From Protection to Retaliation: The Welfare Costs of Tariffs

Cristian Espinosa*

March 27, 2026

This paper shows how endogenous trade policy shapes estimates of trade elasticities and their implied welfare costs. Recent work using US tariffs, particularly those imposed by Trump, finds modest elasticities and correspondingly small welfare losses. I argue that these estimates reflect systematic selection in the goods targeted by trade policy. I develop a two-country political economy model in which governments choose tariffs based on revenue motives and strategic retaliation. Revenue-maximizing governments target sectors with low demand elasticities, while retaliating partners target sectors with high elasticities to maximize economic harm. This selection generates two distinct sources of variation: protectionist and retaliatory tariffs, identifying opposite ends of the elasticity distribution. Using administrative data on Canadian imports and exploiting the 2018 retaliatory tariffs against the United States, I estimate import demand elasticities between 2.5 and 5.2, substantially above conventional estimates based on US protectionist tariffs. The implied welfare costs of recent trade policies are up to twice as large, reaching $22 billion.

Keywords: Trade Policy, Trade Wars, Welfare Costs, Trade Elasticities
JEL Classification: D72, F13, F14, F42, O19

*University of Houston. Email: cespinosad@uh.edu. I am very grateful to Morten Ravn for his guidance and support throughout this project. I would also like to thank Franck Portier, Kei-Mu Yi, José-Víctor Ríos-Rull, Raffaella Giacomini, and Kalina Manova for their valuable discussions and continued support. I am also grateful to seminar participants at various institutions for helpful comments and suggestions. These include the Vigo Workshop on Dynamic Macroeconomics, the MMF Annual Conference, the ENTER Seminar at the University of Mannheim and the Stockholm School of Economics, the RES Easter School at the University of Bristol, the Macroeconomic Workshop at the University of Surrey, and the Southern Economic Association (SEA). All views expressed in this paper are my own.

1 Introduction

Recent estimates of the welfare costs of trade wars rely on tariff-induced variation to identify trade elasticities and typically find modest effects. Studies using US tariffs, particularly those imposed by Trump, report low import demand elasticities and near-zero export supply elasticities, implying limited welfare losses. This paper argues that these estimates are shaped by endogenous policy selection. Tariffs are not assigned randomly across goods but instead target specific sectors based on political and economic incentives. As a result, existing estimates recover only a subset of the elasticity distribution.

I develop a two-country political economy model in which governments choose tariffs based on revenue motives and strategic interaction. A key implication is that trade policy systematically targets goods at the extremes of the demand elasticity distribution. Protectionist tariffs are imposed on goods with low demand elasticities, minimizing deadweight losses while generating revenue and satisfying politically influential industries. In contrast, retaliatory tariffs target goods with high demand elasticities in order to maximize economic harm on the trade partner and induce policy reversal. This selection mechanism implies that protectionist and retaliatory tariffs provide distinct sources of identifying variation, corresponding to the lower and upper bounds of the elasticity distribution.

Building on this framework, I propose a novel identification strategy that exploits retaliatory tariffs to recover the upper bound of import demand elasticities. I exploit administrative data on Canadian imports and the 2018 retaliatory tariffs against the United States to estimate elasticities between 2.5 and 5.2, substantially above conventional estimates based on US protectionist tariffs. These results imply that the welfare costs of recent trade policies are significantly larger than previously thought, potentially doubling existing estimates. The model delivers two distinct sources of identifying variation: protectionist tariffs on goods with low demand elasticities and retaliatory tariffs on goods with high demand elasticities. As a result, estimates based on tariffs recover different points of the elasticity distribution rather than its average. Estimates using US protectionist tariffs yield modest elasticities and low implied welfare costs, whereas retaliatory tariffs point to substantially larger effects. I combine both sources of variation to bound the average demand elasticity. The estimates imply an elasticity range between 2.5 and 5.2, with an export supply elasticity of zero. These results suggest that the welfare costs of recent US tariffs are significantly larger than previously estimated, potentially doubling to around $22 billion.

An export supply elasticity of zero implies complete pass-through of tariffs into duty-inclusive prices, so the welfare cost scales directly with the demand elasticity and is borne entirely by consumers. This finding is consistent with existing evidence based on US trade

policy (e.g., Fajgelbaum et al. (2020)). The upper-bound estimate is also in line with a separate strand of the literature that relies on gravity-based approaches rather than tariff variation, which typically finds larger trade elasticities (see Head and Mayer (2014) for a discussion).

To implement the empirical strategy, I exploit Canada's 2018 retaliation against US tariffs on steel and aluminum. The retaliation targeted both the same sectors affected by US protectionism and a broad set of consumption goods. I interpret within-sector retaliation as capturing protectionist variation, corresponding to goods with low demand elasticities, and cross-sector retaliation as a strategic response targeting goods with higher elasticities. These two components map directly into the lower and upper bounds of the elasticity distribution, respectively, and provide the basis for the identification strategy.

I use Canadian administrative data covering the universe of imports at a monthly frequency from 1988 to 2020. Trade flows are observed at the 10-digit Harmonized System level, providing detailed product-level variation across trading partners. The estimation focuses on the 2018–2019 period, when most tariffs between the United States and Canada were implemented. Identification exploits variation across varieties within product-time cells to estimate import demand elasticities. I instrument duty-inclusive prices to recover the demand elasticity, while the inverse export supply elasticity is identified by instrumenting quantities.

The identification strategy relies on the assumption that tariff rates are exogenous to idiosyncratic demand and productivity shocks at the variety level. World Trade Organization rules require retaliatory tariffs to match the magnitude of tariffs imposed by the trade partner, while allowing discretion over the set of targeted goods. As a result, although US tariffs may respond to domestic conditions, their allocation across goods by Canada is orthogonal to idiosyncratic shocks in the Canadian economy. This provides a source of plausibly exogenous variation for identification. The argument is particularly strong for cross-sector retaliation, which targets industries different from those protected in the United States. After controlling for aggregate conditions, shocks are unlikely to be correlated across these sectors, strengthening the exogeneity of the instrument.

The data reveal several stylized facts that support the mechanism of the model. First, tariffs are countercyclical, increasing during economic downturns, consistent with evidence from the trade policy literature (e.g., Bown and Crowley (2013, 2014)). Second, protectionist tariffs are concentrated in intermediate inputs, particularly in sectors such as metals, which tend to exhibit relatively low demand elasticities (see Ossa (2015)). Third, retaliatory tariff rates closely mirror those imposed by the trade partner, reflecting institutional constraints. Finally, a substantial share of retaliatory tariffs targets consumption goods, which

are typically associated with higher demand elasticities. These patterns are consistent with the model's prediction that protection and retaliation target opposite ends of the elasticity distribution.

The recent US–Canada trade war provides a clear illustration of these mechanisms. The United States imposed tariffs of 25% on steel and 10% on aluminum imports, affecting $12.4 billion of Canadian exports and increasing average tariff rates by 16%.[1] Canada retaliated within a month with tariffs of the same magnitude on $12.7 billion of US exports, maintaining a comparable average tariff level. Approximately $5.5 billion of the retaliatory measures targeted consumption goods, consistent with a shift toward sectors with higher demand elasticities. Political economy considerations also played a central role. In the United States, steel production is concentrated in politically important swing states and has historically been protected due to strong lobbying influence (see, e.g., Waugh (2019)). In response, Canada targeted emblematic US products such as bourbon whiskey, a key industry in Kentucky, a state won by Trump in 2016, and one exposed to foreign competition (see Lake and Nie (2023)). These features closely align with the selection mechanisms highlighted in the model and provide empirical support for the identification strategy.

Related literature

This paper relates to several strands of the literature on trade wars, political economy, and the measurement of trade elasticities. A classic literature studies the incentives for countries with market power to impose tariffs and the welfare consequences of retaliation. Early contributions include Johnson (1953) and Markusen and Wigle (1989). Bagwell and Staiger (1999) shows that a country with sufficient market power may benefit from a tariff through an improvement in its terms of trade, although once retaliation is taken into account all countries are worse off than under free trade. Similarly, Broda et al. (2008) shows that optimal tariffs depend on the extent of foreign export supply responses, so that the gains from taxation are shaped by the inverse price elasticity of supply for exports. These papers highlight why trade elasticities are central for quantifying the welfare effects of trade policy.

A related strand of the literature studies the political economy of tariff formation. In the seminal contribution of Grossman and Helpman (1994), tariffs arise not only from market power considerations but also from domestic political pressures. Organized industries lobby for protection, and governments trade off political contributions against consumer welfare losses. In this environment, optimal tariffs depend on both lobbying strength and the demand elasticity of the protected good, since inelastic demand reduces the welfare cost of protection.

[1] US tariffs on steel and aluminum in 2018 were designed to increase capacity utilization to at least 80%. In 2017, capacity utilization was 72.3% in the steel sector and 39% in the aluminum sector.

Goldberg and Maggi (1999) provides empirical support for these predictions using data on US trade protection. These insights motivate the role of endogenous selection in tariff policy.

A central object in this paper is the trade elasticity. A large literature estimates these elasticities using different sources of variation and different structural environments. Feenstra (1994), building on Krugman (1979, 1980), develops a nested CES framework to identify the elasticity of substitution across imported varieties. Using related approaches, Broda et al. (2008) and Broda and Weinstein (2006) estimate a median elasticity of 3.1 for the United States. Boehm et al. (2023) estimate trade flow elasticities to Most Favored Nation tariffs across time horizons and find an elasticity of 0.76 in the short run and 2 in the long run. In work based on gravity equations, Caliendo and Parro (2014), following Eaton and Kortum (2002), estimate a median elasticity of 4.4 using variation across industries.

More broadly, gravity-based models provide another benchmark for the magnitude of trade elasticities. Building on Anderson (1979) and Anderson and van Wincoop (2003), this literature explains bilateral trade flows as a function of country size and trade costs. Quantitative trade models such as Eaton and Kortum (2002) and Caliendo and Parro (2014) use this structure to evaluate how changes in trade costs affect trade flows across countries and sectors. A common finding in this literature is that trade elasticities are larger than those typically estimated from recent tariff episodes, often lying between 4 and 6, with a median close to 5 according to Head and Mayer (2014).

The paper is most directly related to the recent literature that uses tariff variation from the trade war to identify trade elasticities. Fajgelbaum et al. (2020) use US import data at the HS-10 level and instrument duty-inclusive prices with tariff rates, estimating an import demand elasticity of 2.5 and welfare costs of about $11 billion. Amiti et al. (2019) study the effects of the 2018 US tariffs and estimate an elasticity of 1.3 when regressing import quantities directly on tariffs, close to the OLS estimates reported by Fajgelbaum et al. (2020). A broad set of studies finds that the export supply elasticity is close to zero, implying nearly complete pass-through of tariffs into consumer prices; see Amiti et al. (2019), Fajgelbaum et al. (2020), Flaaen et al. (2020), and Cavallo et al. (2021). These findings suggest relatively modest welfare effects of recent trade policies.

A related literature studies the role of retaliatory tariffs during the recent trade war. Retaliation against the United States often targeted consumption goods, automobiles, and agricultural products. Waugh (2019) shows that Chinese retaliatory tariffs were imposed on highly exposed counties and reduced US export capacity. Using more aggregate data, Amiti et al. (2019) estimate an elasticity of US export quantities with respect to foreign retaliatory tariffs of 1.2, while Fajgelbaum et al. (2020) report a similar estimate of 1.04.

This paper contributes to these literatures by showing that endogenous selection in trade

policy shapes estimates of trade elasticities. Within a structural political economy model of trade wars, protectionist tariffs identify the lower end of the elasticity distribution, while retaliatory tariffs identify the upper end. This provides a novel instrument based on retaliatory tariffs and reconciles the gap between elasticity estimates derived from recent trade-war tariffs and those obtained from gravity-based approaches. As a result, the paper delivers bounds on the average demand elasticity and implies substantially larger welfare costs of recent trade policies.

