Tariffs and State Capacity: A Specific Example

Erik Madsen
NYU

Martin Rotemberg
NYU

Sharon Traiberman
NYU & NBER

Shizhuo Wang
NYU

March 2025

Abstract

We study how bureaucratic capacity affects the policies of the state, focusing on the emergence of the US tariff code from 1789-1842. We focus on the qualitative form of tariffs: if they are ad valorem or specific. Each type of tariff is associated with challenges. Specific tariffs do not require understanding the prices of imports, but distort consumption when defined on expansive categories. Ad valorem tariffs do not require a detailed customs list, but importers are tempted to cheat on declared prices. We model these trade-offs with an equilibrium theory of costly monitoring, where customs officials pay fixed costs to inspect goods to verify their prices. The model predicts how tariff policy evolves with development. With low state capacity, very few goods were explicitly enumerated, and ad valorem tariffs covered most imports. Over time, as the customs office professionalized, the tariff code became more disaggregated and specific. Consistent with the model, goods with specific tariffs were those with less price variation and where the tariff burden was lower. The theory also predicts patterns of modern tariff policies across countries.

Please contact emadsen@nyu.edu, mrotemberg@nyu.edu, sharon.traiberman@nyu.edu, and shizhuo.wang@nyu.edu with any questions or comments. We are particularly grateful to Jacob Carrasco, Xianru Han, Katie McDonald, Stuti Saria, and Marios Tsoukis for excellent research assistance. We are grateful to Miguel Acosta, Lydia Cox, Andrew Greenland, John Lopresti, and Christopher Meissner for helpful comments. This material is based upon work supported by NSF grant #2314696. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

1 Introduction

The existence of a state requires sources of revenue, often tariffs. As it collects revenue and gains experience, the state builds the capacity to provide public goods and generate funds more effectively (Levi, 1988). In this paper, we explore how the structure of revenue generation evolves alongside its capacity, focusing on tariff policy in the early United States (1789-1842).

During our primary sample period, customs accounted for around 90% of total government revenue (Reamer, 2016; Irwin, 2017). Due to the relative ease of observing goods entering at ports, tariffs remain a relatively important source of revenue for modern developing countries (Bown and Irwin, 2019; Chalendard et al., 2023). However, even after deciding to tax imports, and broadly deciding if the tariff will be high or low, the state still has several decisions to make. First, the state has to decide the disaggregation of the tariff code. Second, the state has to decide the form of each good's tariff. Broadly, tariffs can take one of two types: ad valorem (charged as a percent of value) or specific (charged as a function of quantities).[1] We show that over the first fifty years of the Republic, the tariff code (a) became more complicated (there were more distinct tariff rates) and (b) evolved towards specific tariffs. These changes occur in tandem, as specific tariffs are charged on relatively narrow categories. We develop a theory to explain the underlying forces behind these changes.

Our theory highlights a fundamental tension: while each shipment has a theoretically optimal tariff that the government would like to impose, these tariffs require enforcement. To avoid paying the correct duties, importers may try to mislead customs officials (Koh, 2020; Rodrigue, 2024). Our model starts from the premise that each type of tariff presents its own challenges and advantages in addressing tariff avoidance.

Ad valorem tariffs are susceptible to misvaluation, as it requires costly effort for custom's officials to verify and enforce the correct import price (Bhagwati, 1964; Mastrorocco and Teso, 2023). Importers are willing to risk punishment in order to potentially pay a lower tariff.

Specific tariffs are generally not as affected by misvaluation, as they charge the same (dollar) rate for all covered shipments, and it is much easier (and more verifiable) to measure physical units. However, when a product category is associated with high levels of price variation, under specific tariffs the cheapest variety will be charged too much and/or the more expensive variety too little (Falvey, 1979). Therefore, specific tariffs are relatively

[1] Formally, some tariffs are a mix of both, or have other features, but we focus on these two categories, which compromise the vast majority of all tariffs.

preferable when shipments covered by a particular tariff line have similar prices.

However, it requires bureaucratic capacity to enforce narrow categories for a tariff leads, as it is easier for importers to misclassify goods when the distinctions are subtle. To give an example, in 1842 nine different types of carpets had their own specific tariff (in addition to a "not-elsewhere-classified" carpet with an ad valorem tariff), including ingrain carpets at 30 cents per square yard and treble ingrain carpets at 65 cents. Enforcing those different tariffs requires investing in customs officials with carpeting expertise.[2]

We argue a key force for trade policy is that capacity allows the state to have a more dissaggregated tariff code, which in turn pushes for specific tariffs. As a result, contrary to conventional wisdom (Pahre, 2007), specific tariffs became a larger share of the tariff code as the government matured.

We use the model to guide a description of tariffs for the Early Republic. Indeed, a primary contribution of our research is creating a panel of tariffs from the era.[3] This required intensive human effort, as we created the panel by manually reading the tariff bills. Product codes or classifications did not exist at the time, nor were imports systematically reported by good.[4]

To analyze the data, we use the following nomenclature. *Labels* are what are written in the tariff bills themselves. Each label covers potentially many *goods*, which we consider as objects that have a unique path of tariffs in our setting. Each good contains many latent *varieties*, each of which has its own price. A key force for trade policy is that each good is associated with different price dispersion across its varieties.[5]

Our model does well at predicting patterns in the data. First, as state capacity grew over time, the tariffs themselves became more targeted. The first tariff bills covered had 105 labels, 12 of which were different kinds of tea.[6] By 1842, 1,291 different goods had been enumerated.

[2]Misclassification is not only a historical issue (Fisman and Wei, 2004). Recent examples of misclassification include Ford misclassifying cargo vans by installing "sham rear seats and other temporary features to make the vans appear to be passenger vehicles," and Johnson and Johnson declaring shower gels as soap substitutes (Shepardson, 2024; Aris, 2000).

[3]This complements recent efforts by Acosta and Cox (2024), Greenland and Lopresti (2024), and Klein and Meissner (2025) compiling later tariff rates.

[4]There were no import-by-good statistics published until the 1820s, and the coverage is fairly aggregated until the 1840s.

[5]A potentially confusing feature of the English language is that the word "specific" both means a particular kind of tariff, and a level of disaggregation. In this paper, we only use the word specific to mean the type of tariff.

[6]The tariff for a given shipment of tea was both determined by the type of tea and its source: each type of tea we consider there to be three "goods" - (1) imported from China or India on American-owned ships, (2) imported from Europe on American-owned ships, or (3) either from a different place or on a non-American-owned ship.

Second, for every good in each bill, we measure how many other goods share the same label. As in the model, disaggregation predicts specificity. For instance, goods are ten times more likely to switch to specific tariffs when they get their own unique label for the first time.

Third, we show that the model captures the aftermath of a large customs house reform of 1818. Due to widespread concerns that importers were being charged too little, Congress invested in tariff collection by hiring professional appraisers, instead of relying on local merchants (Rao, 2016). The subsequent tariff bills increased the number of goods listed by over 25%, and the share covered by specific tariffs almost doubled.

Fourth, we merge our measures of tariffs to the reported imports in the *Commerce and Navigation of the United States* (United States Treasury, 1843). This allows us to estimate ad valorem equivalents for the specific tariffs, as the source reports both quantities and values by good. As noted in a different context by Becker (1968), if the social loss from misvaluation is small, then it is optimal not to have to enforce the rules. Our model also predicts that specific tariffs are preferable for low levels of tariff, as they are easier to enforce, which we also find in the data.

Finally, we find support for a key mechanism of the model, that specific tariffs are most effective when applied to goods with little price variation across varieties. Concording the 19th century tariffs to the Rauch (1999) classification, we show that goods with more homogeneous varieties (because their prices eventually could be described either on commodity markets or in reference journals) were more likely to be covered by specific tariffs during the period.

Our results on differentiated products is potentially surprising, as Javorcik and Narciso (2008) argue that falsifying declared prices is more difficult for homogeneous products, which in turn would mean that they would be more amenable for ad valorem tariffs, not less. The key force in our model which generates this result is that the customs official has to pay fixed costs of starting a court case in order to punish malfeasance. Even if the importer is *obviously* lying, a judge still needs to be involved. As a result, specific tariffs are relatively preferable for homogeneous products as for those goods there is little scope for distorting the relative prices of different varieties.

While the model is motivated by the patterns we find for the eighteenth and nineteenth centuries, its ingredients are not particular to this setting. Specific tariffs remain important in the 2020s: in the OECD, around 15% of goods have specific tariffs, covering around 5% of imports. We show the model's predictions also hold in modern data. Countries with higher bureaucratic customs capacity, measured by the extent of misreporting in Comtrade (Farhad et al., 2024), tend to have (a) more distinct tariff lines, and (b) more specific tariffs.

Specific tariffs are (c) applied to more disaggregated goods, particularly (d) those with more predictable prices and (e) those with lower ad valorem equivalents.

Creating and applying concordances is an inescapable aspect of modern empirical research (Pierce and Schott, 2012; Fort and Klimek, 2018). Because concordances are difficult to do well, misclassification is an important concern (especially as the tariff code complexified).[7] Over the 19th century, the US government created several tables covering the tariffs during our sample period (U.S. Congress, 1832; Walker, 1845; United States Treasury Department, 1888). These government documents highlight the difficulties of keeping track of goods, and for several reasons we cannot use them for our primary analysis. First, the documents have mistakes, where the actual bill imposes one import duty but the later-compiled list records something else. Second, these retrospective documents are often incomplete: they do not report the duty for every enumerated good. The incompleteness is probably due to a mix of error and the fact that it is difficult to list all the goods and labels, since there are many and some are relatively complicated. The heart of our model is that policymakers understood the difficulty of keeping track of, and implementing, a complicated tariff code. Indeed, the authors of the 1888 Treasury report discuss the "great labor in its preparation" in the *Foreign Commerce and Navigation of the United States*, noting themselves that it was "almost" accurate. Indeed, it is difficult even today to know current global tariff rates (Teti, 2024).

We contribute to a literature comparing the returns to setting specific versus ad valorem tariffs, often focusing on the role of competition and price and quality dispersion (Das and Donnenfeld, 1987; Helpman and Krugman, 1989; Krishna, 1990). A growing empirical literature documents the historical prevalence of specific tariffs in the United States (Crucini, 1994; Irwin, 1998; Acosta and Cox, 2024; Greenland, Lake and Lopresti, 2024; Greenland and Lopresti, 2024; Klein and Meissner, 2025). To the best of our knowledge, we are the first to develop an equilibrium model to show how administrative capacity shapes the optimal form of tariff, or to examine the choice of tariff regime in this setting.

Our research also relates to work on administrative capacity. A large literature emphasizes the importance of observability for the state (Scott, 1998; Jensen, 2022; Mastrorocco and Teso, 2023). We take a complementary approach to the literature on state capacity (Besley and Persson, 2009; Aneja and Xu, 2024), studying how the state's constrained ability to observe goods affects choices on the type of tax. This complements Betz (2019), who shows that more bureaucratic capacity is associated with a more complicated tariff code.

[7]Matching physical goods to their tariff classification remains difficult. For instance, the Customs Broker License Examination has a pass rate of around 10-25% (Customs and Protection, 2024).

2 Historical Context

Tariffs were crucial to the survival of the young Republic, and indeed were the focus of the first major legislation passed after the ratification of the Constitution (Hofstadter, Miller and Aaron, 1957).

After the War of 1812, policymakers used tariffs both to raise revenue and to shield key industries from foreign competition. The Tariff of 1816 aimed to protect domestic textile manufacturers in particular (Irwin, 2017). The Tariff of 1824 broadened protection for iron and wool, reflecting mounting pressure from northern producers (Taussig, 1910). Controversy deepened with the Tariff of 1828, (the "Tariff of Abominations") which sparked fierce objections in the South, culminating in the Nullification Crisis (Irwin, 2017). Under President Andrew Jackson, Congress passed the Compromise Tariff of 1833, gradually lowering rates to mitigate sectional tensions while still providing the government with a vital revenue base (Taussig, 1910). The Tariff of 1842 (the "Black Tariff") dramatically increased rates after the economic downturn of the late 1830s, reinstating high duties (Irwin, 2017). Throughout the period, there were many smaller tariff bills as well.

Yet as tariffs evolved to serve both protective and fiscal purposes, administration and enforcement posed ongoing challenges. Policymakers understood that to prevent fraud, tariffs should be "simple in their provisions and easily understood" (Hayes, 1877). Furthermore, policymakers understood that ad valorem rates invited misrepresentation of goods' value (Rao, 2016). To address this risk, in the wake of a scandal reveling the low rate of Custom's collections, in 1818 Congress authorized the hiring of additional, qualified inspectors tasked with verifying import declarations and minimizing revenue losses (Rao, 2016). Echoing Taylor (1849), Secretary of the Treasury Manning argued "it is desirable that in revising and reducing rates of duty they should be made specific instead of ad valorem so far as the nature of the merchandise will admit. Theoretically considered, ad valorem are preferable to specific duties; but in practice, under such rates as we have had and must continue to have for years to come, the former are the too easy source of deception and inequality at the custom-house" (Congressional Record, 1894). While some argued that misvaluation was only relevant for high ad valorem tariffs, 19th century Treasury Department studies found that importers undervalued goods even when faced with low tariffs (Congressional Record, 1894).

