order approximation) of changes in price indices and prices only require knowing the initial expenditure shares. Moreover, the presence of specific tariffs add an additional layer of non-linearity to the exact hat algebra system. This can be seen from (A.38)-(A.39) which imply $\hat{p}^*_{vgt}$ enters the right hand side of (A.38) only in the presence of specific tariffs and does so non-linearly.

# E Heteroskedastic elasticity estimator

We begin by double differencing the import demand and export supply share equations – with respect to time and a reference variety $k$. The first difference eliminates time-invariant tastes for varieties and the second difference removes good level price indices. For the import demand curve, we thus have

$$\Delta^k \ln s^*_{vgt} = -\left(\sigma_g - 1\right) \Delta^k \ln p^*_{vgt} - \sigma_g \Delta^k \ln\left(1 + AVE_{vgt}\right) + \varepsilon^k_{vgt} \tag{A.40}$$

where

$$\begin{aligned}
\varepsilon^k_{vgt} &= \left(\varepsilon_{vgt} - \varepsilon_{vgt-1}\right) - \left(\varepsilon_{kgt} - \varepsilon_{kgt-1}\right) \\
&= \left(\left(\sigma_g - 1\right) P_{gt} + \ln b_{vgt} - \left(\sigma_g - 1\right) P_{gt-1} - \ln b_{vgt-1}\right) \\
&\quad - \left(\left(\sigma_g - 1\right) P_{gt} + \ln b_{kgt} - \left(\sigma_g - 1\right) P_{gt-1} - \ln b_{kgt-1}\right) \\
&= \left(\ln b_{vgt} - \ln b_{vgt-1}\right) - \left(\ln b_{kgt} - \ln b_{kgt-1}\right) \\
\varepsilon^k_{vgt} &= \Delta^k \ln b_{vgt}.
\end{aligned} \tag{A.41}$$

For the export supply curve we have

$$\Delta^k \ln p^*_{vgt} = \frac{\omega_g}{1 + \omega_g} \Delta^k \ln s^*_{vgt} + \delta^k_{vgt} \tag{A.42}$$

where

$$\begin{aligned}
\delta^k_{vgt} &= \left(\delta_{vgt} - \delta_{vgt-1}\right) - \left(\delta_{kgt} - \delta_{kgt-1}\right) \\
&= \frac{1}{1 + \omega_g} \left(\omega_g \ln E_{gt} + \eta_{vgt} - \omega_g \ln E_{gt-1} - \eta_{vgt-1}\right) \\
&\quad - \frac{1}{1 + \omega_g} \left(\omega_g \ln E_{gt} + \eta_{kgt} - \omega_g \ln E_{gt-1} - \eta_{kgt-1}\right) \\
&= \left(\ln \eta_{vgt} - \ln \eta_{vgt-1}\right) - \left(\ln \eta_{kgt} - \ln \eta_{kgt-1}\right) \\
\delta^k_{vgt} &= \Delta^k \ln \eta_{vgt}.
\end{aligned} \tag{A.43}$$

This system looks nearly identical to the standard F/BW system. The key differences are that our endogenous variables are measured in tariff-exclusive rather than tariff-inclusive prices and we have the extra AVE term in the demand equation.

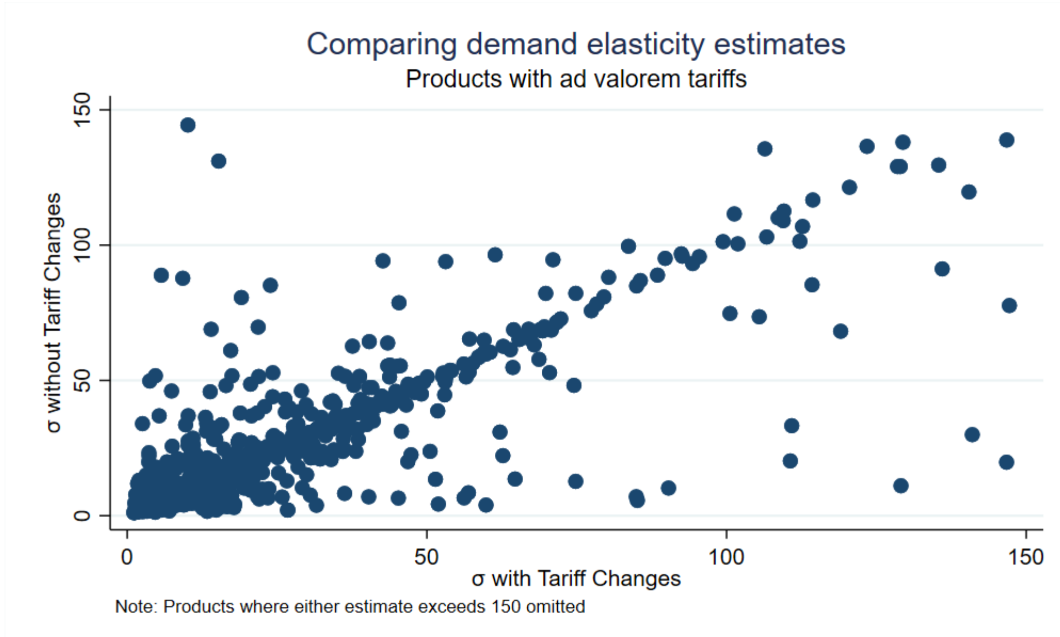
Multiplying (A.40) and (A.42) yields

$$\left(\Delta^k \ln p^*_{vgt}\right)^2 = \theta_{g1}\left(\Delta^k \ln s^*_{vgt}\right)^2 + \theta_{g2}\Delta^k \ln p^*_{vgt}\Delta^k \ln s^*_{vgt} + \theta_{g3}\Delta^k \ln p^*_{vgt}\Delta^k \ln\left(1+AVE_{vgt}\right) + \theta_{g4}\Delta^k \ln s^*_{vgt}\Delta^k \ln\left(1+AVE_{vgt}\right) + \frac{\varepsilon^k_{vgt}\delta^k_{vgt}}{\sigma_g - 1} \tag{A.44}$$