The rest of the paper is organized as follows. Section 2 presents the data and stylized facts. Section 3 introduces the theoretical model. Section 4 outlines the identification strategy for the empirical estimation. Section 5 discusses the estimation results, followed by the conclusion.

2 Empirical Evidence

This section first describes the administrative records for Canadian imports and explains how the variables are constructed. Then, using this data along with public information on countries' temporary trade barrier policies, I document four stylized facts that motivate certain modeling decisions in the analysis. Finally, I conduct an event study to assess whether Canada's retaliatory tariffs exhibit anticipation effects and to compare the behavior between targeted and untargeted varieties.

2.1 Data

The dataset comprises administrative records from the Canadian International Trade Division, featuring monthly data on Canadian imports at the HS-10 product level from 1988 to 2020. Each observation represents the import of a variety (trade partner-product pair) in a given month and includes the entire universe of Canadian imports from around the world. Data include details on prices, quantities, and import duties collected at the border.

To construct the tariff measure, I calculate the ad valorem rate by dividing the value of duties collected by the quantity. Import duties encompass various types, including ad valorem, specific, antidumping, countervailing, and safeguard duties. The unit value price is derived by dividing the import value by the quantity, while the duty-inclusive price is obtained by summing the import value and duties, and then dividing by quantity. These two prices represent the ex-factory price and the Cost, Insurance, and Freight (CIF) price of imports, respectively. A sector is defined at the four-digit level of the North American Industry Classification System (NAICS-4) that comprises approximately 317 sectors, allowing

a granular level of variation to be analyzed.

The strength of this database lies in its detailed reporting on imported products at the HS-10 level, the most granular tariff line, enabling precise analysis of price and quantity responses to tariffs. Unlike databases such as TRAINS and UN Comtrade, which provide data at the HS-6 level, this database offers significantly greater granularity. It closely aligns with the US counterpart (USA Trade Online), commonly used in studies on the impact of the US trade war. For estimation purposes, I will use data from 2018 to 2019, a period that captures Canada's retaliation against US tariffs on steel and aluminum. The following sections present key stylized facts using historical Canadian data and an event study that previews potential pre-trends between goods chosen for treatment and those not.

2.2 Stylized Facts

This section addresses four empirical findings in the literature: (i) tariffs exhibit a countercyclical profile, (ii) they are predominantly imposed on intermediate inputs, (iii) retaliatory tariff rates match the ones imposed by the counterpart, and (iv) a large portion of retaliation targets consumption goods. These insights help clarify certain modeling decisions in the theoretical framework.

To show these facts, I use historical data on Canadian temporary trade barriers, combining administrative data with the database compiled by Bown (2016), covering the period from 1985 to 2015 at monthly frequency. This database includes detailed information on duties imposed by Canada and those received from different trade partners, specifically documenting the antidumping and countervailing policies enacted by each country, the targeted trade partner, and the corresponding tariff imposed.[2] Here, tariffs are expressed as a percentage of prices rather than values, resulting in higher magnitudes.

To distinguish protection from retaliation episodes, I adopt the approach in Espinosa (2022), consistent with Feinberg and Reynolds (2006, 2018). Retaliation is defined as the action taken within one year of a tariff imposed by a trading partner that targets Canada. This classification categorizes episodes as retaliatory or protective tariffs, applied throughout the empirical analysis that follows.

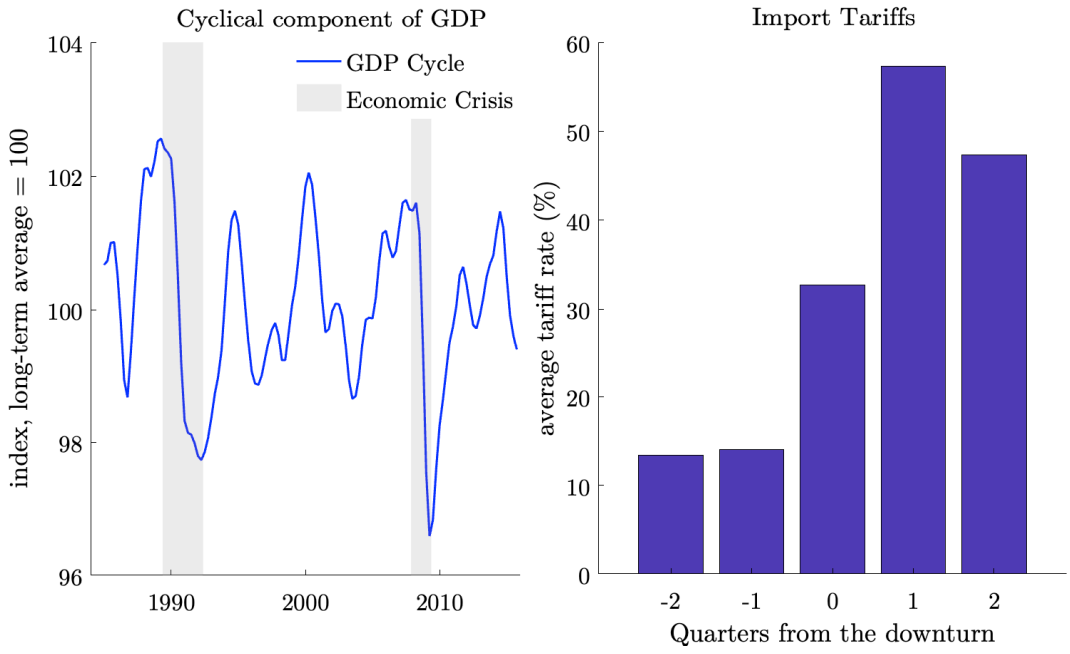
Stylized Fact 1: *Countercyclical tariffs*

This decomposition is used to analyze the behavior of episodes in which a country imposed tariffs discretionarily, compared to when the tariffs were a reaction to a trade partner's dis-

[2]The primary tool for temporary trade barriers is antidumping policy, measured by the dumping margin—the percentage difference between the normal value and the export price. This margin applies to specific products to counteract dumping practices by trade partners.

cretionary tariffs. First, to address the countercyclical profile, I focus on Canada's two most recent recessions. During these periods, I analyze the timing of tariffs for the quarter at the peak and the two surrounding quarters. Figure 1 illustrates this relationship, showing that during economic downturns, countries tend to impose higher import tariffs on competitors. This suggests that tariffs are used as a discretionary tool, for example, to raise revenue during recessions. It is important to note that during economic downturns, countries tend to impose higher import tariffs on competitors. This suggests that tariffs are used as a discretionary tool, for example, to raise revenue during recessions.

Figure 1: Countercyclical tariffs



Notes: Figure taken from Espinosa (2022). The left panel shows the annual evolution of the real GDP index, normalized to 100 for the long-term average, with recessions highlighted in gray. The right panel plots the average tariff rate from 2 quarters before to 2 quarters after the downturn.

Appendix B.1 examines the decomposition between the intensive and extensive margins. To do this, I classify periods as expansions or contractions, following the definition of the OECD, which is based on the cyclical component of quarterly GDP.[3] The results of regressing tariffs on the contraction dummy indicator, both using the OLS and a probit model, show that protective tariffs are about 10 percentage points higher during recessions and 20% more likely to be imposed. However, no significant effect is observed for the retaliatory component. This

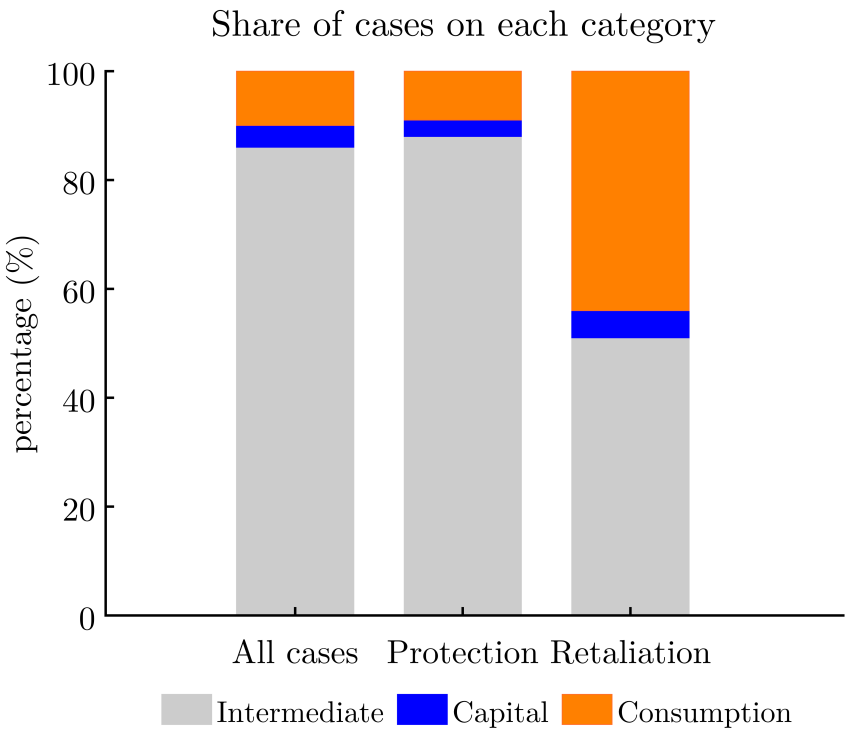
[3]The OECD defines contractions and expansions using the cyclical component of quarterly GDP.

supports the conventional view that protective tariffs are used as a stabilizing tool during economic downturns.

Stylized Fact 2: *Protective tariffs target intermediate inputs*

Second, import tariffs are predominantly imposed on intermediate inputs. Figure 2 shows that 84% of cases involving temporary trade barriers are concentrated on these types of goods. Protective episodes focus heavily on intermediate goods, particularly in the metal industry. This pattern is consistent with the aggregate data, where protection accounts for just over 90% of the cases in the sample.

Figure 2: Composition of tariff's cases in Canada



Notes: Each bar represent the share of product subject to temporary trade barriers in Canada, by type of good. These are classified according to protection or retaliation following the definition outlined in the text.