The tariff bills themselves contained a variety of provisions for dealing with potential malfeasance. A common clause was what to do when faced with an importer who mixed high and low quality goods, or imported dirty wool. In those cases, the customs official was instructed to charge the higher tariff. Another clause instructed census officials to inspect

"one package at least of every ten."

3 Data

3.1 Historical Data

Our primary source of data comes from the tariff bills themselves. We, with the help of several excellent research assistants, read each bill and manually harmonized each tariff. In order to describe the evolution of the tariff code, we use the following taxonomy.

Labels are what are written in the tariff bills themselves. The connection between labels across time requires careful reading. Consider carpets: at times, the tariff code listed a single category of "carpets," or different tariffs for particular kinds of carpets. These are straightforward to track, as they get progressively more dissagregated, moving along what we would now consider a heirarchy of a classification system. However, in other years the tariff code had different tariffs for manufactures of wool, worsted, cotton, and silk. Different carpets can be made out of different materials, but this is not clear only from the name. For instance Wilton carpets were made out of wool, whereas while Aubusson carpets were typically made out of wool, high end versions were made from silk (Sherrill, 1996). In addition to tariffs on types of goods, there were occasionally also more general tariffs targeting all of the goods that weren't otherwise enumerated in a bill, or on goods with tariffs of a particular current rate.[8]

Matching the labels to each other over time, we define a *good* as the smallest conceptual object that has one unique tariff. For instance, various fermented bottled beverages always have the same tariff, and we consider "ales, beers, porters, ciders in bottles" to be one good. While ingrain carpets and treble ingrain carpets are conceptually similar (and both typically made out of wool), they do not always have the same tariff, and so we consider them as different goods. On the other hand, while "mats of straw and grass" and "milk of roses" (a cosmetic product made from rosewater and almond oil) always had the same tariff, we nevertheless consider them to be separate goods.[9] The match is many-to-many, as within a given bill, most labels correspond to many goods, and over time most goods are associated

[8]The Compromise Tariff of 1833, enacted to resolve the Nullification Crisis, mandated a gradual reduction of tariffs. This was difficult for customs officials to implement for specific tariffs, as they needed to calculate ad valorem equivalents themselves (Taussig, 1910). For our perspective, we are unable to know the exact rates at this time, but for our purposes what is relevant is specificity versus ad valorem, which was preserved.

[9]The nature of what exactly distinguishes goods is a philosophical question (for instance, beers are brewed but ciders are not, so it might be defensible to consider them different goods, and indeed they do not share an HS code in the modern classification.). The set of goods is likely a function of the economic environment (Grant, 2023). We think that a principled approach is to consider goods as distinguished by the nature and by their tariff. For a robustness analysis, we also use as our level of analysis distinct SITC Revision 2 codes.

with several distinct labels.

Each good is comprised of many *varieties*, which are latently different objects that are never disaggregated in the tariff code.[10] We start our analysis after the Constitution, with the first tariff bill in 1789, and end our sample in 1842, as the 1846 Walker Tariff removed all specific tariffs.[11]

Beginning in the early 1820s, import data by good became available in the *Commerce and Navigation of the United States*, published by the U.S. Treasury Department (initially titled the *Annual Report on Commerce and Navigation*). We digitized the 1843 edition, which is the most detailed one for which we have contemporaneous tariff data (though it is still fairly aggregated, only reporting disaggregated tariffs for around half of the goods). In addition to using this resource for checking our work,[12] we also use the resource to calculate ad valorem equivalents for the specific tariffs by dividing the total value imported by the total quantity.[13]

3.2 Modern Data

Our primary source of modern tariff information is the World Trade Organization (WTO)'s Integrated Database (IDB), accessed via Tariff Analysis Online.[14] This database contains applied tariffs reported by each country. We use data from the most recent year available for 139 countries between 2012 and 2023.[15] We focus on most-favored-nation (MFN) applied duties. The tariffs are available at the level of tariff lines, where a tariff line represents a product classified by a system of tariff codes, using the World Customs Organization's Harmonized System (HS).[16] The HS codes are standardized across countries up to six digits. Countries can extend product classifications beyond six digits when defining tariff lines, the first six digits of which are HS codes. The tariff lines are the most detailed product level, typically using eight- to ten-digit codes.

[10]For example, we consider refined sugar a single good. While there are many varieties of refined sugar, during our sample period they always had the same tariff. Note that, after our sample in 1862, the tariff code introduced four different tariffs for refined sugars with different "Dutch Standard" color classifications. Our approach implies that the nature of goods and varieties is time-period specific.

[11]After the civil war, specific tariffs were periodically re-introduced, but by this point the choice of tariff was often driven by philosophical differences between Democrats and Republicans (Irwin, 1998).

[12]In all honestly, there are two tariffs in *Commerce and Navigation* that are listed as having specific tariffs, but we thought had ad valorem. One is "flannels," which we think is a processing error: the actual tariff is specific for flannels *other than those made of cotton*, which was not separately detailed in the imports book. The other is "floor cloths," which did have a specific tariff in 1832, but as far as we can tell got covered by ad valorem tariffs in 1842, though only implicitly through its material.

[13]Quantities were only reported for goods with specific tariffs.

[14]https://tao.wto.org/.

[15]The European Union is a single reporting entity in the database.

[16]The HS has multiple versions. Each country reports its tariff data in a given year using a specific version. We account for this when merging tariff data with other sources.

Our main outcome of interest is whether a tariff is ad valorem or specific. The duty nature in the WTO's database provides this classification by categorizing each tariff line as one of the five types: Ad valorem, Specific, Compound, Mixed, or Other.[17] We define an indicator for non ad valorem tariffs, equal to one if the duty nature of a tariff line is not Ad valorem.

We use the WTO tariff data to construct three country-level measures.[18] First, we calculate the share of tariff lines with a non ad valorem tariff in each country, based on our indicator at the tariff line level. Second, we count the number of distinct tariff rates per country. A tariff rate is considered distinct if it differs from others, regardless of whether it is ad valorem or specific. For example, 4 percent and 10 percent (both ad valorem) and 1.4 cents/kg and 4.4 cents/kg (both specific) represent four distinct tariff rates. Third, we compute the share of HS six-digit codes with variation in tariff duties for each country. If all tariff lines within an HS six-digit category (i.e., tariff lines sharing the same first six digits) have the same tariff rate, then the category has no variation. If at least two distinct tariff rates exist within the category, we classify it as having variation.

For robustness, we also compute the share of products with a non ad valorem tariff weighted by imports in each country. Our data on imports comes from BACI, an international trade database developed by CEPII (Gaulier and Zignago, 2010).[19] BACI provides bilateral trade flows at the six-digit HS level. It builds on data from the United Nations Statistical Division's Comtrade dataset and applies a harmonization procedure that reconciles trade flows to enhance accuracy and consistency.

We examine correlations between our country-level tariff measures and bureaucratic capacity. To measure a country's bureaucratic customs capacity, we use trade misreporting indices derived by Farhad et al. (2019). These indices quantify the extent of trade misreporting by comparing countries' reports to their trading partners. We think that customs houses that are more able to agree with their trading partners are in general more capable. Our main analysis uses the overall trade misreporting index and export misreporting index, as export misreporting is a measure of capacity but does not directly implicate tariff collection. We also include the export under-reporting and over-reporting indices in robustness checks. All indices range from zero to one, where lower values indicate less misreporting. Farhad et al. (2019) provide annual indices for each reporting country from 1996 to 2015. We use the most recent year available for each country in the database as our measure of bureaucratic

[17] About 0.1% of tariff lines fall under Prohibited, Not applicable/not available, or have missing values. We exclude these from our main analysis.

[18] We exclude tariff lines with a zero tariff in our main analysis, and use the full sample including all tariff lines to verify our findings.

[19] https://www.cepii.fr/CEPII/en/bdd_modele/bdd_modele_item.asp?id=37.

customs capacity.

We also use two alternative measures of a government's bureaucratic capacity. The first is GDP per capita in 2023, from the World Bank's World Development Indicators (WDI) database. The second is the Bureaucracy Quality index from the International Country Risk Guide (ICRG), a widely used measure in studies of state capacity (Betz, 2019). This index assesses a country's political stability by capturing the strength and expertise of its bureaucracy to govern effectively without major policy shifts or disruptions in government services (PRS, 2022). Countries with more autonomous bureaucracies, less political pressure, and established recruitment and training mechanisms tend to receive higher scores. The index is available at a monthly frequency. We compute the 2023 average of the monthly values to measure bureaucracy quality for each country.

For our country-level analysis, we estimate the following equation:

$$y_c = \beta\, MRI_c + \epsilon_c, \tag{1}$$

where y_c is one of our tariff measures defined above for country c, such as the share of non ad valorem tariffs. MRI_c represents the trade misreporting index for country c. We replace it with GDP per capita or bureaucracy quality in robustness checks.

We also undertake product-level analysis. To measure disaggregation, we calculate the leave-one-out share of tariff lines with the same duty rate within a product category in each country. We define a category as a group of tariff line codes that share the same first 2, 4, 6, or 8 digits. For each tariff line, we compute the share of other tariff lines within the same 2/4/6/8-digit group that have the same tariff rate. A higher share indicates less disaggregation.

We examine the correlation between specificity and disaggregation by estimating the following equation:

$$y_{ci} = \beta\, NonAV_{ci} + \gamma_c + \eta_h + \epsilon_{ci}. \tag{2}$$

Here, y_{ci} is the leave-one-out share for tariff line i in country c. $NonAV_{ci}$ is the indicator for non ad valorem tariffs. We include country fixed effects, γ_c, and category fixed effects, η_h. Category h corresponds to the same 2/4/6/8-digit grouping applied in the share calculation. We cluster standard errors at the same category level.

Additionally, we control for ad valorem equivalents (which are just the ad valorem duty rates for products with an ad valorem tariff) as a robustness check. We obtain ad valorem equivalents for non ad valorem tariffs from UN Trade and Development's (UNCTAD's) Trade Analysis and Information System (TRAINS), accessed via the World Integrated Trade So-

lution (WITS) database.[20] Data from TRAINS are also available at the most detailed tariff line level for each country. We merge ad valorem equivalents into our primary WTO tariff data using tariff line codes.

We test whether products with low price variation are more likely to have specific tariffs. We use the Rauch (1999) classification to determine whether a product has low or high price variation across varieties. Rauch (1999) categorizes commodities into three groups: goods traded on an organized exchange, reference-priced goods (which are not traded on organized exchanges but have benchmark prices), and differentiated products (which lack both organized exchange pricing and reference prices).[21] We define an indicator for homogeneous products, which likely exhibit low price variation, setting it to one if a product falls into either of the first two categories. This indicator is at the HS six-digit level.[22]

We also examine whether the correlation between homogeneity and specificity is more pronounced for goods with low ad valorem equivalents and for goods within narrowly defined groups. We classify a product as having a low ad valorem equivalent if its value is below 2.5 percent. To capture narrow groups, we define an indicator for whether all products within an HS four-digit category share the same duty rate.

Since our homogeneity measure is at the HS six-digit level, we construct all variables at this level. In particular, we measure specificity as the share of tariff lines with a non ad valorem tariff within an HS six-digit category, compute the average ad valorem equivalent within the category and compare it to the 2.5 percent threshold, and check whether all HS six-digit products within an HS four-digit category have the same duty rate. For robustness, we also construct corresponding measures at the level of tariff lines.

We estimate these two equations to test whether low variation predicts specificity:

$$NonAV_{ch} = \beta\, Homogeneous_h \times LowAVE_{ch} + \beta_1 Homogeneous_h + \beta_2 LowAVE_{ch} + \gamma_c + \epsilon_{ch}. \tag{3}$$

$$NonAV_{ch} = \beta\, Homogeneous_h \times Grouped_{ch} + \beta_1 Homogeneous_h + \beta_2 Grouped_{ch} + \gamma_c + \epsilon_{ch}. \tag{4}$$

Here, $NonAV_{ch}$ is the share of tariff lines with a non ad valorem tariff within HS six-digit category h in country c. $Homogeneous_h$ is an indicator for whether h has low price variation.

[20] https://wits.worldbank.org/.

[21] Rauch (1999) provides two versions of the classification – conservative and liberal – to account for ambiguities in product categorization. The conservative version minimizes the number of products classified as either organized exchange or reference-priced, while the liberal one maximizes them. Our main analysis uses the conservative classifications, and we show robustness using the liberal definitions.

[22] Rauch (1999) classifications are based on SITC Rev. 2 codes. When converting these to the six-digit HS codes in our tariff data, some HS codes correspond to multiple SITC Rev. 2 codes with different Rauch (1999) classifications. In these cases, we classify the product as differentiated but also test robustness by treating them as homogeneous.