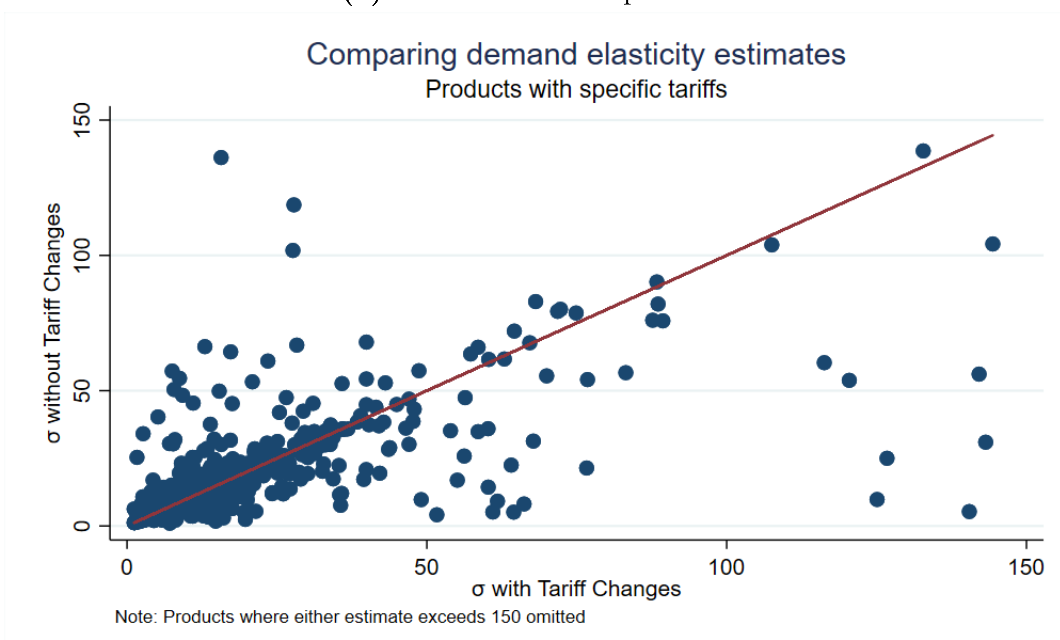
where $\theta_{g1} = \frac{\omega_g}{(1+\omega_g)(\sigma_g-1)}$, $\theta_{g2} = -\frac{\omega_g(2-\sigma_g)+1}{(1+\omega_g)(\sigma_g-1)}$, $\theta_{g3} = \frac{\sigma_g}{\sigma_g-1}$, and $\theta_{g4} = \frac{\sigma_g\omega_g}{(1+\omega_g)(\sigma_g-1)}$. While $\theta_{g1}$ and $\theta_{g2}$ take exactly the same functional form as the standard F/BW setup, we have the additional coefficients $\theta_{g3}$ and $\theta_{g4}$. We solve (A.44) using our full sample from 1972-1988 using non-linear least squares and imposing $\omega_g > 0$ and $\sigma_g > 1$.

Figure A.10 plots our estimate of the standard F/BW elasticities on the $y$-axis – denoted "$\sigma$ without tariff changes" – against the our generalized elasticity estimates – denoted "$\sigma$ with tariff changes". Both sets of elasticities are obtained from estimating (A.44) but the standard F/BW estimates impose $\theta_{g3} = \theta_{g4} = 0$ while our generalized elasticity estimates do not impose $\theta_{g3} = \theta_{g4} = 0$.

Overall, Figure A.10 illustrates a modest empirical bias when ignoring specific and ad valorem tariffs in estimating the structural elasticity $\sigma_g$. The clustering along the 45-degree line illustrates the clear majority of products have very similar elasticity estimates regardless of whether one imposes $\theta_{g3} = \theta_{g4} = 0$. However, the bias is non-trivial for a considerable number of products, with a larger bias among varieties facing specific tariffs. Specifically, the respective mean absolute difference for the two elasticities is 16.6% and 10.9% for the respective sub-samples of products that only have ad valorem tariffs and have specific tariffs. The larger bias for specific tariff products is expected, as variation in the foreign price across varieties is enough to ensure $\Delta^k \ln\left(1+AVE_{jt}\right)$ is non-zero. Nevertheless, the bias for products facing only ad valorem tariffs suggests a role for preferential tariff margins across exporters that vary over time at the tariff-line level – e.g., for reasons related to the Generalized System of Preferences.




**(a)** Ad valorem tariff products




**(b)** Specific tariff products

**Figure A.10:** Comparing demand Elasticity estimates

Notes: Figure plots estimates of $\sigma$ estimated using equations (A.44) when imposing $\ln(1 + AVE_{jt}) = 0$ ($y$-axis) and when using $\ln(1 + AVE_{jt})$ from the data ($x$-axis). Products where either elasticity estimate exceeds 150 excluded from figure.