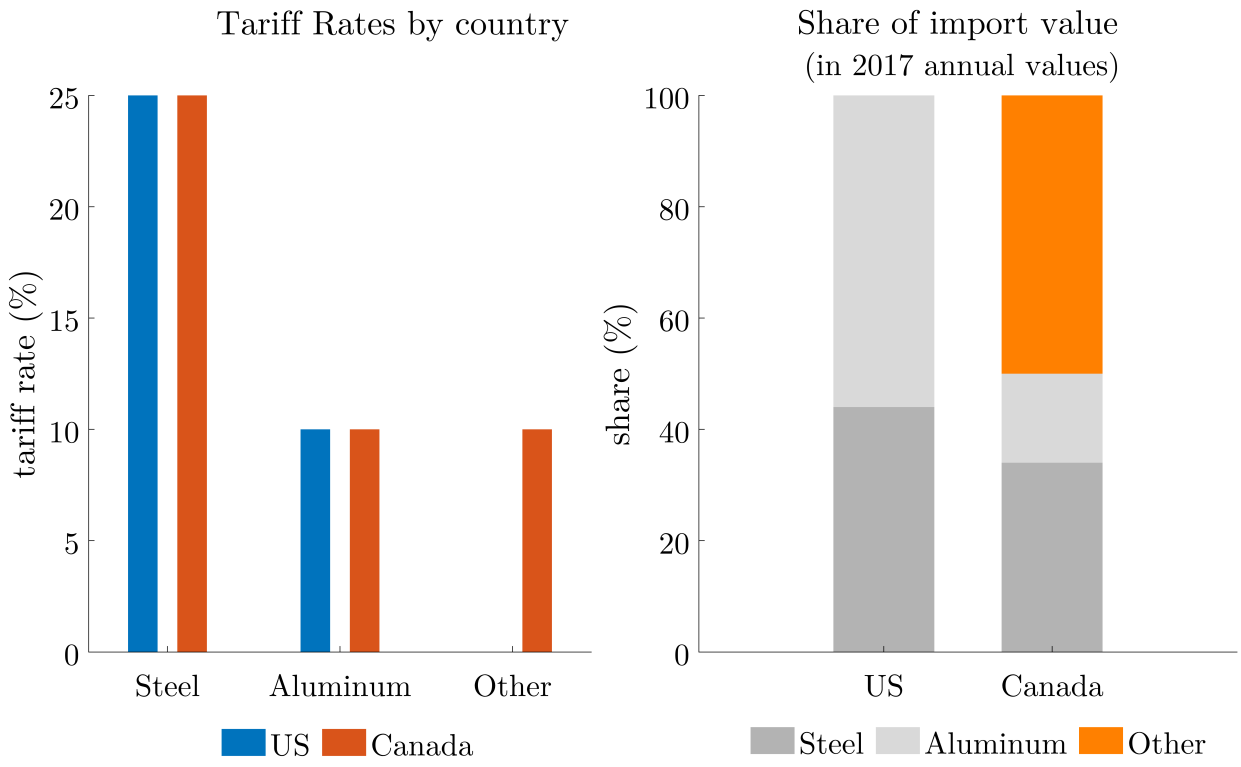
This contrasts sharply with retaliation cases, where half of the tariffs are imposed on consumption goods. Compared to these, intermediate goods are more difficult to substitute in the short run since they are used as inputs for other industries. Long-term supply contracts between firms and supplier search costs delay the adjustment of these inputs. Protecting relatively inelastic industries ensures a higher source of government revenue or, alternatively,

for a given amount of revenue, minimizes the distortion in these sectors. These considerations are central when governments aim to maximize revenue.

Stylized Fact 3: *Retaliatory tariffs match counterpart rates*

Third, during retaliation, tariff rates match those of the counterpart as regulated by the WTO. Retaliatory tariffs are set to mirror those imposed by the trading partner. For antidumping duties, countries report the dumping margin—the percentage difference between normal value and export price. A country receiving an antidumping duty can dispute it by filing a complaint with the WTO, in which case any retaliatory tariff must match the dumping margin. During the trade war, the US imposed safeguard tariffs of 25% on steel and 10% on aluminum. As seen in Figure 3, Canada matched these and imposed them on a set of goods, maintaining a similar average rate—16% in the US and 15% in Canada.

Figure 3: Canadian retaliation against US protective tariffs



Notes: The left panel displays the tariff rate applied by each country across product-level categories. The right panel shows the share of imports subject to tariffs, weighted by 2017 import shares.

The left panel shows the level of the average tariff rate between the US and Canada and the type of products each targeted. The bars reflect the contribution to the average tariff

by type of good, weighted by the value of the 2017 import share. The right panel shows the share of goods targeted by Canadian retaliation. The basket of goods, in 2017 values, is equivalent to the products covered by US protectionism. However, half of the retaliation was directed at sectors different from those protected.

Stylized Fact 4: *Retaliation largely targets consumption goods*

Fourth, the retaliatory response shifted toward consumption goods. As shown in Table 1, which categorizes the products subject to this policy by economic activity using the BEC indicator, tariffs on steel and aluminum were set at 25% and 10%, respectively. These are the US-protected products that Canada also targeted. Industries outside these sectors were subject to 10% tariffs, primarily targeting final consumption goods, which account for around 40% of the value share. These include foods, beverages, and durable and non-durable goods. Appendix B.4 provides a detailed breakdown of these goods.

Table 1: Retaliatory tariffs by sectors

Type of good (BEC Indicator)	Products (units)	Value (2017 $bn)	Value share (%)	Tariff (%)	Av. Tariff rate (weighted, %)
Steel	329	4,326	34	25	8.5
Aluminum	41	2,048	16	10	1.6
Food and beverages	46	2,397	19	10	1.9
Consumer goods, durables	59	1,239	10	10	1.0
Consumer goods, non-durables	25	1,337	10	10	1.0
Transport equipment, non-industrial	19	511	4	10	0.4
Capital goods (except transport)	4	536	4	10	0.4
Other Industrial supplies	23	368	3	10	0.3
	546	12,763			15.1

Notes: Products are classified by the Broad Economic Categories (BEC) definition, including all products chosen by Canada for retaliation. Value shares are based on annual 2017 import values in billion dollars.

This behavior, as also highlighted in the second empirical fact, suggests that it is optimal for the government to target goods with different characteristics. More importantly, compared to protectionist measures, these goods have higher elasticity. The rationale behind the government's objective function is to target goods from competitors that are strategically significant to the foreign government. This strategy aims to decrease demand, thereby harming both competitors and the trade partner. Consequently, this approach increases the likelihood of tariff withdrawal, a feature that is incorporated into the model.

Event Study

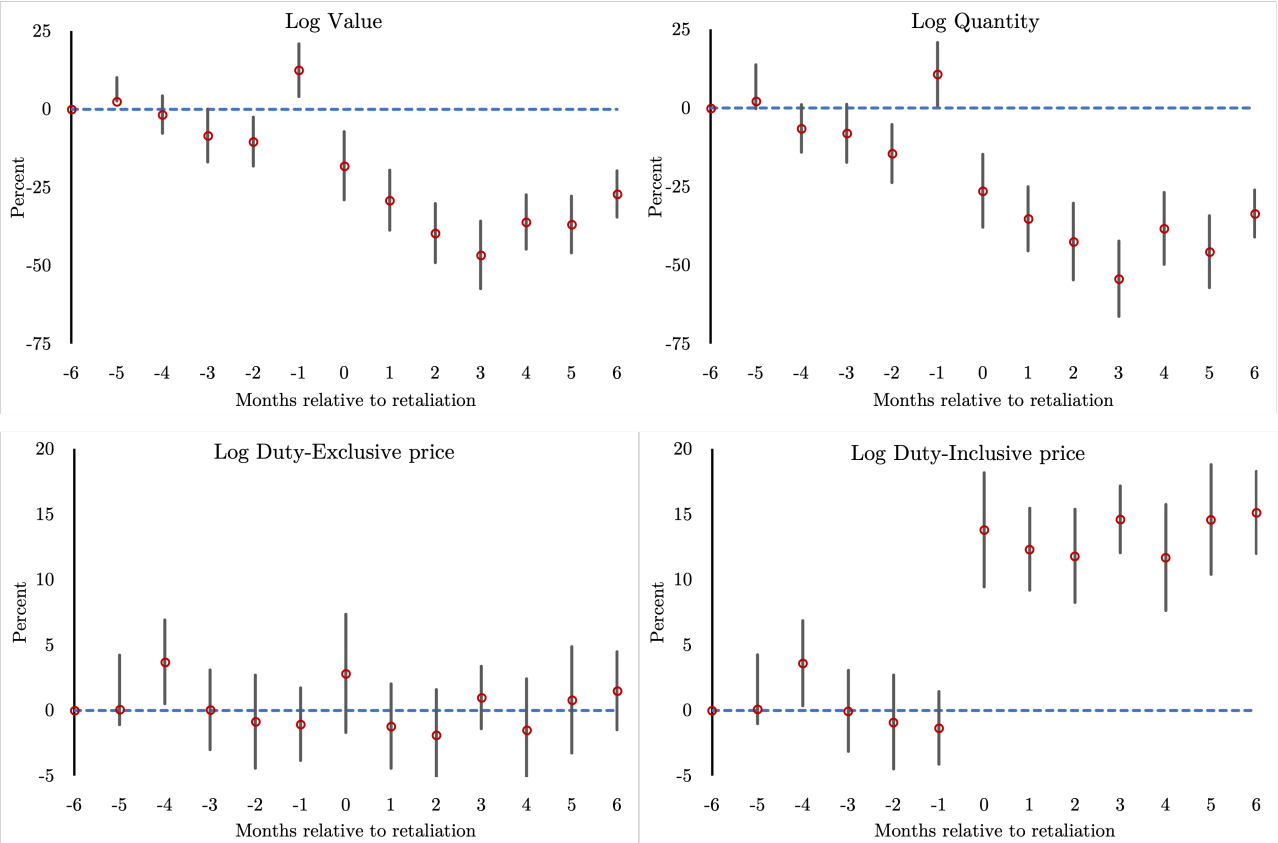
This section conducts an event study to examine the presence of anticipation effects in the retaliatory tariffs and to assess pre-trends between targeted and untargeted varieties. Taking period zero as the point when Canada implemented the retaliation (July 2018), I analyze the evolution of the data six months before and after this event. Periods earlier than six months before (-6) are excluded, while those beyond six months after (+6) are grouped together. The regression specification is as follows:

$$\begin{aligned}\ln(x_{sjit}) =& \phi_{ji} + \phi_{jt} + \phi_{it} + \sum_{h=-6}^{6} \beta_{0h} \mathbb{1}\{\text{event}_{sji} = 1\} \\ &+ \sum_{h=-6}^{6} \beta_{1h} \mathbb{1}\{\text{event}_{sji} = 1\} \times \text{target}_{sji} + \epsilon_{sjit}\end{aligned}$$

where the first three terms on the right-hand side represent product-country, product-time, and country-time fixed effects. This setup ensures that β_{1h} is identified using variation between target and untargeted varieties. Dummy variable "target_{sji}" captures those varieties affected by tariffs, while "event_{sji}" is the tariff enactment date. The dependent variable includes import values, quantities, duty-inclusive prices, and duty-exclusive prices. Figure 4 shows a significant drop in values at the time of retaliation, approximately 50%, which is primarily explained by a similar decrease in quantities. The duty-exclusive price remains unchanged, indicating full pass-through from tariffs to duty-inclusive prices, as foreign producers do not absorb the tariffs by reducing markups. This outcome also suggests a flat supply curve, consistent with the insignificant foreign export supply elasticities reported in the literature.

Another important observation is the absence of significant pre-trend dynamics in any of the cases. However, mild anticipation effects are noted in the month preceding the tariff's enactment, particularly visible in the graphs for import values and quantities. This behavior is largely driven by the steel and aluminum sector. Appendix B.5 decomposes the dynamics of these variables into within-sector and cross-sector retaliatory tariffs. From this analysis, anticipation effects are entirely explained by the within-sector component, as the same behavior is observed in both values and quantities during period -1. Cross-sector retaliatory tariffs do not exhibit this issue, and therefore, this is not a concern when using them as an instrument.

Figure 4: Event study



Notes: Each dot represents a point estimate of β_{1h} for each month relative to the period of retaliation, labeled as zero. Vertical gray lines indicate the 95% confidence intervals of the point estimate. Period -6 is taken as the baseline period.

3 Theoretical Framework

The model consists of two countries: Home (H) and Foreign (F). The Home country lacks market power, while Foreign is a large country with significant market power to influence terms of trade. The economy operates within a multi-industry framework, where each industry is indexed by $s = 1, \ldots, S$, and within each industry, there are multiple varieties of tradable goods, indexed by $j = 1, \ldots, J$. Each product $j \in J$ is associated with a unique sector $s(j) \in S$, defining a subset in the product-sector space. In each of the two blocks, there are L units of labor. Workers supply these to the industries and earn after-tax wages, with governments in both Home and Foreign imposing taxes on labor income. Labor is mobile across industries but immobile between countries. Both countries can impose discretionary tariffs on goods within a sector.

3.1 Households

The representative agent's utility function in each country depends on consumption, government spending, and the disutility of labor:

$$U = \prod_s C_s^{\beta_s} + \ln(G - \bar{G}) - \frac{L^{1+\frac{1}{\kappa}}}{1+\frac{1}{\kappa}} \tag{1}$$

Aggregate consumption is modeled as a Cobb-Douglas function of industry-level consumption, with the parameters β_s representing expenditure weights, satisfying $\sum_s \beta_s = 1$. Government expenditure follows a Stone-Geary form, where $\bar{G}$ denotes the minimum subsistence level of government spending. Labor supply Frisch elasticity is constant and equal to κ.