$LowAVE_{ch}$ is an indicator equal to one if the ad valorem equivalent for h is smaller than 2.5 percent. $Grouped_{ch}$ is an indicator equal to one if all the products within the HS four-digit category that h belongs to in country c share the same duty rate. γ_c is country fixed effects. We cluster standard errors at the HS six-digit level.

4 Model

A planner in the customs house of a small open economy funds the government solely with tariff revenue. As this is a small open economy, there are no motives for tariffs beyond hitting a revenue target, R. As such, the planner's goal is always to minimize the distortion to the consumer given their revenue target.[23]

4.1 Setup

The government faces an exogenous revenue requirement R, and must collect this amount at the customs house, net of any monitoring costs. We are interested in characterizing tariffs as a function of revenue, and the resulting import price index that consumers face. The planners goal is to minimize the price index, conditional on raising enough revenue. For simplicity, we normalize total expenditure to 1, but note that our results are in *per dollar of expenditure* terms.

The planner has two instruments available to them. First, they may charge a simple specific tariff on the units of a good that enters the port, charging a value for each unit. Second, they may charge a single ad valorem tariff. The latter requires soliciting the value of the merchandise at port. Since importers may lie, the customs house must engage in costly monitoring. We first describe the preferences of consumers and the behavior of importing firms. We then turn to a discussion of each instrument available to the planner, the choice of optimal instrument, and how the planner can construct an optimal tariff schedule—i..e, how the planner ought to create categories of goods.

4.2 Preferences and the Importer's Problem

4.2.1 Preferences

We assume that consumers have nested CES preferences over domestic and imported varieties. We assume that at the outer nest, the elasticity of substitution is 1 (i.e., consumers

[23] In practice, goods do have different tariff rates for different purposes. Our model is similar if for some good the planner has ideosyncratic reasons to prefer high or low tariffs, or indeed to prefer specific or ad valorem.

have Cobb-Douglas preferences over foreign and domestic goods). [24] The elasticity of substitution of the inner nest is $\sigma > 1$.

Since we do not directly consider domestic varieties, we ignore these going forward and focus on foreign varieties. Let E be expenditure on imports and P be the import price index. Under our CES assumptions we have,

$$P = \left(\int_{\omega} p(\omega)^{1-\sigma} d\omega \right)^{\frac{1}{1-\sigma}},$$

where $\omega \in \Omega$ is the measure of goods imported into the country.

4.2.2 Importing Firms

In every period, a good of base price v arrives at the port. The supply of the good is perfectly elastic, with risk-neutral importers. The importers commit to quantities (by loading goods onto a ship) before interacting with customs officials (and, in particular, learning if they will be punished). Because the supply is infinitely elastic, the expected value of bringing a good to the United States must be v. The distribution of these base prices is given by $f(v)$. As in Melitz (2003), we work with the price index integrated over the productivity distribution, v rather than ω:

$$P = \left(\int_{0}^{\infty} p(v)^{1-\sigma} f(v) dv \right)^{\frac{1}{1-\sigma}},$$

where $p(v)$ is the pricing functional net of any tariffs charged by the government. In order to solve for $p(v)$ we further assume that importers try to maximize profits by undervaluing goods, and that they completely pass through the costs of the customs house. Note that this assumption is consistent with perfect competition abroad for each variety.

When orders arrive at the customs house, the importer declares a per-unit-value, v'. Based on their report, there is an expected collection, $E_{\text{tax}}(v', v)$. For example, if the customs house charges a simple specific tariff, t, then $E_{\text{tax}}(v', v) = t \; \forall v, v'$. If the customs house could perfectly assess v, then $E\tau(v', v) = \tau v$. The assumptions above imply that the price charged to consumers will always be

$$v + E_{\text{tax}}(v', v),$$

and they will choose the quantity in advance that would clear the market at this price.

We begin by analyzing how different tariff instruments impact revenue collection for a give tax. We then show how we can solve for the optimal tariffs for a given label, and show

[24] This simplification holds total expenditure on imports fixed as a share of national income. Alternatively, one could condition our model on raising revenue for a given amount of total foreign expenditure, and then adjust by expenditure shifting to domestic consumption.

comparative statics. Finally, we show how the customs house shuold partition goods into different tariff regimes.

4.3 Ad Valorem Tariffs with Inspection

4.3.1 Baseline Inspection Game

Consider an ad valorem tariff rate $\tau > 0$. If an importer is caught cheating, then they pay a penalty equal to $\kappa > 1$. times the amount evaded (as in Yitzhaki 1987). An importer must declare the value $v' \in \mathbb{R}_+$ of their goods. If the inspector does not challenge the declaration, the importer pays a tariff $\tau \cdot v'$ per unit. If the inspector challenges the declaration, the package is inspected and its true value v is assessed. If the importer is found to have underreported, they pay an additional penalty tariff $\kappa \cdot \tau \cdot (v - v')$ per unit. A key assumption is the inspector must pay a cost $c > 0$ per unit of goods inspected, and inspection perfectly reveals the value of the inspected goods. Conceptually, we consider c to include both the cost of expertise, and the cost of verifying for a judge the extent of underreporting. The latter is a fixed cost, motivating our modeling choice. The importer seeks to minimize their expected tariff payments, while the inspector seeks to maximize their expected customs income net of inspection costs.

Suppose that values are distributed according to distribution $F \in \Delta(\mathbb{R}_+)$ with mean μ. (For technical convenience, assume that F is atomless with full support.) First suppose that $\mu \leq c/(\kappa \cdot \tau)$. Then there exists an equilibrium in which all importers declare zero and no inspections take place. This is because inspecting is too expensive relative to the value of the potential fine. This equilibrium yields zero customs profit. We select this equilibrium in that regime, though it is trivial and so for the remainder of this analysis, we assume that $\mu > c/(\kappa \cdot \tau)$.

Following the tariff bill instructions that the collectors must inspect a tenth of packages, we consider an equilibrium in which the inspector inspects each unit of cargo at a fixed rate $\phi \in (0, 1)$ no matter the declared value. For this to be an equilibrium, then the collector must be indifferent between inspecting or not any given package. To see how the equilibrium is sustained, note that, given such an inspection policy, an importer's expected tariff bill from declaring a value $v' \in [0, v]$ is

$$T(v, v') = \tau \cdot \Big(v' + \phi \cdot \kappa \cdot (v - v') \Big).$$

If $\phi = 1/\kappa$, then $T(v, v') = \tau \cdot v$ for all $v' \in [0, v]$, and any reporting strategy is optimal. Assume this inspection rate going forward.

Now suppose that importers use a pure declaration strategy π. In particular,

$$\pi(v) = \begin{cases} v - c/(\kappa \cdot \tau), & v \geq \hat{v} \\ 0, & v < \hat{v} \end{cases}$$

.

The sole equilibrium condition is that the inspector be indifferent over inspection when $v' = 0$ is declared.[25] This condition amounts to

$$\kappa \cdot \tau \cdot \mathbb{E}[v \mid v < \hat{v}] = c.$$

Since F is continuous with full support, the left-hand side of this expression is increasing and continuous in $\hat{v}$. Additionally, it must be less than c when $\hat{v} = c/(\kappa \cdot \tau)$. Since additionally $\mu > c/(\kappa \cdot \tau)$, the left-hand side is greater than c for sufficiently large $\hat{v}$. Hence there exists a unique $v^* \in (c/(\kappa \cdot \tau), \infty)$ satisfying

$$\kappa \cdot \tau \cdot \mathbb{E}[v \mid v < v^*] = c.$$

It follows that the inspection strategy $\phi = 1/\kappa$ coupled with the declaration strategy

$$\pi(v) = \begin{cases} v - c/(\kappa \cdot \tau), & v \geq v^* \\ 0, & v < v^* \end{cases}$$

can be supported as a PBE of the inspection game. We select this equilibrium in our analysis. This equilibrium makes the inspector indifferent between inspecting or not given any declared value. Hence per-unit customs profits are:

$$\begin{aligned} \Pi^C &= \int_{v^*}^{\infty} \tau \cdot \left(v - \frac{c}{\kappa \cdot \tau} \right) dF(v) \\ &= \tau \cdot \left(\mu - \int_0^{v^*} v \, dF(v) \right) - \frac{c}{\kappa} \cdot (1 - F(v^*)) \\ &= \tau \cdot (\mu - \mathbb{E}[v \mid v < v^*] \cdot F(v^*)) - \frac{c}{\kappa} \cdot (1 - F(v^*)) \\ &= \tau \cdot \mu - \frac{c}{\kappa}. \end{aligned}$$

Recall that this equilibrium exists whenever $\mu > c/(\kappa \cdot \tau)$. If this inequality is violated, we have selected an equilibrium with $\Pi^C = 0$. Hence, a general expression for per-unit customs

[25] Declarations in the range $(0, \hat{v})$ are off-path, but $\phi = 1/\kappa$ can be sustained by a belief that $v = v' + c/(\kappa \cdot \tau)$ for such reports.

profits under our equilibrium selection is

$$\Pi^C = \left(\tau \cdot \mu - \frac{c}{\kappa}\right)^+.$$

.

Implications of the Equilibrium When there is undervaluation, it is an *additive* shift in declared prices. This stands in contrast to a standard assumption in the literature on tariff evasion, where the importer evades a *share* of value (Mishra, Subramanian and Topalova, 2008). Following a long tradition of how policy can adapt to behavioral responses (Ramsey, 1927; Mirrlees, 1971; Akerlof, 1978; Björkegren, Blumenstock and Knight, 2024), if the planner understands that the importer can evade a constant share of tariffs, they can then increase the ad valorem rate accordingly so in the end the tariff paid is correct. As a result, we think the models prediction of an additive shift has interesting implications for the type of tariff that will be enacted.

4.3.2 The Tariff Distortion

As in equilibrium importers are exactly indifferent between telling the truth and lying, the price they charge is the same as under perfect monitoring:

$$p = (1+\tau)v.$$

The average per-unit revenue the customs house receives from an importer with value v is,[26]

$$\tau v - c/\kappa.$$

Under CES preferences this leads to the following two equations for the price index faced by consumers, and the revenue collected at the customs house:

$$P = \left(\int_0^\infty ((1+\tau)v)^{1-\sigma} f(v)dv\right)^{1-\sigma}$$
$$R = \int_0^\infty (\tau v - c/\kappa)\frac{((1+\tau)v)^{-\sigma}}{P^{1-\sigma}} f(v)dv.$$

[26]To see this formally,

$$r(v) = \tau v' + \phi(\kappa\tau(v'-v) - c) = \tau v - c/\kappa,$$

where we use that $\phi = 1/\kappa$.

In Appendix A.1 we simplify the revenue expression to

$$R = \frac{\tau}{1+\tau} - \frac{\frac{c}{\kappa u}}{1+\tau},$$

where u is the pre-tariff unit value of goods in the bundle. This object is invariant to the level of the tariff. The presence of u reflects the fact that the total amount of gross receipts paid out to monitoring costs is decreasing in u—goods that are, on average, more expensive, return the same amount of tariff revenue but require fewer physical inspections.

We can invert the expression to write down the tariff required for a collection of revenue as

$$\tau = \frac{R + \frac{c}{\kappa u}}{1-R}.$$

Consequently this yields an expression for the price index as a function of desired revenue:

$$P = \begin{cases} P_0 & \text{if } R = 0 \\ \frac{1+\frac{c}{\kappa u}}{1-R} P_0 & \text{if } R > 0. \end{cases}$$

This function is discontinuous at 0. Whenever $R > 0$,

$$\frac{dP}{dR} = \frac{P}{1-R} = \frac{P}{1-R-\sigma(R-R)}. \tag{5}$$

Note that Equation (5) is identical even if $c = 0$, so the growth in the price index as a function of revenue is independent of monitoring, other than at $R = 0$. Adding $\sigma(R-R)$ to the denominator will be useful for comparing ad valorem to specific tariffs.

4.4 Specific Tariffs

The customs house also has access to specific tariffs, and it can charge a uniform per-unit tax, t. We assume that counting is easily verifiable, and so for specific tariffs there is no monitoring costs. The two equations that govern the price index and revenues are given by,

$$\begin{aligned} P =& \left(\int_0^\infty (v+t)^{1-\sigma} f(v) dv \right) \\ R =& t \int_0^\infty \frac{(v+t)^{-\sigma}}{P^{1-\sigma}} f(v) dv, \end{aligned}$$

where the second line multiplies t by the total quantity of units arriving at port. Using the implicit function theorem,

$$\frac{dP}{dR} = \frac{P}{1 - \sigma W(R) + (\sigma - 1)R},$$

where $W(R)$ is the quantity-weighted ad valorem equivalent, or QWAVE, across goods:

$$W(R) = \int_0^\infty \frac{(v+t)^{-\sigma}}{\int_0^\infty (v+t)^{-\sigma}} \times \frac{t}{v+t} f(v) dv,$$

which is implicitly a function in R through t.