The representative agent's budget constraint is given by $PC = \Pi + w(1-\tau_L)L + T$, where P is the aggregate price level, C is total consumption, w is the wage rate, L is labor supply, τ_L denotes the labor income tax rate, Π represents domestic firms' profits, and T are government's lump-sum transfers. Consumption at the industry level follows a two-tier Nested Constant Elasticity of Substitution (CES). At the top tier, expenditures are allocated between domestically produced goods and foreign imports. The bottom tier is a CES bundle over imported varieties. This tier can be further disaggregated across trading partners in a multi-country framework, something explored in the empirical section.[4] Both tiers are:

$$C_s = \left((1-\psi_s)^{\frac{1}{\rho_s}} Y_{Hs}^{\frac{\rho_s - 1}{\rho}} + \psi_s^{\frac{1}{\rho_s}} Y_{Fs}^{\frac{\rho_s - 1}{\rho_s}} \right)^{\frac{\rho_s}{\rho_s - 1}}$$

$$Y_{Fs} = \left(\sum_j d_{Fsj}^{\frac{1}{\lambda_s}} Y_{Fsj}^{\frac{\lambda_s - 1}{\lambda_s}} \right)^{\frac{\lambda_s}{\lambda_s - 1}}$$

At the upper tier, ρ_s governs the elasticity of substitution between domestic and foreign composites, while ψ_s represents the sectoral expenditure share on foreign goods. At the bottom tier, λ_s governs the elasticity of substitution between imported products Y_{Fs} within sectors s, while d_{Fsj} represents the expenditure share on each product, subject to demand shocks. The demand for imported products follows by minimizing expenditure subject to the Nested-CES structure:

$$Y_{Fsj} = d_{Fsj} \left(\frac{(1+\tau_{sj}) P^*_{Fsj}}{P_{Fs}} \right)^{-\lambda_s} Y_{Fs} \tag{2}$$

[4]For simplicity, I am assuming that the elasticity of substitution between the two bundles is the same. In effect, that the elasticity of substitution across imported products is the same as the one between imported varieties (the elasticity of substitution between products across different trading partners)

Demands depend on the relative duty-inclusive (consumer) price P_{Fsj} to the imported sector price, the price elasticity of demand, demand expenditure shocks, and the imported sectoral demand. Import tariffs generate a wedge between the producer and the consumer price, such that $P_{Fsj} = (1+\tau_{sj})P^*_{Fsj}$. Finally, preferences in the foreign country are symmetric to those in Home. However, in this case, the duty-inclusive price is $P^*_{Hsj} = (1+\tau^*_{sj})P_{Hsj}$, where P^*_{Hsj} is the price Home producers charge abroad, and P_{Hsj} is the price they charge domestically.

3.2 Firms

In each industry, foreign monopolistically competitive firms produce goods using a technology that exhibits decreasing returns to scale with respect to labor input:

$$Y_{Fsj} = A^*_{sj}(L^*_{Fsj})^{\sigma^*_s} \tag{3}$$

Productivity, $A^*_{sj} = e^{\varepsilon^*_{A_{sj}}}$, depends on two components: aggregate and idiosyncratic shocks, such that $\varepsilon_{A^*_{sj}} = \xi^*_A + \xi^*_{A_{sj}}$. Firms minimize costs subject to equations (2) and (3), which yields the optimal pricing function:

$$P^*_{Fsj} = \left(\frac{\lambda_s}{\lambda_s - 1}\right)\left(\frac{W^*}{\sigma^*_s A^*_{sj}}\right)\left(\frac{Y_{Fsj}}{A^*_{sj}}\right)^{\omega^*_s}, \text{ where } \omega^*_s = \left(\frac{1-\sigma^*_s}{\sigma^*_s}\right) \tag{4}$$

The inverse export supply elasticity, denoted by ω^*_s, captures the firms' responses to changes in quantities. Additionally, in each country, monopolistic firms also produce goods for their domestic markets, operating under the same technology described above. This implies that total production in the foreign country, $Y^*_{sj} = Y^*_{Fsj} + Y_{Fsj}$, is split between domestic production and exports.

3.3 Equilibrium for Given Tariffs

The equilibrium for these variables depends on both state variables and policy instruments. The former comprise a set of productivity and demand shocks, while the latter consist of taxes and tariffs imposed by each government. We denote these, respectively, as:

$$\mathcal{S} = \{\mathcal{S}_{sj}, \mathcal{S}^*_{sj}\}, \text{ where } \mathcal{S}_{sj} = \{\varepsilon_{A_{sj}}, \varepsilon_{d_{sj}}\}, \text{ and } \mathcal{S}^*_{sj} = \{\varepsilon^*_{A_{sj}}, \varepsilon^*_{d_{sj}}\}$$

$$\mathcal{T} = \{\mathcal{T}_{sj}, \mathcal{T}^*_{sj}\}, \text{ where } \mathcal{T}_{sj} = \{\tau_\ell, \tau_s, \tau_{sj}\}, \text{ and } \mathcal{T}^*_{sj} = \{\tau^*_\ell, \tau^*_s, \tau^*_{sj}\}$$

The price and quantity equilibrium for imported products can be obtained by solving equations (2) and (4) given the tariff rate. Expressing the variables in log deviations (denoted

by lowercase letters) yields:

$$y_{Fsj} = \left[\frac{1}{(1+\omega_s^*\lambda_s)}\right]\left(-\lambda_s(1+\tau_{sj}) + \lambda_s(1+\omega_s^*)\varepsilon_{A^*_{sj}} + \varepsilon_{d^*_{Fsj}} + \phi^*_{y_{sj}}\right) \tag{5}$$

$$p^*_{Fsj} = \left[\frac{1}{(1+\omega_s^*\lambda_s)}\right]\left(-\omega_s^*\lambda_s(1+\tau_{sj}) - (1+\omega_s^*)\varepsilon_{A^*_{sj}} + \omega_s^*\varepsilon_{d^*_{Fsj}} + \phi^*_{p^*_{sj}}\right) \tag{6}$$

where ϕ^*_{sj} denotes a linear combination of variables at the sectoral and aggregate levels in each equation. The rest of the equations in the model follow from (5) and (6). These are the price indices associated with each layer of the nested CES, the associated firms' profits, and the household's first-order conditions:

$$p_{Fsj} = (1+\tau_{sj}) + p^*_{Fsj} \tag{7}$$

$$p_{Fs} = \sum_j [d_{Fsj}p_{Fsj}] \tag{8}$$

$$p_s = \sum_s [(1-\psi_s)p_{Hs} + \psi_s p_{Fs}] \tag{9}$$

$$\pi_{Fsj} = (p^*_{Fsj} + y_{Fsj}) \tag{10}$$

$$w = \sum_{sj} \beta_s \pi_{sj} \tag{11}$$

$$\ell = \kappa[w + (1-\tau_L)] \tag{12}$$

The first three equations represent the duty-inclusive price, as well as the price indices for imported products and at the sector level. The pass-through of tariffs to duty-inclusive prices is given by $1/(1+\omega_s^*\lambda_s)$, which is complete when the inverse export supply elasticity is equal to zero. The remaining equations pertain to foreign profits, tariff revenue, wages, and labor supply. Following Ossa (2014), firm profits are proportional to industry sales, and consequently, variables in these equations are proportional as well. Additionally, consumption at the product level is equal to $C_{sj} = Y_{Hsj} + Y_{Fsj}$, the sum of domestic production and imports. A similar set of equations arises when analyzing the Foreign country, though these depend on the import tariffs imposed by the Home country.

3.4 Governments

Each government chooses a set of policy instruments. Strategic interactions make these choices depend not only on economic conditions but also on the other country's policy choices. There are two states of the world: bad times and normal times. In the bad state, a sufficiently negative productivity shock takes place, such that $\xi_A < 0$, while in normal times, the economy faces no aggregate shocks ($\xi_A = 0$). Assume that the Foreign country starts in the bad state and remains there with probability q. The Home country is assumed to be in the normal state, which is absorbing.

Assume that there are two periods. At time zero, the Home country commits to a state-contingent strategy: if the Foreign government imposes a tariff $\tau^*_{sj} > 0$, the Home government responds with equivalent tariffs on a sector of its choice. Assume that at the start of each period, the state is realized, and governments take their choices at the end. In this period, the bad state occurs for the Foreign economy, prompting the imposition of tariffs. The Home country retaliates with the following policy rule:

$$\tau_{s'j'}(\mathcal{S}^*_{sj}) : \ \tau_{s'j'} = \tau_{sj} \tag{13}$$

At time one, the Foreign country decides whether to withdraw the tariff. This decision follows a stochastic choice model that takes into account the Home country's best response. Furthermore, the Home country's actions influence the probability of Foreign withdrawing its tariff.

3.4.1 Foreign Government

The government's budget constraint is defined as:

$$G^* = \tau^*_L w^* + \sum_s \tau^*_s P^*_{Hs} Y^*_{Hs} + \sum_{sj} \tau^*_{sj} P^*_{Hsj} Y^*_{Hsj} - T^*$$

Government revenue consists of labor income taxes, as well as uniform and discretionary tariffs. Government spending is divided between lump-sum transfers and exogenous expenditures.[5] At time zero, the foreign country has uniform sector-level tariffs in place to exploit its market power. These tariffs are set to maximize welfare and are equal to the inverse export supply elasticity for each sector, $\tau^*_s = \omega_s$.[6] Discretionary tariffs are equal to zero

[5]For example, this could be the provision of public goods, which enters the utility function of the representative agent.

[6]A tariff equal to ω_s allow the government to capture a portion of the foreign producers' surplus, thereby maximizing welfare. Since the inverse export supply elasticity measures how responsive producers are to lowering prices given a change in tariffs, import quantities are not significantly affected.

before the realization of the shock.

The bad state implies a drop in government revenue and, consequently, of the budget constraint, $\partial G^*/\partial \mathcal{S}^*_{sj} < 0$.[7] Given (1), this increases the marginal utility of government revenue, leaving the government with two options: (i) raise taxes or (ii) impose tariffs on goods. Labor taxes reduce labor supply in (12), consequently affecting firms' profits and production:

$$\frac{\partial u(L^*)}{\partial \mathcal{T}^*_{sj}} < 0, \quad \frac{\partial u(C^*)}{\partial \mathcal{T}^*_{sj}} < 0$$

Import tariffs sharply increase the marginal benefit of government revenue. However, they also reduce the consumer surplus in the affected market:

$$\frac{\partial u(G^*)}{\partial \mathcal{T}^*_{sj}} > 0, \quad \frac{\partial u(C^*)}{\partial \mathcal{T}^*_{sj}} < 0$$

Given the above, applying tariffs on international trade is the most efficient policy tool. The government, however, needs to trade off these two forces.

Political Economy. Government preferences are given by the following objective function:

$$\tilde{\mathrm{W}}^* = \sum_s \theta^*_s \tilde{\mathrm{W}}^*_s$$

As in Ossa (2014), $\tilde{\mathrm{W}}^*$ represents a sector-level weighted average of the welfare function, reflecting additional welfare driven by political economy motives relative to uniform tariffs that maximize terms of trade. The political economy weights, θ^*_s, represent the importance the government assigns to various lobby groups within each industry. Following Grossman and Helpman (1994, 1995), industries with greater electoral contributions from lobbyists receive higher weights in the sector-level welfare. In the bad state, the government also considers products that generate higher revenue, preferences that are reflected in this measure of welfare. Thus, $\tilde{\mathrm{W}}^*_s$ is the sum of firm's profits and government revenue. Substitute back and express in log-differences:

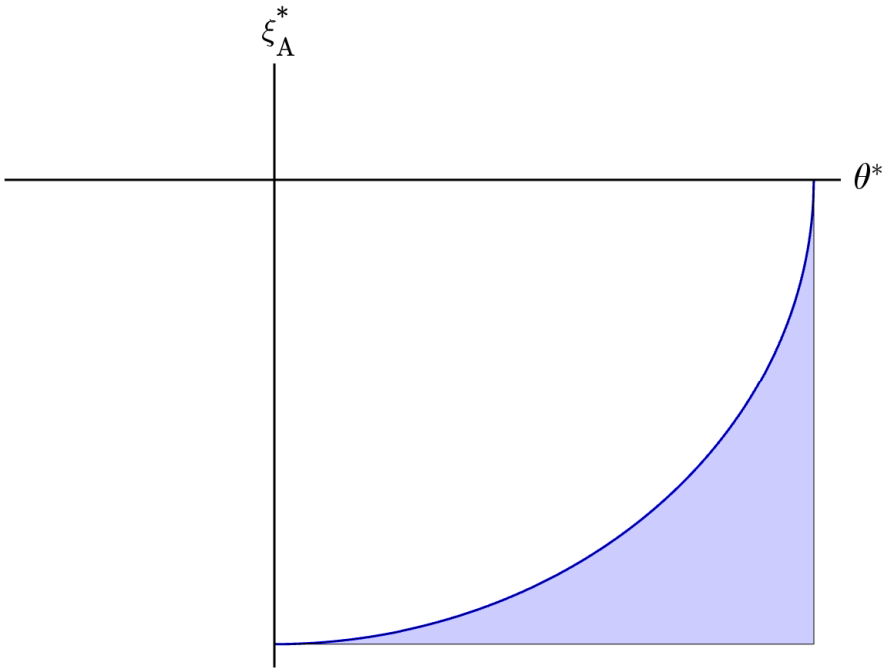
$$\tilde{\mathcal{W}}^* = \sum_s (\theta^*_s + \tilde{\mathcal{W}}^*_s) \tag{14}$$

where $\tilde{\mathcal{W}}^*_s = \pi^*_{Fs} + \delta_b r^*_s$ and $r^*_s = \tau^*_s + \pi^*_{Fs}$. Parameter δ_b is equal to one in the bad state and zero otherwise. The bad state is a combination of economic conditions and political pressures, as Figure 5 illustrates. Large negative shocks, high values of θ^*, or a combination

[7] In particular, $\mathcal{S}^*_{sj} = \{\xi_A < 0, \xi_{A_{sj}} = 0, \varepsilon_{d_{sj}} = 0\}$

of both trigger this state. The further to the right in the region, the more the government aligns with the lobbyists' interests. A tariff on a given product has a dual effect: it raises revenue and protects foreign firms in their own domestic market. Depending on the tariff's pass-through, it raises import prices, allowing them to increase their prices without adjusting their markups. When a tariff is imposed on goods with low demand elasticity, it produces three effects: (i) generates significant government revenue, (ii) minimizes the distortion on consumer surplus, and (iii) increases tariff pass-through, benefiting foreign firms.

Figure 5: Region defining the bad state



Notes: The area shaded in blue represents combinations of negative productivity shocks and high government propensity toward lobbyists, resulting in the realization of the bad state.

The government chooses tariffs to maximize the following value function:

$$V_b^*(\mathcal{S}) = \max_{\tau_{sj}^*} \tilde{\mathcal{W}}^*(\mathcal{T}_{sj}^*, \mathcal{S}) + \beta \left[q V_b^*(\mathcal{S}') + (1-q) V_n^*(\mathcal{S}') \right] \tag{15}$$

Proposition 1. *Given the government's value function (15), subject to (5)-(12) and (14), the tariff rate that maximizes these preferences is given by:*

$$\tau_{sj}^* = \left(\frac{\psi_s^*}{\lambda_s^*(1+\omega_s)} \right)$$

Proof. *See Appendix A.1* □

The optimal tariff varies inversely with the demand and supply elasticity and proportionally with ψ_s^*, the share of Home's exports in the sector's expenditure. Intuitively, the government imposes the tariff on the most demand-inelastic goods while also leveraging the impact on Home producers. The latter depends on the effect of tariff pass-through on sector-level prices, governed by ψ_s^*.

Protectionist Instrument. The industry on which the tariff is imposed depends not only on how inelastic its demand is, but also on the government's propensity to lobby groups, modeled as structural noise and expressed as $\theta_s^* = \xi_s$. This implies that industries face different probabilities of receiving tariff protection. To see this, use (14) and the result in Proposition 1 to express the government's decision problem as:

$$\tilde{\mathcal{W}}^* | D_{sj}^* = \tilde{\mathcal{W}}_s^*(\tau_{sj}^*) + \xi_s$$

where D_{sj}^* is an indicator function equal to one if the tariff is imposed on industry s (zero otherwise), and $\tilde{\mathcal{W}}_s^*$ is the welfare function evaluated at the optimal tariff. Taking the difference with respect to any other sector s', the probability of targeting industry s is:

$$P\left(\xi_s - \xi_{s'} > \tilde{\mathcal{W}}_{s'}^*(\tau_{s'j'}^*) - \tilde{\mathcal{W}}_s^*(\tau_{sj}^*)\right)$$

Industries with higher lobbying propensity are more likely to be treated. This probability depends on the functional form of $\Delta\theta_s^*$, the difference with respect to sector s', taken as a reference point. This can be interpreted as noise around the optimal tariff rate: goods with low demand elasticity are more likely to be treated, though this probability is less than one. If the difference in these shocks is distributed as Extreme Value Type I, and $\Delta\tilde{\mathcal{W}}_s^*(\tau_{sj}^*) = \tilde{\mathcal{W}}_s^*(\tau_{sj}^*) - \tilde{\mathcal{W}}_{s'}^*(\tau_{s'j'}^*)$, then this probability can be written as:

$$P(D_{sj}^* = 1) = \left(\frac{1}{1 + \exp\left[-\Delta\tilde{\mathcal{W}}_s^*(\tau_{sj}^*)\right]}\right) \tag{16}$$

3.4.2 Home Government

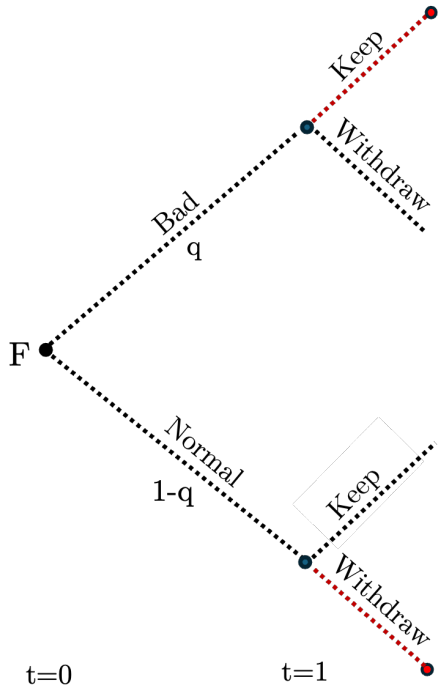
The Home government commits to retaliation, but this comes at the cost of consumer surplus. Retaliation affects the continuation value in the value functions in normal times, as it

increases the probability of withdrawal on this state, denoted by $1 - p_n$. The value function of the Home country is:

$$V_b(\mathcal{S}) = \max_{\tau_{s'j'}} \mathcal{W}(\mathcal{T}_{s'j'}, \mathcal{S}) + \beta \left[qV_b(\mathcal{S}') + (1-q)p_n V_n(\mathcal{S}') \right] \tag{17}$$

Home maximizes welfare subject to (13). The welfare function is discussed in the next section. The government's objective is to restore welfare to its level prior to the imposition of tariffs. The extent of retaliation's effect depends on the industries targeted, as this impacts Foreign's producer surplus. However, the scale of the productivity shock implies the punishment level is insignificant in the bad state, as firms' profits are low. In bad times, therefore, the probability of withdrawal is zero, while it becomes positive in normal times when the scale of profits is much higher. This game is represented in Figure 6.

Figure 6: Sequential game



Notes: Each branch represents the decision made by the foreign government in each state, normal or bad. These are either to keep the tariff in place or to withdraw it, taken in period one. The red dashed lines correspond to the SPNE in each state.

The red dashed lines represent the Subgame Perfect Nash Equilibrium (SPNE) in each state. Home's retaliation affects the withdrawal probability only in the normal state, making withdrawal the SPNE. In the bad state, the absence of retaliation costs leads the Foreign government to keep its tariffs.

3.5 Strategic Interactions Between Governments

On each state, there is a matrix of welfare payoffs for each government. These correspond to the outcomes in the decision tree of Figure 6. Each country decides to withdraw or keep their tariffs, where Foreign is the column player, while Home is the row. The payoffs matrix in the bad state is:

Table 2: Payoffs matrix in bad times

	Withdraw	Keep
Withdraw	$(0, 0)$	$(-ps^*_{s'j'}, -cs_{s'j'})$
Keep	$(\tilde{\mathcal{W}}^*, -ps_{sj})$	$(\tilde{\mathcal{W}}^*, -ps_{sj} - cs_{s'j'})$

Notes: cs and ps represent consumer and producer surplus, respectively. $\tilde{\mathcal{W}}^*$ denotes the welfare gain for the foreign government given the imposed tariff.

The Foreign government benefits from a profitable deviation, W^*_s, as both domestic producers and the government are better off. Retaliation bears no significant cost,[8] and therefore, the SPNE is to keep tariffs during bad times. In normal times, payoffs are:

Table 3: Payoffs matrix in normal times

	Withdraw	Keep
Withdraw	$(0, 0)$	$(-ps^*_{s'j'}, -cs_{s'j'})$
Keep	$(\tilde{\mathcal{W}}^*, -ps_{sj})$	$(\tilde{\mathcal{W}}^* - ps^*_{s'j'}, -ps_{sj} - cs_{s'j'})$

Notes: cs and ps represent consumer and producer surplus, respectively. $\tilde{\mathcal{W}}^*$ denotes the welfare gain for the foreign government given the imposed tariff.

Compared to the bad state, retaliation has a significant impact. However, Home must weigh this against the higher cost to consumer surplus in this state. By targeting Foreign's producer surplus, this reduces the benefits of a deviation in normal times and, consequently, is more likely to abandon its tariffs, making free trade the SPNE in this scenario. The functional form that each of these surpluses has depends on the model's solution in equations (5)-(12):

[8] Technically, retaliation still incurs a cost, but it is negligible compared to normal times, and thus assumed to be near zero for illustration purposes.

$$cs_{s'j'} = -\lambda^*_{s'}(1+\tau^*_{sj}) \tag{18}$$

$$ps_{s'j'} = -\lambda_{s'}(1+\tau^*_{s'j'}) \tag{19}$$

$$ps_{sj} = \left[\frac{\lambda^*_s(1+\omega_s)}{1+\lambda^*_s\omega_s}\right](1+\tau^*_{sj}) \tag{20}$$

Proposition 2. *Given the value function in (17) and equations (18)-(20), there exists a cutoff for the withdrawal probability, $1-p_n$, above which retaliation becomes the dominant strategy, given by:*

$$(1-\tilde{p}_n) = \left[\frac{\lambda^*_{s'}(1+\lambda^*_s\omega_s)}{(\lambda^*_s+\lambda^*_{s'})+\lambda^*_s\omega_s(1+\lambda^*_{s'})}\right]$$

Proof. *See Appendix A.2* □

This represents the minimum withdrawal probability at which retaliation becomes a sustainable strategy. The Home country's objective is to impose tariffs in a way that ensures this probability exceeds the cutoff. When tariff pass-through is complete, the cutoff simplifies to $1-\tilde{p}_n = \lambda^*_{s'}/(\lambda^*_{s'}+\lambda^*_s)$. Although targeting a sector with higher demand elasticity raises the cutoff requirement, it also increases the withdrawal probability, requiring Home to weigh the effectiveness of pressure against the resulting costs in consumer surplus.