Rearranging slightly,

$$\frac{dP}{dR} = \frac{P}{(1-R) - \sigma(W(R) - R)}. \tag{6}$$

Comparing Equations (5) and (6) shows that the growth in the price index as a function of revenue will be faster for specific tariffs if $W(R) > R$. In Appendix A.1, we show that $W(R) > R$ everywhere (other than $R = 0$). The intuition is straightforward. $W(R)$ is a quantity-weighted ad valorem equivalent tariff. R can be rewritten as the expenditure weighted ad valorem equivalent tariff. By definition, cheaper goods have (a) relatively high ad valorem equivalent tariffs and (b) relatively high quantities, given their expenditure. This introduces a higher correlation between the weights and the values for the quantity weighted average relative to the expenditure weighted average, and so $W(R) > R$. As a result, any given positive revenue, the price index grows faster under specific tariffs. Furthermore, the gap between $W(R) > R$ is increasing in R around 0.

It is also the case that $W(R)$ is increasing in the variance of $f(v)$ (holding fixed its mean). The reason is that the quantity weights,

$$\frac{(v+t)^{-\sigma}}{\int_0^\infty (u+t)^{-\sigma} f(u), du}, \tag{7}$$

are a decreasing function of v. Since the ad valorem equivalent, $g(v) = \frac{t}{v+t}$, is also decreasing and convex, a mean-preserving spread in $f(v)$ increases the relative probability weight on lower values of v, where $g(v)$ is higher. By Jensen's inequality and the definition of second-order stochastic dominance, the quantity-weighted measure, $W(R)$ must increase.

4.5 Optimal Tariff Regimes

4.5.1 Single Good

For a single good, when R is small, it is clear that the planner will initially choose a specific tariff. This is because there is a discontinuity at 0 in the ad valorem regime. The customs house needs to cover the cost of inspection before revenue is returned to the government. On the other hand, it is easy to see that at $R = 0$, the first derivative with respect to R in the specific regime is finite.

Figure 1 plots an example situation. As a benchmark, we also plot the price index if the customs house had access to the first-best ad valorem tariffs. As in the model, small specific tariffs are not very much more distortionary than ad valorem, but grow at a much faster rate; ad valorem tariffs with monitoring grow at the same rate as the optimal ad valorem tariffs, but start with an initial shift up of the price index to raise any positive revenue.

In the figure, for low revenue targets specific tariffs distort less, and for large tariffs ad valorem tariffs distort less. However, this turns out to not be a general feature. This is because as $R \to 1$, the QWAVE function approaches R: for high enough t, the underlying v do not matter much for the prices paid by consumers, and so quantity shares and expenditure shares get close. As a result, eventually the growth rates of specific and ad valorem tariffs become arbitrarily close together. If c/κ is very large, then this convergence can occur quickly enough that the specific tariff is never worse than the initial jump in the price index induced by monitoring costs. In Appendix A.1, we formalize this intuition. We show that if c is not too large, then there is a single crossing point, $\bar{R}$, where price indices are equalized. In particular, the crossing point occurs at the specific tariff given by

$$\frac{\int_0^\infty v(v+t)^{-\sigma} f(v) dv}{\left(\int_0^\infty (v+t)^{1-\sigma} f(v) dv\right)^{\frac{\sigma}{\sigma-1}}} = (1+\tilde{c}) P_0.$$

If there is a crossing point, then there is only one—this follows from the fact that the specific price index grows more quickly than the ad valorem price index.

This leads to a particularly simple, and as we shall see useful, characterization of how the price index changes as revenue needs change. In particular, we have, with a slight abuse of notation, that

$$\frac{d \log P}{dR} = \frac{1}{1 - W(R) + (\sigma - 1)R}, \tag{8}$$

with

$$W(R) = \begin{cases} QWAVE(R) & \text{if } R < \bar{R} \\ R & \text{if } R > \bar{R}. \end{cases} \tag{9}$$

We call this function the WAVE function, as both net revenue in both cases can be written as a kind of weighted ad valorem equivalent tariff.

Figure 2 plots the WAVE function for the above example. The QWAVE function is concave. At the point where the customs house switches to ad valorem with monitoring there is a discrete jump down—this occurs because at the kink in the optimal price index, the ad valorem price index is growing slower than the specific price index. After the jump, the WAVE is the 45-degree line.

4.5.2 Multiple, Fixed, Categories

Suppose that the in addition to charging an ad valorem or specific tariff, the customs house can now split up goods on a *known* dimension. That is to say, there is now a tariff schedule, and the customs house can use a different instrument in each categorized good.

The planner's problem is now to solve,

$$\begin{aligned} \min_{\{R_j\}} \quad & \left(P_j^{1-\sigma}\right)^{\frac{1}{1-\sigma}} \\ \text{subj. to} \quad & \sum_j E_j R_j \geq R, \end{aligned}$$

where P_j is the CES price index of basket j, E_j is the expenditure on that basket, and R_j is the *net* revenue per expenditure from basket j.

In Appendix A.1 we prove the following:

Proposition 1. *The optimal split of instruments across baskets equalizes the WAVE function across baskets. In particular,*

$$W_j(R_j) \equiv W \forall j.$$

Moreover, the derivative of the overall price index with respect to revenue is given by,

$$\frac{d \log P}{dR} = \frac{1}{1 - \sigma W + (\sigma - 1)R}.$$

To visualize the solution, Figure 3 plots two WAVE functions. The optimal solution is to find a single horizontal line such that the total net revenue generated across baskets sums to the revenue target, as this equalizes the price index distortion across the two baskets.

The main result is robust to changes in the instruments available to the planner. Indeed, for a quite general class of instruments, which can be indexed by a single variable for each basket, the planner will equate a certain kind of WAVE function. However, the result hinges on the elasticity of substitution between varieties within and across nests being identical.

Without this assumption, the result would break.

This result is particularly useful for characterizing ad valorem tariffs in our setting. In particular, since for any ad valorem tariff, $W(R) = R$, we have that the *net revenue* in all baskets that use ad valorem tariffs is equalized. This leads to the following corollary,

Corollary. *For any basket that uses ad valorem tariffs, $R_j = W$ and*

$$\tau_j = \frac{W + \frac{c}{\kappa u_j}}{1 - W},$$

where u_j is the unit cost in basket j. Hence, tariffs are ranked by their inverse unit value.

4.5.3 Optimal Categorization

Suppose that the price index can be written as

$$P = \left(\int_0^1 \left[\int_0^\infty p(v)^{1-\sigma} f(v,\theta) dv \right] g(\theta) d\theta \right)^{\frac{1}{1-\sigma}},$$

where θ is some index that the planner can control. That is to say, $f(v,\theta)$ is a sequence of PDF's indexed by θ on the line $[0,1]$. One can think of θ as an observable characteristic of a good that is horizontally differentiated. For example, one can observe for free whether apparel entering the port are pants or shirts.

We constrain the planner to group goods by cuts in θ-space, and the ordering of goods is exogenously given. For example, the planner can distinguish bottoms and tops, but cannot group together pants with sweaters, and shirts with leggings.

We focus on a single cut point, $\bar{\theta}$. Depending on the instruments chosen, revenue can always be written as,

$$R = \frac{\int_0^{\bar{\theta}} \left[\int_0^\infty (g_1(v,\tau_1) - \bar{c}_1) p_1(v)^{-\sigma} f(v,\theta) dv \right] g(\theta) d\theta + \int_{\bar{\theta}}^1 \left[\int_0^\infty (g_2(v,\tau_1) - \bar{c}_2) p_2(v)^{-\sigma} f(v,\theta) dv \right] g(\theta) d\theta}{P^{1-\sigma}},$$

for some function g and some cost c. In the specific case, $g = \tau$ and $\bar{c} = 0$, in the ad valorem case $g = \tau v$ and $\bar{c} = c/\kappa$. In both cases, $p_j(v) = v + g_j(v,\tau_j)$. We call the first function $N(\tau_1, \tau_2, \bar{\theta})$ and write down the planner's problem:

$$\min_{\tau_1,\tau_2,\bar{\theta}} \; P$$
$$\text{subj. to} \frac{N(\tau_1,\tau_2,\bar{\theta})}{P^{1-\sigma}} \geq R.$$

We can exploit previous results on the value of the Lagrange multiplier at the optimum to solve for $\bar{\theta}$. Specifically, in Appendix A.1 we show,

$$\frac{\sigma}{\sigma-1} \times (1-W) = \frac{\int_0^\infty [(v+\bar{c}_1)p_1(v)^{-\sigma} - (v+\bar{c}_2)p_2(v)^{-\sigma}]f(v,\bar{\theta})dv}{\int_0^\infty [p_1(v)^{1-\sigma} - p_2(v)^{1-\sigma}]f(v,\bar{\theta})dv}, \tag{10}$$

where W is the value of the WAVE at the optimum.

As a special case, suppose that rather than cut along some horizontal dimension, the planner can cut a single distribution f in the vertical dimension (for example, cheap and nice rugs). Our analysis extends to this case and we have,

$$\frac{\sigma}{\sigma-1} \times (1-W) = \frac{(\bar{v}+\bar{c}_1)p_1(\bar{v})^{-\sigma} - (\bar{v}+\bar{c}_2)p_2(\bar{v})^{-\sigma}}{p_1(\bar{v})^{1-\sigma} - p_2(\bar{v})^{1-\sigma}},$$

where now $\bar{v}$ is the cutoff in the vertical dimension.

Additionally, nothing in the above discussion requires only a single cutpoint. The solution for multiple baskets extends easily to,

$$\frac{\sigma}{\sigma-1} \times (1-W) = \frac{\int_0^\infty [(v+\bar{c}_j)p_j(v)^{-\sigma} - (v+\bar{c}_{j+1})p_{j+1}(v)^{-\sigma}]f(v,\bar{\theta}_j)dv}{\int_0^\infty [p_j(v)^{1-\sigma} - p_{j+1}(v)^{1-\sigma}]f(v,\bar{\theta}_j)dv},$$

where j indexes baskets, so that $[0,\bar{\theta}_1)$ is the first basket, $[\bar{\theta}_1,\bar{\theta}_2)$ the second, and so forth.

One interesting result is that if the regime is for two ad valorem tariffs, then, since $W = R$, $(1+\tau_j) \propto 1/(1-R)$, and $p_j \propto \tau_j$, the optimal cut is independent of the revenue target.

4.6 Recap of Model Predictions

The model has several predictions we use to describe the evolution of tariffs in the 19th century. The starting assumption is that over time, the planner has access to more cuts of the data. Endogenously, as they cut the data, some of the partitions will have low variance, which will lead to a shift towards specific tariffs. These specific tariffs will be concentrated in relatively homogeneous labels: those that capture few goods, and in which the goods have relatively similar varieties. Furthermore, they will be goods with relatively low tariff burdens, as specific tariffs distort the price index less for low revenue targets.

5 Empirical Results

In this section, we describe the patterns of tariff complexity and form. We start with describing the evolution of the tariff code in the United States, before turning to modern

cross-country evidence.

5.1 The Early Republic

Over time, tariff legislation in the United States became increasingly detailed. Figure 4 shows that the number of distinct tariff labels grew modestly, starting from 105 labels in 1789, and then stabilized through the War of 1812. However, substantial expansions occurred in the 1820s, 1830s, and most notably in 1842, resulting in over 800 distinct labels by the end of the sample period. This expansion underscores how legislators increasingly differentiated among imported goods.

In addition to becoming more numerous, tariff labels also became narrower in their coverage. Figure 5 shows that initially, many labels encompassed numerous goods, and most items fell under broad categories, including a general catch-all tariff. Over subsequent decades, labels became increasingly specialized. By 1841, half of labels applied exclusively to individual goods, illustrating a shift toward highly detailed categorization within tariff legislation.

One way to observe the trend toward narrower disaggregation over time is by considering how extensively goods are grouped under fewer labels. Figure 6 shows that initially, fewer than 15% of goods were covered by labels with under five goods, and only a very small fraction—mostly teas—had labels associated with a single good. Starting in the 1820s, however, this extensive disaggregation increased significantly, in tandem with the general proliferation of labels. By the 1840s, over three-quarters of goods were categorized under relatively disaggregated labels.

Alongside labeling more goods, the tariff code itself became increasingly complex, requiring customs officials to track a growing variety of duties. Figure 7 shows that the number of distinct tariff rates generally increased over time, although it experienced a decline following the Tariff of Abominations (1828), before sharply rising again with the Black Tariff of 1842. By 1842, importers faced around 150 distinct tariff rates.

Having shown the increasing ability of the US Customs House to impose a more detailed tariff, we turn to showing how this affected the types of tariffs charged.

5.1.1 The Spread of Specific Tariffs

The increasing complexity of the tariff code was accompanied by a shift toward specific tariffs. Figure 8 shows that in 1789, approximately one-tenth of goods had specific tariffs, a proportion that increased notably in 1824, coinciding with the hiring of new collectors at major ports (Rao, 2016). A notable pattern is the decline in specific tariffs during the 1830s,

mirroring the reduction in the overall number of tariffs, followed by a sharp rise in 1842, when nearly half of all goods had specific tariffs.