Withdrawal Probability. Assume Foreign's value functions are subject to shocks $\{\varepsilon^{k^*}, \varepsilon^{w^*}\}$. The decision to withdraw in normal times can be expressed as:

$$V^*_n(\mathcal{S}) = \max\{V^{w^*}_n(\mathcal{S}) + \varepsilon^{w^*}, V^{k^*}_n(\mathcal{S}) + \varepsilon^{k^*}\}$$

These shocks can be interpreted as changes in the government's propensity to respond to lobby groups in the protected sectors. The withdrawal decision occurs when the utility of withdrawing is higher, with the probability:

$$P\left(\varepsilon^{w^*} - \varepsilon^{k^*} > V^{k^*}_n(\mathcal{S}) - V^{w^*}_n(\mathcal{S})\right) \tag{21}$$

If the shocks to the value functions follow an extreme value type I distribution, this probability can be expressed as:

$$1-p_n = \left(\frac{1}{1+\exp\left[\Delta V^{k^*}_n\right]}\right)$$

where $\Delta V^{k^*}_n = (V^{k^*}_n - V^{w^*}_n)$. Home actions reduce the value of $V^{k^*}_n$, increasing the withdrawal probability. Therefore, there exists a cutoff at which the foreign government is indifferent

between withdrawing or not in normal times. Define $\eta = (\varepsilon^w - \varepsilon^k)$, and let $\tilde{\eta}$ be the cutoff defined by:

$$\tilde{\eta} = \inf\{\eta | \Delta V_n^{k^*} \geq 0\}$$

Foreign withdraws whenever $\eta > \tilde{\eta}$. Home retaliation aims to lower this cutoff to maximize the probability of withdrawal. That is, during normal times, the foreign country is more likely to give up its tariffs. The effect that retaliation has on Foreign is a reduction in the producer surplus. Since the home country lacks market power, it cannot influence world prices, meaning $\omega_s^* = 0 \ \forall s$. Thus, the impact of Home's retaliation depends on the demand elasticity of the good and the weight the foreign government assigns to it.

Proposition 3. *Define* $\Delta\tilde{V}_n^{k^*} = \frac{\psi_s^*}{1+\omega_s^*\lambda_s} - \Delta\theta_{s'}^* - \psi_{s'}\Delta\lambda_{s'}$, *such that the cutoff is equal to:*

$$\tilde{\eta} = \frac{1}{1 + \exp(\Delta\tilde{V}_n^{k^*})}$$

If $\Delta\lambda_{s'} > 0$ *or* $\Delta\theta_{s'}^* > 0$, *the cutoff for the withdrawal probability is strictly decreasing in these arguments.*

Proof. *See Appendix A.3* □

From Proposition 3, the extent of this impact is moderated by $\psi_{s'}$, The extent of this impact is moderated by $\psi_{s'}$, which measures the Foreign country's exposure to retaliation. Assume now that the Home country consists of a continuum of small open economies (SOEs). This implies that only a portion of Home's SOEs would retaliate, depending on the extent to which each can individually influence the probability of tariff withdrawal.

Lemma 1. *There exists a cutoff value* $\psi_{s'}$ *such that the condition in Proposition 2 holds. Denote this cutoff as:*

$$\tilde{\psi}_{s'} = \frac{\pi_{F_s}^*}{\pi_{F_{s'}}} \left[1 - \frac{1}{\pi_{F_s}^*} \ln\left(\frac{1}{1-\tilde{p}_n} - 1\right)\right]$$

Proof. *See Appendix A.4* □

This cutoff represents the minimum sector expenditure share required for retaliation to be a sustainable action. The following proposition establishes the proportion of SOEs with sector expenditure shares above this cutoff and, consequently, the portion that takes retaliatory action.

Proposition 4. *There exists a threshold, denoted as* $\Psi(\{\tilde{\psi}_{s'}\})$*, such that the proportion of countries that choose to retaliate is given by* $\alpha = 1 - F\left(\Psi(\tilde{\psi}_{s'})\right)$.

Proof. See Appendix A.5 □

Only a share α can trade off the benefits of retaliation, by affecting the withdrawal, against the costs this imposes on their own economy. In bad times, the foreign country anticipates this, and because the punishment is insignificant, it fully profits from the deviation. In normal times, however, the marginal utility of tariffs rests solely on the protection provided to foreign firms. When compared to the costs of retaliation on other exposed industries, it is likely that these costs outweigh the benefits, making the counterpart more inclined to withdraw in this state.

Retaliation Instrument. Given that the level of the tariff rate is fixed, Home chooses the industry in which to retaliate:

$$\left[(1+\tau_{s'j'})|\tau^*_{sj}\right] = (D_{s'}|D^*_s = 1)(1+\tau^*_{sj})$$

where $D_{s'} = 1$ if this sector is targeted by retaliation (zero otherwise). From Proposition 3, this decision is a combination of products of high demand elasticity, high industry relevance to the trade partner, or both. Given this, reexpress the above as:

$$\left[(1+\tau_{s'j'})|\tau^*_{sj}\right] = \Delta\lambda_{s'}(1+\tau^*_{sj}) + \Delta\theta^*_{s'}$$

The decision to switch industries, from s to s', depends on the relative size of the demand elasticity compared to the industry protected by Foreign. Since Home can also select industries relevant to its trade partner, this does not necessarily mean it will choose the most demand-elastic good. Given the random nature of $\Delta\theta^*_{s'}$, industries are targeted under different probabilities:

$$P\left(\xi_{s'} - \xi_s > -\Delta\lambda_{s'}(1+\tau^*_{sj})\right)$$

This can be interpreted as noise around the retaliation: goods with high demand elasticity are more likely to be treated, though this probability is less than one. If the difference in these shocks is distributed as Extreme Value Type I, then this probability can be expressed as:

$$P(D_{s'} = 1|D^*_{sj} = 1) = \left(\frac{1}{1+\exp\left[-\Delta\lambda_{s'}(1+\tau^*_{sj})\right]}\right) \tag{22}$$

4 Structural Estimation

The estimation uses information about varieties (i.e., trade partner-product pairs), as the database comprises information about the universe of Canadian imports. In this context, the identified demand elasticity, λ_s, corresponds to the elasticity of substitution across imported varieties. Conversely, the supply elasticity refers to the inverse price elasticity of supply for export varieties. In the following two sections, I explain the empirical methodology to estimate these elasticities and the identification strategy that pins down structural parameters. I employ the results from the model to outline the two instruments that will be used to identify these parameters.

4.1 Empirical Methodology

The import demand and export supply curves from equations (5) and (6) can be rewritten as:

$$y_{Fsjit} = \phi_{jt} + \phi_{it} + \phi_{is} - \lambda_s p_{Fsjit} + \xi^d_{sjit} \tag{23}$$

$$p^*_{Fsjit} = \phi_{jt} + \phi_{it} + \phi_{is} + \omega^*_s y_{Fsjit} + \xi^s_{sjit} \tag{24}$$

These are expressed in terms of log-differences with respect to time, and by adding the subscript i, referring to imports from a given trade partner—that is, a variety pair ji. Terms ϕ_{jt}, ϕ_{it}, and ϕ_{is} are fixed effects controlling for product-time, country-time, and country-sector variation, respectively. The product-time fixed effect controls for seasonal patterns and product-specific dynamics, the country-time fixed effect captures aggregate effects, including shocks and exchange rate fluctuations, and the country-sector fixed effect accounts for sector characteristics relevant for selection.

The error terms in each equation capture demand and supply unobservables at the variety level. Standard errors are clustered by country and HS-8 product codes. Importantly, the fixed effect for product-time variation also operates at the HS-8 level, thereby controlling for US tariffs imposed on Canada, as these tariffs are applied at this level of disaggregation. The two elasticities are identified using variation in Canadian retaliatory import tariffs to estimate import demand and export supply elasticities at the variety level. Three instruments are employed: one using all retaliatory tariff changes, and the others decomposing these into within-sector and cross-sector retaliatory tariffs, each providing an estimate for opposite ends of the elasticity distribution.

4.2 Identification Strategy

The identification strategy follows by linking the previous two equations with the structural parameters of the model. In particular, to those derived from the Nested CES and the monopolist pricing function, the demand and supply equations. These now include subscript i to account for imports from many trade partners and for the time dimension. The supply and demand curve, along with the expression for the duty-inclusive price given by (7), can be expressed as:

$$y_{Fsjit} = \phi_{y_{Fsjit}} - \underbrace{\left[\frac{\lambda_s}{1+\omega_s^*\lambda_s}\right]}_{\varepsilon_{y_F}}(1+\tau_{sjit}) + \xi_{y_{Fsjit}} \tag{25}$$

$$p_{Fsjit} = \phi_{p_{Fsjit}} + \underbrace{\left[\frac{1}{1+\omega_s^*\lambda_s}\right]}_{\varepsilon_{p_F}}(1+\tau_{sjit}) + \xi_{p_{Fsjit}} \tag{26}$$

$$p^*_{Fsjit} = \phi_{p^*_{Fsjit}} - \underbrace{\left[\frac{\omega_s^*\lambda_s}{1+\omega_s^*\lambda_s}\right]}_{\varepsilon_{p^*_F}}(1+\tau_{sjit}) + \xi_{p^*_{Fsjit}} \tag{27}$$

where ϕ denote the high-dimensional fixed effects outlined in the empirical methodology section. The error terms in each equation are a linear combination of productivity and demand shocks. In the context of IV estimation using tariffs, demand and supply elasticities can be identified as: $\lambda_s = -\left(\frac{\varepsilon_{y_F}}{\varepsilon_{p_F}}\right)$ and $\omega_s^* = \left(\frac{\varepsilon_{p^*_F}}{\varepsilon_{y_F}}\right)$. For each elasticity, the numerator and denominator correspond to the first and second stage coefficients in the IV approach. The underlying assumption is that tariffs are uncorrelated with the residuals.

For each instrument, the probability that the government targets specific industries is given by equations (16) and (22). The first equation corresponds to the protectionist instrument, and the second to the retaliatory instrument:

$$P(D^*_{sjit} = 1) = \left(\frac{1}{1+\exp\left[-\Delta\tilde{\mathcal{W}}^*_{si}(\tau^*_{sjit})\right]}\right)$$

$$P(D_{s'} = 1 | D^*_{sjit} = 1) = \left(\frac{1}{1+\exp\left[-\Delta\lambda_{s'}(1+\tau^*_{sjit})\right]}\right)$$

Protectionist policies are driven by the interaction between the state of the US economy and the government's sensitivity to lobbying in specific industries. Even without an increase in lobbying, the government's responsiveness to these groups intensifies during downturns.

This interaction influences the selection of industries for tariff imposition, as shown in the first equation. From Canada's perspective, the tariff is orthogonal to its own economic conditions. Canada responds by selecting goods based on industry characteristics, such as demand elasticities and the US government's sensitivity to lobbyists, which are unrelated to Canada's economic state. This makes them valid instruments for identifying Canada's trade elasticities.

The two instruments are subject to selection at each tail of the distribution, implying that they estimate a local average treatment effect rather than an average treatment effect. For the retaliatory instrument, selection is influenced by the US government's lobbying sensitivity, explaining why goods with low demand elasticity might still be chosen for retaliation. Sectors with strong lobbying influence in the US are appealing targets despite lower elasticities, leading to what is termed within-sector retaliation, while cross-sector retaliation is based on higher elasticities. Both instruments are used to estimate trade elasticities in Canada. The inclusion of industry fixed effects in the regressions is crucial, as these control for $(D_{s'}|D^*_{sjit} = 1)$, which reflects the likelihood of targeting demand-elastic varieties during retaliation. With this in place, the within- and cross-sector retaliation instruments enable identification for $\{\lambda_s, \omega^*_s\}$ and $\{\lambda_{s'}, \omega^*_{s'}\}$, respectively.

5 Results

This section presents the baseline results for the elasticity estimation based on (23) and (24), and it is organized as follows. First, the elasticity is estimated using all tariff changes as an instrument. Second, a decomposition is provided between within-sector and cross-sector tariffs. Lastly, an analysis of the welfare costs of tariffs.

Table 4 presents the baseline estimations using both OLS and IV. The first estimates both supply and demand equations, ignoring that these two equations are jointly determined. The coefficients are a combination of the structural parameters. The OLS coefficient for the demand equation is -0.76 and is significant, while for the supply equation it is -0.22 and not significant. It is important to note that these coefficients are biased toward zero due to simultaneity. To overcome these endogeneity concerns, the last two columns of this table employ tariffs as an instrument for each equation to identify the elasticities. The demand elasticity increases (in absolute terms) to -2.37, substantially larger than the OLS estimate. As for the supply elasticity, it is negative, marginal in both cases, and insignificant in the case of IV.

These results are in line with those in the literature. The zero supply elasticity implies a complete pass-through of tariffs into duty-inclusive prices and therefore, the tariffs are borne

by consumers. Using (25) and (27), express the average effect on trade values as:

$$\Delta \ln \left(P^*_{Fsjit} Y_{Fsjit} \right) = - \left[\frac{\lambda_s (1 + \omega^*_s)}{1 + \omega^*_s \lambda_s} \right] (1 + \tau_{sjit}) \approx -33\%$$

Taking the average Canadian tariff rates, which increased by 15% on average, and the estimates from the table above, this leads to an average drop of 33%. This is driven by the demand side, as the supply elasticity is zero.

Table 4: OLS and IV estimation using all tariff changes

	OLS		IV - All Tariffs	
	λ_s	ω^*_s	λ_s	ω^*_s
$\hat{\beta}$	-0.76***	-0.22***	-2.37***	-0.05
se($\hat{\beta}$)	(0.02)	(0.00)	(0.33)	(0.03)
Product x time FE	Yes	Yes	Yes	Yes
Country x time FE	Yes	Yes	Yes	Yes
Country x sector FE	Yes	Yes	Yes	Yes
1st-stage F			165	65
R^2	0.27	0.27	.	.
N	2,073,856	2,073,856	2,073,856	2,073,856

Notes: (***): $p < 0.01$, (**): $p < 0.05$, (*): $p < 0.1$. Standard errors clustered by trade partner and product at the HS-8 level. The sample period is monthly data from 2017:1 to 2019:12. The IV All Tariff approach uses retaliatory tariffs on all products as instrument to estimate λ_s and ω^*_s. The first-stage F-statistic is from a regression of the duty-inclusive price on the instrument for λ_s, and of the quantity imported on the instrument for ω^*_s.

Comparing these results with the existing literature, the IV coefficients align closely with the commonly reported values of -2.5 for demand elasticity and zero for supply elasticity. Consequently, the observed drop in trade values is comparable, suggesting that this analysis using Canadian data effectively replicates findings from studies on the US counterpart. However, import tariffs may obscure the effects of the cross-sector retaliatory component. To address this, a decomposition is applied to run the same regressions.

Retaliatory tariff rates are decomposed into two groups. Within-sector retaliation refers to tariffs imposed on goods in the steel and aluminum sector, while cross-sector retaliation applies to goods outside these sectors. It is important to note that within-sector retaliation, by targeting the same sectors protected by the US, serves as a proxy for protectionist tariffs. This allows for the estimation of elasticities on the Canadian counterpart, comparable to

those previously estimated for the US.

Table 5: IV estimation of tariff decomposition

	IV within-sector		IV cross-sector	
	λ_s	ω_s^*	λ_s	ω_s^*
$\hat{\beta}$	-1.87***	-0.12***	-5.23***	0.10**
se($\hat{\beta}$)	(0.28)	(0.04)	(1.45)	(0.05)
Product x time FE	Yes	Yes	Yes	Yes
Country x time FE	Yes	Yes	Yes	Yes
Country x sector FE	Yes	Yes	Yes	Yes
1st-stage F	163	46	21	24
R^2	.	.	.	.
N	2,073,856	2,073,856	2,073,856	2,073,856

Notes: (***): $p < 0.01$, (**): $p < 0.05$, (*): $p < 0.1$. Standard errors clustered by trade partner and product at the HS-8 level. The sample period is monthly data from 2017:1 to 2020:12. The IV within-sector approach uses retaliatory tariffs imposed on steel and aluminum as instrument to estimate λ_s and ω_s^*. The IV cross-sector uses retaliatory tariffs on products in sectors other than steel and aluminum as instrument. The first-stage F-statistic is from a regression of the duty-inclusive price on the instrument for λ_s, and of the quantity imported on the instrument for ω_s^*.

Table 5 shows that the elasticity of -2.37 is primarily driven by the within-sector component, estimated at -1.87. This indicates that selection toward inelastic varieties dominates the aggregate measure. This value represents the lower bound estimate ($\hat{\lambda}_L$) within the interval for the average effect. Conversely, cross-sector retaliatory tariffs consistently estimate the upper bound ($\hat{\lambda}_H$), with an elasticity of -5.2, which is more than twice the magnitude of the lower bound. To test whether the lower and upper bounds are statistically distinct, I perform the following test:

$$H_0 : \hat{\lambda}_L = \hat{\lambda}_H$$
$$\text{F} = 5.2, \quad \text{P}_v = 2.4\%$$

At the 5% confidence level, the test rejects the null hypothesis that both bounds are equal, establishing a meaningful range for the average elasticity. On the supply side, within-sector tariffs yield a negative estimate for this elasticity. In contrast, retaliatory tariffs provide a positive, though small, estimate, suggesting that supply factors are not central to explaining average trade effects.

The first-stage F-statistic exceeds the rule-of-thumb threshold of 10 in all specifications, indicating the instrument's strength and relevance. Moreover, the first-stage estimates, reported in Appendix B.2, are significant across all IV specifications. Although the F-statistic values are on the lower end, this can be attributed to the instrument being relevant only for US imports and not for imports from the rest of the world.

The standard errors, clustered by trade partner and products at the 8-digit level, are higher for the cross-sector retaliatory tariffs. This is due to the smaller number of observations for each treatment. Within-sector retaliatory tariffs have twice as many observations as the cross-sector ones, which accounts for the larger standard errors in the latter specification. Despite this, the demand elasticity estimates are significant in both cases. To illustrate the results, Figure 7 portrays a visual representation of the results.

Figure 7: Average elasticity bounds



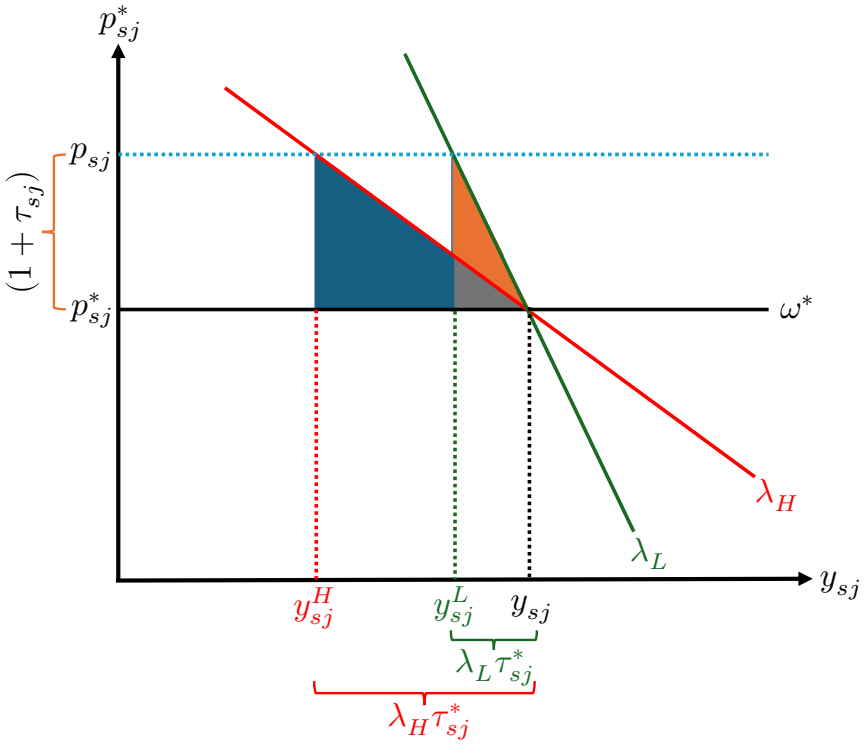
Notes: *LS* denotes the least squares estimator (OLS). Red indicates the low and high bounds, green shows the IV estimator using all tariff changes, and black represents the average elasticity.

The average elasticity lies within the interval of 1.9 to 5.2, marked in red. The elasticity estimated using all tariff changes falls closer to the lower end of this range. The exact location of the average elasticity depends on distribution. The OLS estimate, heavily downward biased, falls outside this interval.

5.1 Welfare Effects

The estimated elasticities can be used to compute the aggregate welfare effect of tariffs. Under certain conditions, the trade elasticities can be used to compute the aggregate deadweight loss. In principle, this is a nonlinear function of the demand and supply elasticities. Depending on the shape of this function, a weighted average between the two bounds could lead to overestimation or underestimation of the welfare costs. However, as the supply elasticity is close to zero, the average deadweight loss becomes a linear function of the import demand elasticity. Figure 8 illustrates this relationship.

Figure 8: Welfare cost of tariffs



Notes: The blue and orange areas represent the deadweight loss of the tariff. The gray area is where they intersect. Green and red lines show demand functions for low and high demand elasticities, respectively, assuming a flat supply curve.

The deadweight loss (DWL) under low demand elasticity is represented by the sum of the gray and orange areas, while under high demand elasticity, it corresponds to the gray and blue areas. Since λ_H is twice as large as λ_L, the associated welfare cost is also twice as large. To quantify this, a second-order approximation to the aggregate equivalent variation implies that the total deadweight loss is given by the area under the curve formed by the Harberger triangles. Using the model's solutions, this can be expressed as:

$$DWL = \frac{1}{2}\sum_s \sum_j \sum_i (P_{Fsjit} Y_{Fsjit}) \lambda_s \tau^*_{sjit} (1 + \tau^*_{sjit})$$

The estimated demand elasticities can be used to compute these welfare costs. As the regression employs a high-dimensional set of fixed effects, these account for the effects in the upper layers of the nested-CES structure. For example, product fixed effects control for the substitution between imported products, while sector-level fixed effects account for the substitution between home and imported composites. As the results for the variety demand elasticity align closely with those from Fajgelbaum et al. (2020), I will use this analysis to

extrapolate the welfare cost implications in the US. In particular, the IV estimations using all tariff changes, as well as the within-sector retaliation instrument, are close to the -2.5 reported in the related literature. I will then employ the cross-sector retaliatory instrument results to compute the welfare losses associated with this upper bound.

To express the DWL in levels, and following Baqaee and Farhi (2019), this can be computed as the product of the import share of value added, the fraction of imports targeted by tariffs, the average tariff rate increase, and the estimated demand elasticities. In the US, the pre-war value of imports in 2016 was $257 billion, while the average tariff rate on affected products increased by 14%. Employing the 2.5 elasticity estimate for the lower bound, this results in a real GDP loss of $11 billion. Table 6 summarizes these welfare losses:

Table 6: Tariff's welfare costs

Imports	$\hat{\lambda}$	$\Delta\tau$	DWL
$257b	-2.5	14%	$11b
$257b	-5.2	14%	$22b

Notes: DWL in billion dollars. Calculated using 2016 annual import values.