The increase specific tariffs was closely related to narrower groupings of goods. Table 2 shows that, throughout the entire sample, goods labeled individually (singletons) were three times more likely to have specific tariffs compared to those grouped with five or more goods. Labels covering fewer than five goods were also substantially more likely to have specific tariffs. Column 2 weights the data by the inverse number of goods in each SITC2 category to address potential overrepresentation of minor categories. When weighting, singletons were more than ten times more likely to carry specific tariffs, so the results are not driven by our own idiosyncratic definition of a good.

Furthermore, specificity increased when goods were newly disaggregated from broader labels. Table 2 illustrates that goods previously grouped under broader labels were far more likely to switch from ad valorem to specific tariffs upon becoming singletons. Disaggregation into unique labels increased the likelihood of such a switch by a factor of ten, a result which is similar weighting by SITC2 categories.

In addition to specific tariffs disproportionately affecting narrowly classified goods, they also targeted more homogeneous goods. We link the goods to the Rauch (1999) classification, defining goods as homogeneous if they are currently traded on exchanges. While commodity exchanges themselves were limited at the time (Banner, 1998), our view is that these goods likely had less price variation across varieties even in the 18th and 19th centuries. Indeed, homogeneous goods were about twice as likely to have specific tariffs during our sample period.

The model also predicts that goods with low ad valorem equivalents are more likely to have specific tariffs, as the relatively high cost of inspection makes ad valorem tariffs unattractive. We find that small tariffs—those in the 10th percentile or lower of the ad valorem equivalent distribution (approximately 11%)—are around five percentage points more likely to be specific.[27] Homogeneity and low tariffs also interact: the gap is larger for commodities.

5.2 The Modern Era

We now turn to showing that our key empirical patterns also describe the modern pattern of tariffs. While our measure of state capacity in the 19th century is somewhat limited, and so instead we focus on the passage of time, our measures in the modern era are better.

[27]Our data does not report unit values for ad valorem tariffs. However, also consistent with our theory, Acosta and Cox (2024) report that cheaper goods are more likely to have higher ad valorem rates in the modern American tariff code. That said, this is not a strong validation of the theory, as they argue this pattern emerged in the 1940s and is relatively unusual across modern economies.

Currently, greater state capacity is associated with more specific tariffs and a more detailed tariff code. Table 3 shows that countries with less capable customs houses, measured by their level of data agreement with trading partners (Farhad et al., 2024), have fewer distinct tariffs and fewer tariff splits within HS Codes. This broad empirical pattern aligns with qualitative evidence as well. Wiseman (2023) documents that border traders and customs officials in Kenya and Uganda often struggle to apply the correct tariff rates, even though these countries have relatively simple tariff schedules—for example, Uganda uses only six distinct ad valorem rates (covering over 99% of goods) and eleven distinct specific duties.[28] Furthermore, less capable customs houses also use fewer specific tariffs.

As in the historical data, specific tariffs are currently associated with narrower groupings. Table 4 shows that goods without an ad valorem tariff are less likely to share common tariff rates within their HS aggregation class. The effect is large, reducing the share of the same tariff rate by about one-third to one-half of the baseline mean.

Table 5 shows that homogeneous goods are about three times more likely to have a specific tariff, as are goods with small ad valorem equivalents. As in the historical data, these effects interact, with the largest gap observed for homogeneous goods that also face relatively low tariffs.

Figure 9 shows the distribution of tariff rates separately for ad valorem and specific tariffs. Panel A plots the data for OECD countries, while Panel B presents the same distribution for non-OECD countries. Visually, there is a notable missing mass of ad valorem tariffs below approximately five percentage points, while many specific tariffs appear at very low rates. The figure also highlights differences in the structure of tariff schedules across country groups: OECD countries exhibit a smoother distribution of tariff rates, whereas non-OECD countries display more heaping.

6 Discussion

States endogenously respond to their capabilities. We show how this phenomenon generates patterns of tariff setting. In particular, high-capacity customs houses are able to have a more dissagregate tariff code, which in turn is complementary to having specific tariffs, in particular for homogeneous goods and those with low levels of protection. This theory both predicts the historical evolution of American tariffs, as well as the cross country patterns of tariffs today.

Recent technological advancements are increasing the capacity of customs houses around

[28]For comparison, the United States employs 407 distinct ad valorem rates and around 1,100 specific rates. Switzerland's tariff schedule is among the most detailed globally, with over 1,600 distinct specific rates.

the world (Budimirovic et al., 2022; Chowdhary and Vomhof, 2024). In addition to helping improve tariff collection by improving the ability of officials to notice miscalssification and misvaluation, our theory argues that this should lead to policymakers enriching their tariff codes, to fully take advantage of the new tools.

References

Acosta, Miguel, and Lydia Cox. 2024. "The Regressive Nature of the U.S. Tariff Code: Origins and Implications." *Working Paper.*

Akerlof, George A. 1978. "The Economics of "Tagging" as Applied to the Optimal Income Tax, Welfare Programs, and Manpower Planning." *American Economic Review*, 68(1): 8–19.

Aneja, Abhay, and Guo Xu. 2024. "Strengthening State Capacity: Civil Service Reform and Public Sector Performance during the Gilded Age." *American Economic Review*, 114(8): 2352–2387.

Aris, Ben. 2000. "Russia: Come Clean." *Business Russia, Economist Intelligence Unit.*

Banner, Stuart. 1998. "The Origin of the New York Stock Exchange, 1791–1860." *The Journal of Legal Studies*, 27(1): 113–140.

Becker, Gary S. 1968. "Crime and Punishment: An Economic Approach." *Journal of Political Economy*, 76(2): 169–217.

Besley, Timothy, and Torsten Persson. 2009. "The Origins of State Capacity: Property Rights, Taxation, and Politics." *American Economic Review*, 99(4): 1218–1244.

Betz, Timm. 2019. "Tariff evasion and trade policies." *International Studies Quarterly*, 63(2): 380–393.

Bhagwati, Jagdish N. 1964. "On the Underinvoicing of Imports." *Oxford Bulletin of Economics and Statistics*, 26(4): 389–397.

Björkegren, Daniel, Joshua E Blumenstock, and Samsun Knight. 2024. "Manipulation-Robust Prediction."

Bown, Chad P., and Douglas A. Irwin. 2019. "Mainly Poor Countries Use Tariffs as a Major Source of Government Revenue." *https://www.piie.com/research/piie-charts/mainly-poor-countries-use-tariffs-major-source-government-revenue*.

Budimirovic, Milena, Vyara Filipova, Tejo Kusuma, Özlem Soysanli, Kian Cassehgari Posada, Emmanuelle Ganne, and Sheri Rosenow. 2022. *The Role of Advanced Technologies in Cross-Border Trade: A Customs Perspective.* World Customs Organization and World Trade Organization.

Chalendard, Cyril, Ana M. Fernandes, Gael Raballand, and Bob Rijkers. 2023. "Corruption in Customs." *The Quarterly Journal of Economics*, 138(1): 575–636.

Chowdhary, Rajat, and Bastian Vomhof. 2024. "Revolutionising Customs with AI: Dream Big, Start Small." Available from PricewaterhouseCoopers (PwC).

Congressional Record. 1894. "Senate Proceedings."

Crucini, Mario J. 1994. "Sources of Variation in Real Tariff Rates: The United States, 1900-1940." *American Economic Review*, 84(3): 732–743.

Customs, U.S., and Border Protection. 2024. "Customs Brokers." *https://www.cbp.gov/trade/programs-administration/customs-brokers*.

Das, Satya P., and Shabtai Donnenfeld. 1987. "Trade Policy and Its Impact on the Quality of Imports: A Welfare Analysis." *Journal of International Economics*, 23(1–2): 77–95.

Falvey, Rod. 1979. "The Composition of Trade within Import-Restricted Product Categories." *Journal of Political Economy*, 87: 1105–1114.

Farhad, Mohammad, Jakob B. Madsen, Michael Jetter, and Andrew Williams. 2024. "The Mystery of Misreported Trade: A Novel Method to Identify Distorted Trade Figures." *The World Economy*, 47(2): 748–778.

Farhad, Mohammad, Michael Jetter, Abu Siddique, and Andrew Williams. 2019. "Mis-

reported Trade." *Economic Statistics Centre of Excellence (ESCoE) Working Paper.*

Fisman, Raymond, and Shang-Jin Wei. 2004. "Tax Rates and Tax Evasion: Evidence from "Missing Imports" in China." *Journal of Political Economy*, 112(2): 471–496.

Fort, Teresa C., and Shawn D. Klimek. 2018. "The Effects of Industry Classification Changes on US Employment Composition." *Center for Economic Studies Working Paper 18-28.*

Gaulier, Guillaume, and Soledad Zignago. 2010. "BACI: International Trade Database at the Product-Level. The 1994-2007 Version." CEPII Working Papers 2010-23.

Grant, Matthew. 2023. "Where Do the Data Come From? Endogenous Classification in Administrative Data." *Working Paper.*

Greenland, Andrew, and John Lopresti. 2024. "Trade and Structural Change: Focusing on the Specifics." *Working Paper.* Updated June 2024. Previously circulated as "Trade Policy as an Exogenous Shock: Focusing on the Specifics".

Greenland, Andrew, James Lake, and John Lopresti. 2024. "US Inequality in the 1980s: The Tokyo Round Trade Liberalization and the Swiss Formula." *Working Paper.* Revisions Requested: The Review of Economics and Statistics, April 2024.

Hayes, Rutherford B. 1877. "First Annual Message." *Presidential Address.*

Helpman, Elhanan, and Paul R. Krugman. 1989. *Trade Policy and Market Structure.* Cambridge, MA:MIT Press.

Hofstadter, Richard, William Miller, and Daniel Aaron. 1957. *The United States: The History of a Republic.* Englewood Cliffs, NJ:Prentice-Hall.

Irwin, Douglas A. 1998. "Changes in U.S. Tariffs: The Role of Import Prices and Commercial Policies." *The American Economic Review*, 88(4): 1015–1026.

Irwin, Douglas A. 2017. *Clashing over Commerce: A History of US Trade Policy.* Chicago:University of Chicago Press.

Javorcik, Beata S., and Gaia Narciso. 2008. "Differentiated Products and Evasion of Import Tariffs." *Journal of International Economics*, 76(2): 208–222.

Jensen, Anders. 2022. "Employment Structure and the Rise of the Modern Tax System." *American Economic Review*, 112(1): 213–234.

Klein, Alexander, and Christopher M. Meissner. 2025. "Did Tariffs Make American Manufacturing Great? New Evidence from the Gilded Age." *Working Paper.*

Koh, Jonathan. 2020. "Machine Learning Approaches for Fraud Analytics in Customs." *35th UN/CEFACT Forum Webinar: Advancements in AI Towards Facilitating Cross Border Paperless Trade.*

Krishna, Kala. 1990. "Protection and the Product Line: Monopoly and Product Quality." *International Economic Review*, 31(1): 87–102.

Levi, Margaret. 1988. *Of Rule and Revenue. California Series on Social Choice and Political Economy*, University of California Press.

Mastrorocco, Nicola, and Edoardo Teso. 2023. "State Capacity as an Organizational Problem. Evidence from the Growth of the US State Over 100 Years." *Working Paper.*

Melitz, Marc J. 2003. "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity." *Econometrica*, 71(6): 1695–1725.

Mirrlees, James A. 1971. "An Exploration in the Theory of Optimum Income Taxation." *Review of Economic Studies*, 38(2): 175–208.

Mishra, Prachi, Arvind Subramanian, and Petia Topalova. 2008. "Tariffs, Enforcement, and Customs Evasion: Evidence from India." *Journal of Public Economics*, 92(10-11): 1907–1925.

Pahre, Robert. 2007. *Politics and Trade Cooperation in the Nineteenth Century: The 'Agreeable*

Customs' of 1815–1914. Cambridge:Cambridge University Press.

Pierce, Justin R., and Peter K. Schott. 2012. "A Concordance Between Ten-Digit U.S. Harmonized System Codes and SIC/NAICS Product Classes and Industries." *Journal of Economic and Social Measurement*, 37(1-2): 61–96.

PRS. 2022. "The ICRG Methodology." The PRS Group, Inc.

Ramsey, Frank P. 1927. "A Contribution to the Theory of Taxation." *Economic Journal*, 37(145): 47–61.

Rao, Gautham. 2016. *National Duties: Custom Houses and the Making of the American State.* University of Chicago Press.

Rauch, James E. 1999. "Networks versus markets in international trade." *Journal of International Economics*, 48(1): 7–35.

Reamer, Andrew. 2016. "Before the U.S. Tariff Commission: Congressional Efforts to Obtain Statistics and Analysis for Tariff Setting, 1789–1916." In *A Centennial History of the United States.* , ed. Paul R. Bardos, Chapter 2, 33–70. International Trade Commission.

Rodrigue, Jean-Paul. 2024. *The Geography of Transport Systems.* . 6th ed., New York:Routledge.

Scott, James C. 1998. *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed.* New Haven, CT:Yale University Press.

Shepardson, David. 2024. "Ford to Pay $365 Million in US Import Tariff Evasion Case." *Reuters.*

Sherrill, Sarah B. 1996. *Carpets and Rugs of Europe and America.* New York:Abbeville Press.

Taussig, Frank W. 1910. *The Tariff History of the United States.* . 6th ed., New York:G.P. Putnam's Sons.

Taylor, Zachary. 1849. "Annual Message." *Presidential Address.*

Teti, Feodora A. 2024. "Missing Tariffs." Working Paper.

United States Treasury. 1843. *Commerce and Navigation of the United States.* Washington, D.C.:GPO.

United States Treasury Department. 1871. *Annual Report of the Bureau of Statistics on the Commerce and Navigation of the United States ("Foreign Commerce and Navigation of the United States").* Washington, DC:Government Printing Office.

United States Treasury Department. 1888. *The Existing Tariff on Imports into the United States, etc.; Together with Comparative Tables of Present and Past Tariffs, Under the Several Acts from 1789 to 1883, Inclusive.* Washington, DC:Government Printing Office.

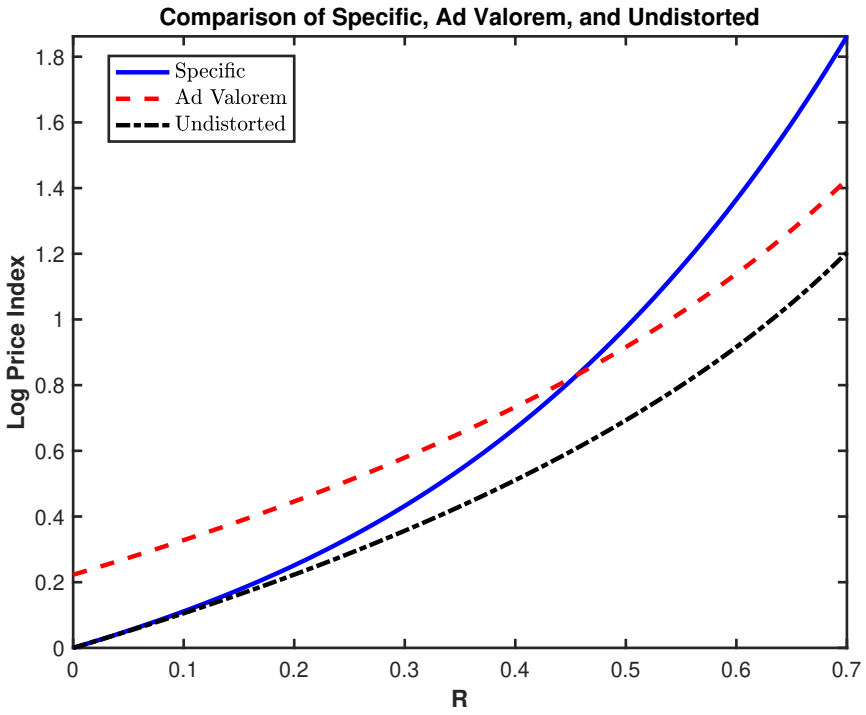
U.S. Congress. 1832. "An Act to Alter and Amend the Several Acts Imposing Duties on Imports." Act of July 14, 1832, ch. 227, 4 Stat. 583.

Walker, R.J. 1845. *Report from the Secretary of the Treasury, on the state of the finances. E. Detailed statement of the several tariffs enacted by Congress, and of the duties prescribed by each.* Washington, DC:John C. Rives.

Wiseman, Eleanor. 2023. "Border Trade and Information Frictions: Evidence from Informal Traders in Kenya." *Working Paper.*

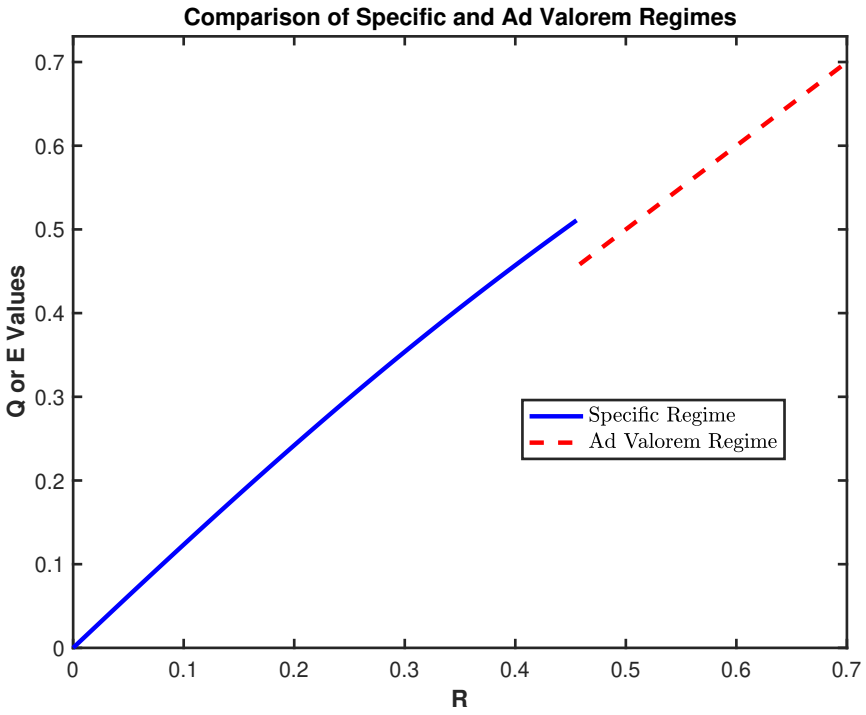
Yitzhaki, Shlomo. 1987. "On the excess burden of tax evasion." *Public Finance Quarterly*, 15(2): 123–137.

Figure 1: Price Indices Under Different Instruments



Notes: This figure plots the Consumer Price Index as a function of the tariff revenue raised, separately for specific tariffs (solid blue line), ad valorem tariffs with monitoring costs (dashed red line), and ad valorem tariffs without monitoring costs (dot dashed black line).

Figure 2: The WAVE Function

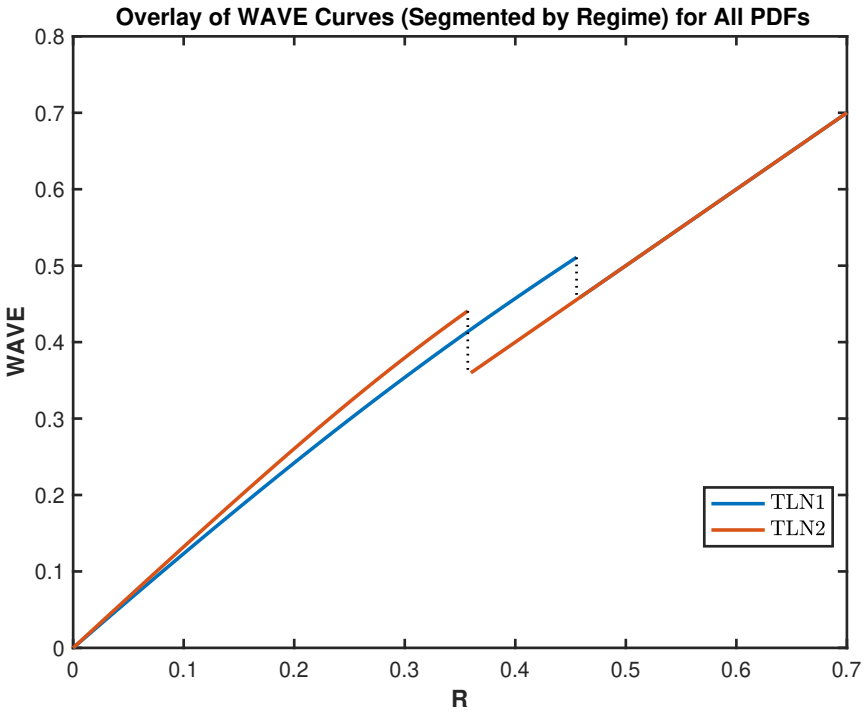


Notes: This figure plots

$$W(R) = \begin{cases} QWAVE(R) & \text{if } R < \bar{R} \\ R & \text{if } R > \bar{R}. \end{cases}$$

for the same parameters as in Figure 1.

Figure 3: Optimal Tariffs on Many Goods

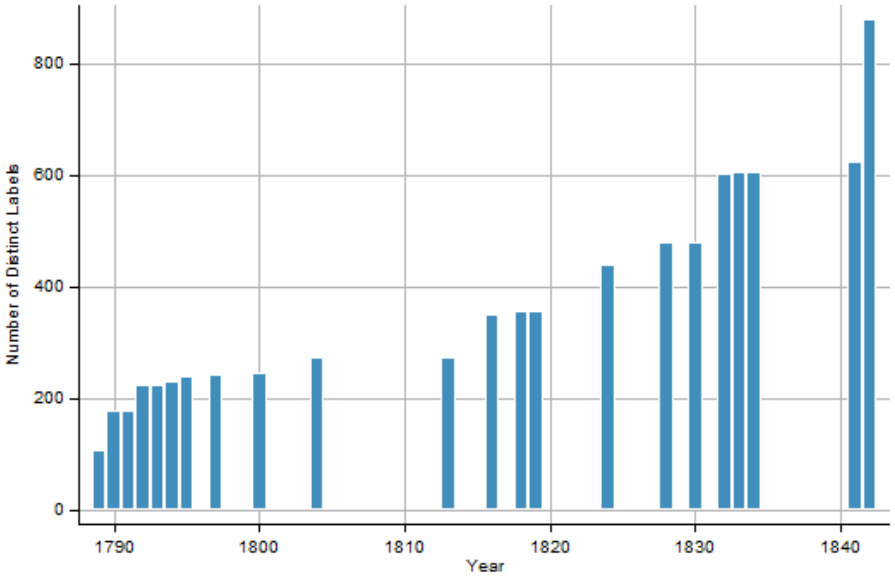


Notes: This figure plots

$$W(R) = \begin{cases} QWAVE(R) & \text{if } R < \bar{R} \\ R & \text{if } R > \bar{R}. \end{cases}$$

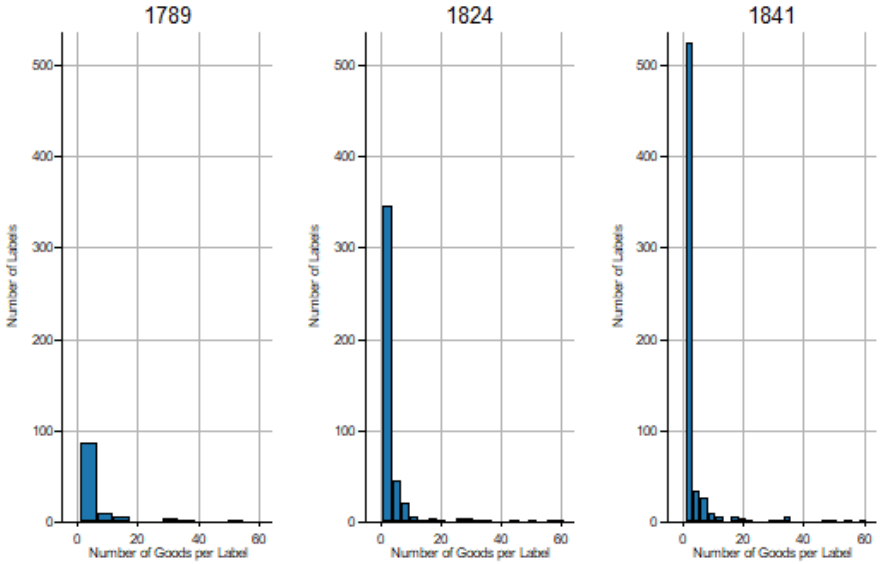
for different parameters.

Figure 4: Number of Distinct Labels Ever Used



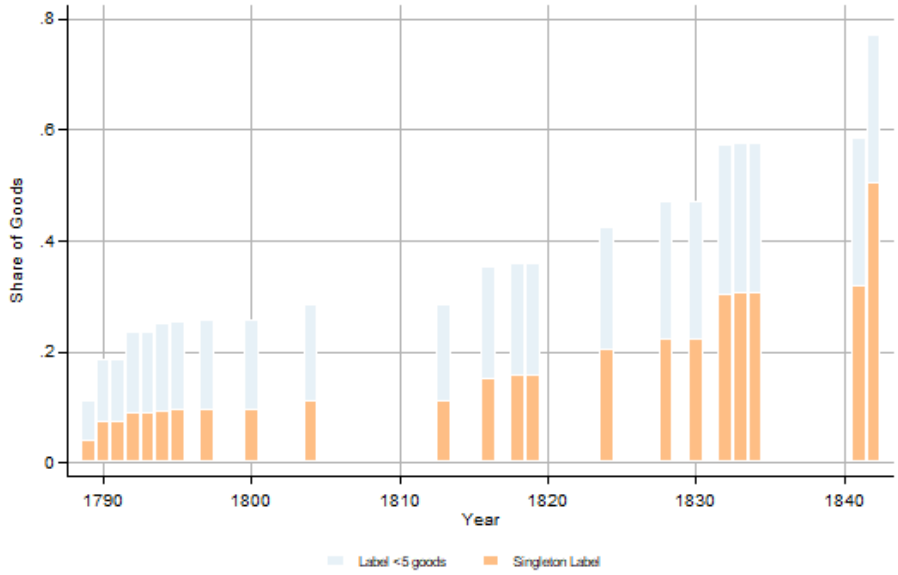
Notes: This figure plots the number of labels ever used in American Tariff Bills. Source: author's calculations from the legislative documents 1789–1842.

Figure 5: Number of Goods per Label



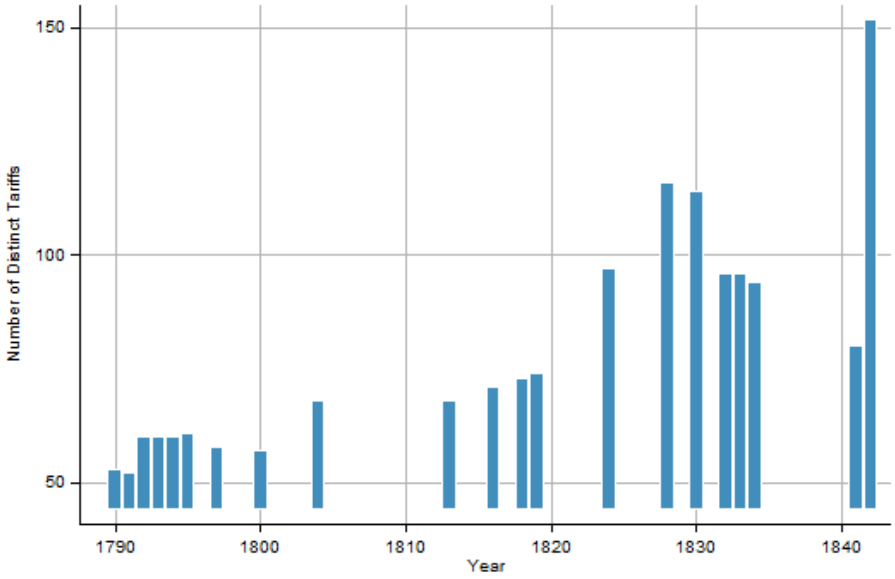
Notes: This figure plots the number of goods per label in the American Tariff Bills. Source: author's calculations from the legislative documents 1789–1842.

Figure 6: Disaggregation to Narrow Groupings



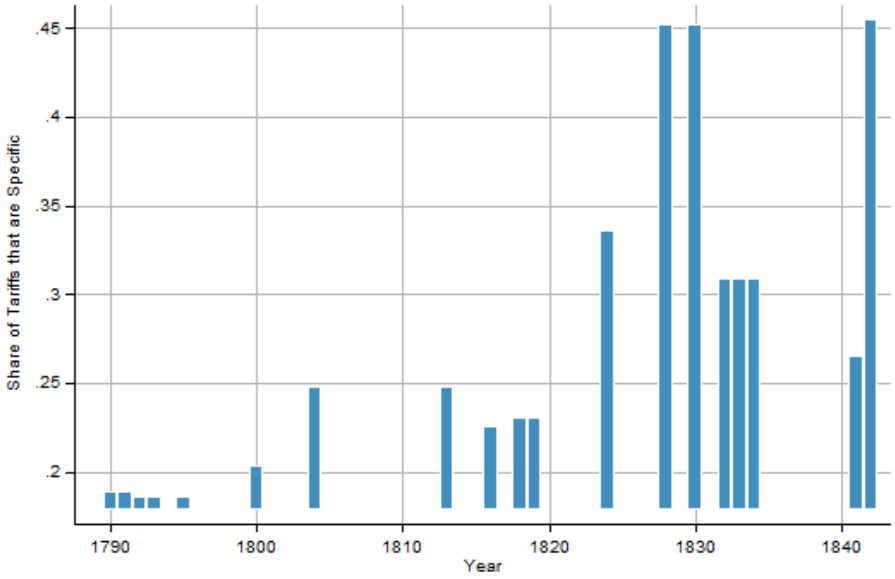
Notes: This figure plots the number of goods per label in the American Tariff Bills, showing the share with under 5 goods or a unique good. Source: author's calculations from the legislative documents 1789–1842.

Figure 7: Number of Distinct Tariff Rates Over Time



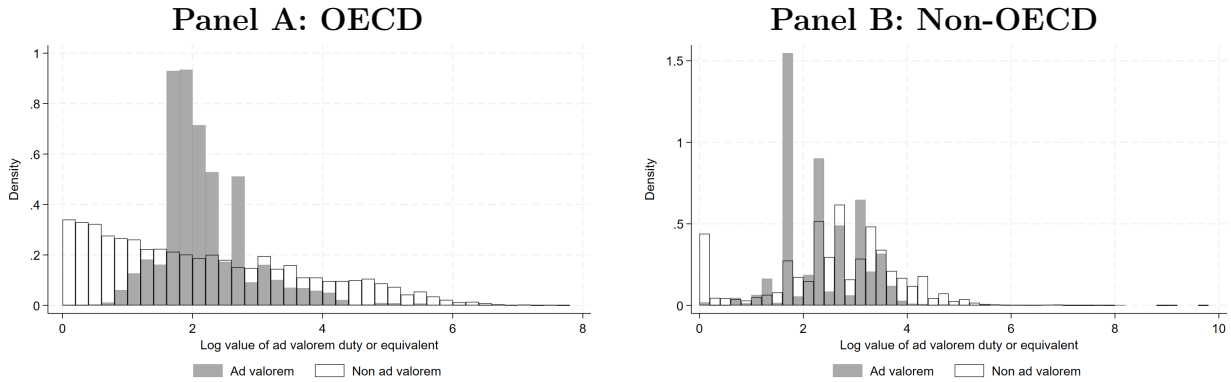
Notes: This figure plots the tariff rates in the American Tariff Bills. Source: author's calculations from the legislative documents 1789–1842.

Figure 8: Share of Specific Tariffs over Time



Notes: This figure plots the share of goods with a specific tariff in the American Tariff Bills. Source: author's calculations from the legislative documents 1789–1842.

Figure 9: Distribution of Tariff Rates by Tariff Type



Notes: This figure reports the density of ad valorem equivalents separately by ad valorem and specific tariffs. Panel A plots the data for OECD countries, and Panel B for non-OECD countries. Data from (Rauch, 1999), the UN, and WTO.

Table 1: Probability of Tariff Types

	Specific	
	Unweighted (1)	Weighted (2)
Singleton	0.58	0.63
≤ 5 and > 1	0.57	0.56
> 5	0.18	0.05
Unconditional	0.28	0.24

Notes: This table shows the share of goods with a specific tariff in the American Tariff Bills, by the number of other goods with the same label. Each observation is a good-by-tariff-year. Source: author's calculations from the legislative documents 1789–1842.

Table 2: Probability of Switching Tariff Types

	Switch to Specific		Switch to Ad Valorem	
	Unweighted (1)	Weighted (2)	Unweighted (3)	Weighted (4)
Disaggregate to Singleton	0.57	0.63	0.21	0.21
Disaggregate to ≤ 5 and > 1	0.39	0.44	0.06	0.06
Disaggregate to > 5	0.19	0.10	0.04	0.01
Unconditional	0.06	0.06	0.04	0.04

Notes: This table shows the share of goods with a specific tariff in the American Tariff Bills, by its level of disaggregation from the previous tariff bill. Each observation is a good-by-tariff-year. Source: author's calculations from the legislative documents 1789–1842.

Table 3: State Capacity and Tariff Codes

	Share of goods with non ad valorem tariffs		Log value of number of distinct tariff rates		Share of HS 6-digit codes with variation in tariffs	
	(1)	(2)	(3)	(4)	(5)	(6)
Overall trade misreporting index	-0.17		-3.18		-0.095	
	(0.061)		(0.73)		(0.047)	
Overall export misreporting index		-0.11		-1.93		-0.057
		(0.036)		(0.46)		(0.028)
Mean Outcome	0.053	0.053	2.95	2.95	0.066	0.066
Number Observations	125	125	125	125	125	125

Notes: This table reports the relationship between trade misreporting (Farhad et al., 2024) and tariff choices. Data from the UN and WTO.

Table 4: Disaggregation and Specificity

	Leave-out share of tariff lines with the same duty rate within a category			
	(1) 8-digit	(2) HS 6-digit	(3) HS 4-digit	(4) HS 2-digit
Indicator for non ad valorem tariffs	-0.240	-0.238	-0.258	-0.294
	(0.020)	(0.011)	(0.015)	(0.021)
Mean Outcome	0.768	0.755	0.809	0.600
Number Observations	69272	372075	792336	815662

Notes: This table reports the relationship between having a non-ad valorem tariff and the disaggregation of tariff rates. Data from the UN and WTO.

Table 5: Homogeneity, Tariff Rates, and Specificity

	Share non ad valorem tariffs			
	(1)	(2)	(3)	(4)
Homogeneous	0.0062		0.0057	0.0047
	(0.001)		(0.001)	(0.001)
Low AVE		0.066	0.065	0.046
		(0.004)	(0.004)	(0.004)
Homogeneous ×				0.036
Low AVE				(0.006)
Mean Outcome	0.021	0.021	0.021	0.021
Number Observations	550546	550546	550546	550546

Notes: This table reports the relationship between product characteristics and tariff type. Data from (Rauch, 1999), the UN, and WTO.

A Appendix

A.1 Algebra Details for Ad Valorem Revenue

$$\begin{aligned} R =& \int_0^\infty (\tau v - c) \frac{((1+\tau)v)^{-\sigma}}{P^{1-\sigma}} f(v) dv \\ =& \frac{\tau (1+\tau)^{-\sigma} P_0^{1-\sigma}}{(1+\tau)^{1-\sigma} P_0^{1-\sigma}} - c \frac{\int_0^\infty ((1+\tau)v)^{-\sigma}}{P^{1-\sigma}} f(v) dv \\ =& \frac{\tau}{1+\tau} - c \left(\frac{\tilde{Q}}{E} \right), \end{aligned}$$

where $\tilde{Q}$ refers to the physical quantity of goods sold (as opposed to the quantity index). This number can be interpreted as the inverse of the *unit value* measured post-tariff. That is to say, it is the inverse of the total expenditure on the good divided by total quantity of the good sold. We may go further however and rewrite this as,

$$R = \frac{\tau}{1+\tau} - \frac{c}{1+\tau} \left(\frac{\tilde{Q}_0}{E_0} \right),$$

This object can be interpreted as the inverse of the weighted harmonic mean of pre-tariff values across goods:

$$\begin{aligned} \frac{\tilde{Q}_0}{E_0} =& \int_0^\infty \frac{v^{-\sigma}}{P_0^{1-\sigma}} f(v) dv \\ =& \int_0^\infty \frac{v^{1-\sigma}}{P_0^{1-\sigma}} \frac{1}{v} f(v) dv \\ =& \int_0^\infty e(v) v^{-1} f(v). \end{aligned}$$

Notice that because τ does not distort relative prices, expenditure shares are independent of the tariff. And so, this object can be interpreted as the inverse expenditure-weighted harmonic mean of pre-tariff unit values. For short, we call this the unit value of the good, as it is indeed the unit value purged of the tariff, $(1+\tau)$.

A.2 Waves

Suppose that the tariff collection scheme is such that $\exists$ a single instrument, t, and a function $g(x,t)$ so that,

$$P = \left(\int_0^\infty (v + g(v,t))^{1-\sigma} f(v) dv \right)^{1-\sigma}.$$

Moreover, assume that this is the per-unit collection of the government so that,

$$R = \frac{\int_0^\infty g(v,t)(v+g(v,t))^{-\sigma} f(v) dv}{P^{1-\sigma}}.$$

We will assume that g is differentiable. However, if g has a cutoff such that $g(v,t) = 0 \forall v \leq \bar{v}(t)$, for some $v(t)$, our results would still hold in a slightly modified form that accounts for the terms coming from the Leibniz rule. Call the integral inside of R, $N(t)$.

We will use the implicit function theorem to derive key properties of P as a function of R. First,

$$\frac{dP}{dR} = \underbrace{P^\sigma \left(\int_0^\infty \frac{\partial g}{\partial t}(v+g(v,t))^{-\sigma} f(v) dv \right)}_{\frac{dP}{dt}} \times \frac{dt}{dR}.$$

Continuing,

$$\begin{aligned} 1 &= \left(\frac{N'(t)}{P^{1-\sigma}} - (1-\sigma)\frac{N(t)}{P^{2-\sigma}}\frac{dP}{dt} \right) \frac{dt}{dR} \\ &= \left(\frac{N'(t)}{P^{1-\sigma}} + (\sigma-1)\frac{R}{P}\frac{dP}{dt} \right) \frac{dt}{dR} \end{aligned}$$

And so,

$$\frac{dt}{dR} = \frac{1}{\frac{N'(t)}{P^{1-\sigma}} + (\sigma-1)\frac{R}{P}\frac{dP}{dt}}.$$

Putting this all together:

$$\begin{aligned} \frac{dP}{dR} &= \frac{\frac{dP}{dt}}{\frac{N'(t)}{P^{1-\sigma}} + (\sigma-1)\frac{R}{P}\frac{dP}{dt}} \\ &= \frac{P}{\frac{N'(t)}{P^{-\sigma}}\frac{dP}{dt} + (\sigma-1)R} \\ &= \frac{P}{\frac{N'(t)}{\int_0^\infty \frac{\partial g}{\partial t}(v+g(v,t))^{-\sigma} f(v) dv} + (\sigma-1)R}. \end{aligned}$$

Now,

$$N'(t) = \int_0^\infty \frac{\partial g}{\partial t}(v+g(v,t))^{-\sigma} f(v) dv - \sigma \int_0^\infty g(v,t)\frac{\partial g}{\partial t}(v+g(v,t))^{-\sigma-1} f(v) dv.$$

Hence,

$$\frac{N'(t)}{\int_0^\infty \frac{\partial g}{\partial t}(v+g(v,t))^{-\sigma} f(v) dv} = 1 - \sigma \int_0^\infty \frac{\frac{\partial g}{\partial t}(v+g(v,t))^{-\sigma}}{\int_0^\infty \frac{\partial g}{\partial t}(v+g(v,t))^{-\sigma} f(v) dv} \frac{g(v,t)}{v+g(v,t)} f(v) dv.$$

The integral in this equation is the weighted average of good-specific ad valorem equivalent tariffs. We call these WAVE functions. The interpretation of the weights depends on the shape of g.

In the case that $g(v,t) = t$, $\frac{\partial g}{\partial t} = 1$. In this case, the weights are quantity weights, so we call this the QWAVE. In all cases, we write $W(R)$, where the dependence on the structure of g is implicit.

Nevertheless, putting together one has,

$$\frac{dP}{dR} = \frac{P}{1 - \sigma W(R) + (\sigma - 1)R}.$$

Rearranging slightly,

$$\frac{dP}{dR} = \frac{1}{1 - R - \sigma(W(R) - R)}.$$

We will assume that $\lim_{R \to 0} W(R) - R = 0$. This holds with specific tariffs for example.

Clearly, properties of $\frac{dP}{dR}$ will depend on the behavior of $W(R)$, which will depend on g. For specific tariffs we have the following important result that we use in the text:

$$\begin{aligned} QWAVE - R =& \frac{t \int_0^\infty (v+t)^{-\sigma-1} f(v) dv}{\int_0^\infty (v+t)^{-\sigma} f(v) dv} - \frac{t \int_0^\infty (v+t)^{-\sigma} f(v) dv}{\int_0^\infty (v+t)^{1-\sigma} f(v) dv} \\ =& t \times \frac{\left(\int_0^\infty (v+t)^{-\sigma-1} f(v) dv\right) \left(\int_0^\infty (v+t)^{1-\sigma} f(v) dv\right) - \left(\int_0^\infty (v+t)^{-\sigma} f(v) dv\right)^2}{\left(\int_0^\infty (v+t)^{-\sigma} f(v) dv\right) \left(\int_0^\infty (v+t)^{1-\sigma} f(v) dv\right)}. \end{aligned}$$

The numerator is strictly positive by the Cauchy-Schwarz inequality applied to $(v+t)^{\frac{-\sigma-1}{2}}$ and $(v+t)^{\frac{1-\sigma}{2}}$.

A.3 Crossing Points

At the crossing point, $R_{Av} = R_S \equiv \bar{R}$ and $P_{Av} = P_S \equiv \bar{P}$. It turns out that the second condition affords a simple expression for τ as a function of t at the crossing point:

$$1 + \tau = \frac{\bar{P}}{P_0},$$

where P_0 is the price index with no tariffs. Defining $\tilde{c} = c/(\kappa u)$ this implies,

$$\bar{R} = \frac{\tau - \tilde{c}}{1 + \tau} = 1 - \frac{(1 + \tilde{c})P_0}{\bar{P}}.$$

From the specific taiff we have,

$$\bar{R} = \frac{t \int_0^\infty (v+t)^{-\sigma} f(v) dv}{\bar{P}^{1-\sigma}}.$$

Combining this, the crossing point happens at the value of t where,

$$\frac{\int_0^\infty v(v+t)^{-\sigma} f(v) dv}{\left(\int_0^\infty (v+t)^{1-\sigma} f(v) dv\right)^{\frac{\sigma}{\sigma-1}}} = (1+\tilde{c}) P_0.$$

To study the asymptotic behavior of the left hand side, factor out t:

$$\frac{\int_0^\infty v(v+t)^{-\sigma} f(v) dv}{\left(\int_0^\infty (v+t)^{1-\sigma} f(v) dv\right)^{\frac{\sigma}{\sigma-1}}} = \frac{\int_0^\infty v(1+v/t)^{-\sigma} f(v) dv}{\left(\int_0^\infty (1+v/t)^{1-\sigma} f(v) dv\right)^{\frac{\sigma}{\sigma-1}}}.$$

To understand asymptotic behavior, we appeal to the dominated convergence theorem for each of the numerator and denominator to place the limit inside of the integral. The terms $(1+v/t)$ go to 1. Hence, the limit reduces to simply $E(v)$. Hence, a crossing point exists so long as,

$$\frac{\int_0^\infty v f(v) dv}{\left(\int_0^\infty v^{1-\sigma} f(v) dv\right)^{1/(1-\sigma)}} > 1 + \tilde{c}.$$

For c/κ sufficiently small, this will hold since the left hand side is always larger than 1 by Jensen's inequality. Recall that $\tilde{c}$ contains the unit value u, which depends on v.

A.4 Optimal Instruments (Fixed Cuts)

We need to solve,

$$\begin{aligned} \min_{\{R_j\}} \quad & \left(P_j^{1-\sigma}\right)^{\frac{1}{1-\sigma}} \\ \text{subj. to} \quad & \sum_j E_j R_j \geq R, \end{aligned}$$

where R_j always refers to net receipts. There are kinks in the function P_j, but we will assume that the solution does not occur at these points. The Lagrangian is given by,

$$\mathcal{L} = \left(P_j^{1-\sigma}\right)^{\frac{1}{1-\sigma}} - \lambda \left(\sum_j E_j R_j - R \right).$$

The first order condition with respect to R_j is given by,

$$\begin{aligned}
\frac{\partial \mathcal{L}}{\partial R_j} : P^\sigma P_j^{-\sigma} \frac{dP_j}{dR_j} =& \lambda \left(E_j + \sum_i R_j \frac{\partial E_i}{\partial P_j} \frac{dP_j}{dR_j} \right) \\
=& \lambda E_j \left(1 + \sum_i R_j \frac{E_i}{E_j} \frac{\partial \log E_i}{\partial \log P_j} \frac{d \log P_j}{dR_j} \right) \\
=& \lambda E_j \left(1 + R_j \frac{\partial \log E_j}{\partial \log P_j} \frac{d \log P_j}{dR_j} + \sum_{i \neq j} R_j \frac{E_i}{E_j} \frac{\partial \log E_i}{\partial \log P_j} \frac{d \log P_j}{dR_j} \right) \\
=& \lambda E_j \left(1 + R_j (1-\sigma) \frac{d \log P_j}{dR_j} - (1-\sigma) \sum_i R_i E_i \frac{d \log P_j}{dR_j} \right) \\
=& \lambda E_j \left(1 + R_j (1-\sigma) \frac{d \log P_j}{dR_j} - (1-\sigma) R \frac{d \log P_j}{dR_j} \right)
\end{aligned}$$

Rearranging,

$$\frac{\partial \log P_j}{\partial R_j} = \frac{\lambda / P}{1 + \frac{\lambda}{P}(\sigma - 1)(R_j - R)}.$$

In all cases, we may write,

$$\frac{d \log P_j}{dR_j} = \frac{1}{1 - \sigma W(R_j) + (\sigma - 1) R_j}.$$

In the case of specific tariffs, this is the WAVE function. In the case of ad valorem with monitoring, W is the identity function so long as R_j is net revenue. Plugging this into the first order condition,

$$\frac{1}{1 - \sigma W(R_j) + (\sigma - 1) R_j} = \frac{\lambda / P}{1 + \frac{\lambda}{P}(\sigma - 1)(R_j - R)}.$$

This implies that $W(R_j) \equiv W$ across all j. In particular,

$$W(R_j) = \frac{1 + (\sigma - 1) R - \frac{P}{\lambda}}{\sigma}.$$

We can rewrite λ in terms of W:

$$\lambda = \frac{P}{1 - \sigma W + (\sigma - 1) R}.$$

This implies that the marginal cost of raising an additional dollar of revenue from many buckets is the same as the marginal cost of raising the revenue from one bucket with a wave

function given by W.

This formula is particularly useful for characterizing optimal policy for ad valorem buckets. In these buckets, $W(R)$ is the identity. Hence, the optimal revenue formula implies that revenues are equalized. Hence,

$$\tau_j = \frac{W + \frac{c/\kappa}{u_j}}{1 - W}.$$

Hence, τ_j will be ranked by u_j: lower unit value goods will have higher tariffs. Intuitively, the planner wishes to distort away from goods with low unit values as these are costly to inspect.

All Ad Valorem If *all* buckets are ad valorem, then one has,

$$\sum E_j W = R \Rightarrow W = R.$$

In this case, *net* revenues are equalized across goods. The tariff is then simply,

$$\tau_j = \frac{R + \frac{c/\kappa}{u_j}}{1 - R}.$$

B Adjusting ad valorem tariffs across categories

Let's suppose we have multiple (exogenous, for now) categories of goods, indexed by $i = 1, ..., N$. If tariffs $\boldsymbol{\tau} = (\tau_1, ..., \tau_N) \gg 0$ are levied on each category, then total revenues are

$$R(\boldsymbol{\tau}) = \sum_{i=1}^{N} \int (\tau_i \cdot p - \bar{c}) Q_i(p, \tau_i)\, dF_i(p),$$

where

$$Q_i(p, \tau_i) = (1 + \tau_i)^{-\sigma} \frac{p^{-\sigma}}{\mathcal{P}(\boldsymbol{\tau})^{1-\sigma}}$$

and

$$\mathcal{P}(\boldsymbol{\tau})^{1-\sigma} = \sum_{i=1}^{N} (1 + \tau_i)^{1-\sigma} \int p^{1-\sigma}\, dF_i(p)$$

and $\bar{c} \equiv c/\kappa$.

Note that R may be equivalently written

$$R(\boldsymbol{\tau}) = 1 - \frac{L(\boldsymbol{\tau})}{\mathcal{P}(\boldsymbol{\tau})^{1-\sigma}},$$

where

$$L(\boldsymbol{\tau}) = \sum_{i=1}^{N} (1+\tau_i)^{-\sigma} \int (p^{1-\sigma} + \bar{c} \cdot p^{-\sigma})\, dF_i(p).$$

We're interested in solving the problem

$$\min_{\boldsymbol{\tau}} \mathcal{P}(\boldsymbol{\tau}) \quad \text{s.t.} \quad R(\boldsymbol{\tau}) \geq \bar{R}.$$

For appropriate choice of Π, the solution to this problem solves the auxiliary problem

$$\min_{\boldsymbol{\tau}} L(\boldsymbol{\tau}) \quad \text{s.t.} \quad \mathcal{P}(\boldsymbol{\tau}) \leq \Pi.$$

When $\sigma > 1$, the equivalent constraint $\mathcal{P}(\boldsymbol{\tau})^{1-\sigma} \geq \Pi^{1-\sigma}$ may be substituted, yielding the Lagrangian

$$\mathscr{L}(\boldsymbol{\tau}; \lambda) = \sum_{i=1}^{N} \mathscr{L}_i(\tau_i; \lambda),$$

where

$$\mathscr{L}_i(\tau_i; \lambda) \equiv \frac{\int (p^{1-\sigma} + \bar{c} \cdot \int p^{-\sigma})\, dF_i(p)}{(1+\tau_i)^{\sigma}} - \lambda \cdot \frac{\int p^{1-\sigma}\, dF_i(p)}{(1+\tau_i)^{\sigma-1}}.$$

These component Lagrangians have derivatives

$$\frac{\partial \mathscr{L}_i}{\partial \tau_i} = (1+\tau_i)^{-\sigma-1} \left((1+\tau_i) \cdot \lambda \cdot (\sigma - 1) \cdot \int p^{1-\sigma}\, dF_i(p) - \sigma \cdot \int (p^{1-\sigma} + \bar{c} \cdot \int p^{-\sigma})\, dF_i(p) \right).$$

They are therefore strictly quasiconvex, with unique minimum

$$\tau_i^*(\lambda) = \left(\lambda^{-1} \cdot \frac{\sigma}{\sigma - 1} \cdot \left(1 + \bar{c} \cdot \frac{\int p^{-\sigma}\, dF_i(p)}{\int p^{1-\sigma}\, dF_i(p)} \right) - 1 \right)_+.$$

In particular, for any value of the Lagrange multiplier, (positive) tariffs are ordered across categories according to $\bar{Q}_i \equiv \mathbb{E}_i p^{-\sigma} / \mathbb{E}_i p^{1-\sigma}$.