The trade literature employing a nested-CES structure to model demand typically assumes a constant and unique elasticity of substitution across imported varieties. This paper shows that the estimated elasticity depends crucially on the identification strategy used. In particular, the findings suggest that the welfare losses from the Trump administration's tariffs may be significantly larger than previously reported—potentially twice as high. Using the upper-bound elasticity estimate of 5.2, I find that the deadweight loss increases from $11 billion to $22 billion. While these aggregate losses remain modest—rising from 0.5% to 1% of total US import value in 2016—the industry-level effects can be substantial. For instance, in the metal industry, losses may reach up to 10% of gross output. Moreover, tariffs imposed on intermediate inputs can propagate through production networks, potentially amplifying the overall welfare cost.

This exercise rests on a few key assumptions. First, because the demand elasticity estimated via IV using all tariff changes for Canada (-2.4) closely matches the estimate reported for the US (-2.5), I treat the elasticities estimated for Canada as proxies for those in the US. Second, I assume that demand elasticities are comparable across countries at the same level of sectoral disaggregation—i.e., 10-digit product-level elasticities are equivalent between Canada and the US. Based on this, I use the Canadian elasticity estimates to compute the welfare cost of tariffs in the US, under the assumption that they reflect the true underlying

elasticities.

5.2 Robustness Checks

This section assesses the robustness of the main results to several alternative specifications: (i) it examines whether the elasticity estimates hold when focusing exclusively on trade between Canada and the US; (ii) it tests the results under alternative definitions of the sector variable; (iii) it evaluates robustness by modifying the estimation window; and (iv) it examines sensitivity to outliers in the sample.

Canada-US Bilateral Trade. Retaliatory tariffs were imposed on goods from the United States, directly impacting trade flows between Canada and the US. To demonstrate that the results are primarily driven by this bilateral trade, I first interact the variables with a US dummy indicator and re-estimate the regressions. Specifically, the duty-inclusive price in the demand equation is interacted with this dummy, and the same treatment is applied to the quantity imported in the supply equation. This approach isolates the effect of US trade from that of other countries, as shown in Table 7.

Table 7: Robustness - Canada and US bilateral trade

	IV within-sector		IV cross-sector	
	λ_s	ω_s^*	λ_s	ω_s^*
$\hat{\beta}$	-1.76***	-0.13***	-5.5***	0.10**
se($\hat{\beta}$)	(0.23)	(0.04)	(1.62)	(0.04)
Product x time FE	Yes	Yes	Yes	Yes
Country x time FE	Yes	Yes	Yes	Yes
Country x sector FE	Yes	Yes	Yes	Yes
1st-stage F	216	55	24	26
R2	.	.	.	.
N	2,073,856	2,073,856	2,073,856	2,073,856

Notes: (***): $p < 0.01$, (**): $p < 0.05$, (*): $p < 0.1$. Standard errors clustered by trade partner and product at the HS-8 level. The sample period is monthly data from 2017:1 to 2019:12. The IV within-sector approach uses retaliatory tariffs imposed on steel and aluminum as instrument to estimate λ_s and ω_s^*. The IV cross-sector uses retaliatory tariffs on products in sectors other than steel and aluminum as instrument. The first-stage F-statistic is from a regression of the duty-inclusive price on the instrument for λ_s, and of the quantity imported on the instrument for ω_s^*.

The estimates closely align with the baseline results. The null hypothesis $H_0 : \hat{\lambda}_L = \hat{\lambda}_H$ is rejected ($F = 5.3,\ P_v = 2.2\%$), indicating that the full sample estimations are primarily

driven by retaliation against the United States. During the trade war, tariffs on other trading partners remained unchanged, while targeted products faced increased tariffs exclusively for the US. This lack of variation in tariffs applied to the rest of the world explains why the results are predominantly influenced by the US-Canada bilateral relationship.

An alternative approach estimates trade elasticities by splitting the sample to focus solely on bilateral trade between Canada and the United States. However, this method relies on a less comprehensive set of fixed effects compared to the full sample, limiting its ability to account for substitution effects across other varieties. The estimations include controls for time, sector, and product fixed effects, with the product defined at the eight-digit level and the sector at the NAICS-4 level. The findings are presented in Appendix B.3.1. While the upper bound demand elasticity is slightly higher than in the main analysis, the qualitative conclusions remain consistent.

Estimation Period. The baseline estimation focuses on the period during which the US imposed protectionist tariffs, followed by Canadian retaliation. These tariffs, however, were lifted by mid-2020 with the implementation of the new NAFTA agreement. To capture the impact of their removal, I extend the estimation window to include the end of 2020. This adjustment not only accounts for the removal of tariffs but also incorporates the influence of additional antidumping policies imposed against the US during this period.

Table 8: Robustness - Changing estimation period

	IV within-sector		IV cross-sector	
	λ_s	ω_s^*	λ_s	ω_s^*
$\hat{\beta}$	-1.83***	-0.13***	-5.4***	0.12**
se($\hat{\beta}$)	(0.27)	(0.04)	(1.68)	(0.06)
Product x time FE	Yes	Yes	Yes	Yes
Country x time FE	Yes	Yes	Yes	Yes
Country x sector FE	Yes	Yes	Yes	Yes
1st-stage F	168	46	16	14
R2	.	.	.	.
N	2,761,708	2,761,708	2,761,708	2,761,708

Notes: (***): $p < 0.01$, (**): $p < 0.05$, (*): $p < 0.1$. Standard errors clustered by trade partner and product at the HS-8 level. The sample period is monthly data from 2017:1 to 2020:12. The IV within-sector approach uses retaliatory tariffs imposed on steel and aluminum as instrument to estimate λ_s and ω_s^*. The IV cross-sector uses retaliatory tariffs on products in sectors other than steel and aluminum as instrument. The first-stage F-statistic is from a regression of the duty-inclusive price on the instrument for λ_s, and of the quantity imported on the instrument for ω_s^*.

The results, presented in Table 8, remain qualitatively consistent with the baseline estimation. The difference between the two demand elasticities is unchanged, and the supply elasticity shows no variation. This confirms the robustness of the findings to changes in the estimation window.

Sector Definition. Sector fixed effects are crucial to control for tariff selection toward the tails of the elasticity distribution. The NAICS-4 classification comprises 317 industry groups, enabling the probability of retaliation against high-elasticity goods to be computed at a highly disaggregated level. Alternative definitions for this variable can be employed using the two-digit or six-digit codes, which include 20 and 1,057 industries, respectively. Notably, the two-digit classification is defined at a much broader level compared to the other two. The results for these regressions are reported in Appendix B.3.2 for each alternative specification. Table 9 provides a summary of these results:

Table 9: Robustness - Different sector definitions

		IV within-sector		IV cross-sector	
Sector		λ_s	ω_s^*	λ_s	ω_s^*
two-digits	$\hat{\beta}$	-1.87***	-0.12***	-5.2***	0.1**
	se($\hat{\beta}$)	(0.28)	(0.04)	(1.50)	(0.05)
six-digits	$\hat{\beta}$	-1.88***	-0.12***	-5.3***	0.1**
	se($\hat{\beta}$)	(0.29)	(0.04)	(1.49)	(0.05)

Notes: (***): $p < 0.01$, (**): $p < 0.05$, (*): $p < 0.1$. Standard errors clustered by trade partner and product at the HS-8 level. The sample period is monthly data from 2017:1 to 2020:12. The IV within-sector approach uses retaliatory tariffs imposed on steel and aluminum as instrument to estimate λ_s and ω_s^*. The IV cross-sector uses retaliatory tariffs on products in sectors other than steel and aluminum as instrument. Two and six digits refers to NAICS-2 and NAICS-4, respectively.

The trade elasticities are nearly identical across the two specifications, and the estimates are significant and closely align with the baseline results. This suggests that while sector fixed effects are relevant for the estimation, the level of granularity in their definition does not significantly impact the main estimates. Alternatively, this may indicate that the product-time fixed effect already accounts for the selection mechanism, rendering the sector definition less critical once this is controlled for. Appendix B.3.2 explores this hypothesis further and shows that the results remain robust even when country-sector fixed effects are excluded. This suggests that product-time fixed effects, which control for US tariffs, also capture differences in product characteristics that are targeted during protectionist or retaliatory measures. In effect, they account for the probability of selection toward the tails of the elasticity distribution.

Sensitivity to Outliers. Finally, I evaluate whether the results are influenced by outliers in the sample. To address this, I cap the top and bottom 5% of the duty-inclusive price for the demand equation and the quantity imported for the supply equation. Appendix B.3.3 shows that trimming the tails results in a slightly lower coefficient for the upper bound compared to the baseline estimates. However, the difference between the upper and lower bounds remains statistically significant, reinforcing the robustness of the main findings. As for the supply elasticity, it remains insignificant across all specifications. These results confirm that while the supply elasticity estimate is positive but marginal, it is not robust to alternative specifications.

6 Conclusion

This paper studies how endogenous trade policy shapes the estimation of trade elasticities and their implied welfare costs. Using retaliatory tariffs as a novel source of identifying variation, I show that estimates based on protectionist tariffs recover only part of the elasticity distribution. Exploiting Canadian administrative data and the 2018 retaliation against the United States, I estimate an import demand elasticity of 5.2, substantially above conventional estimates of around 2.5. Combining protectionist and retaliatory tariffs yields bounds on the average elasticity between 2.5 and 5.2, implying welfare losses between $11 billion and $22 billion.

These results highlight the importance of selection in trade policy. Protectionist tariffs tend to target goods with low demand elasticities, while retaliatory tariffs focus on more elastic goods to maximize economic pressure. As a result, estimates based on different policy environments capture different points of the elasticity distribution. Accounting for this selection is essential for accurately measuring the welfare costs of trade policies and helps reconcile the gap between estimates based on recent trade-war tariffs and those derived from gravity-based models.

More broadly, the findings suggest that the welfare costs of recent trade policies may be substantially larger than previously thought. An important direction for future research is to further characterize the distribution of trade elasticities across countries and sectors. Extending the analysis to other retaliatory episodes, including those involving the European Union and Mexico, would provide additional evidence on the extent to which selection in trade policy affects the measurement of trade elasticities.

References

Amiti, M., Redding, S. J., and Weinstein, D. E. (2019). The impact of the 2018 tariffs on prices and welfare. *Journal of Economic Perspectives*, 33(4):187–210.

Anderson, J. E. (1979). A theoretical foundation for the gravity equation. *The American Economic Review*, 69(1):106–116.

Anderson, J. E. and van Wincoop, E. (2003). Gravity with gravitas: A solution to the border puzzle. *American Economic Review*, 93(1):170–192.

Bagwell, K. and Staiger, R. W. (1999). An economic theory of GATT. *American Economic Review*, 89(1):215–248.

Baqaee, D. R. and Farhi, E. (2019). The macroeconomic impact of microeconomic shocks: Beyond hulten's theorem. *Econometrica*, 87(4):1155–1203.

Boehm, C. E., Levchenko, A. A., and Pandalai-Nayar, N. (2023). The long and short (run) of trade elasticities. *American Economic Review*, 113(4):861–905.

Bown, C. P. (2016). Temporary trade barriers database. *The World Bank*.

Bown, C. P. and Crowley, M. A. (2013). Import protection, business cycles, and exchange rates: Evidence from the great recession. *Journal of International Economics*.

Bown, C. P. and Crowley, M. A. (2014). Emerging economies, trade policy, and macroeconomic shocks. *Journal of Development Economics*.

Broda, C., Limao, N., and Weinstein, D. E. (2008). Optimal tariffs and market power: The evidence. *American Economic Review*, 98(5):2032–65.

Broda, C. and Weinstein, D. E. (2006). Globalization and the Gains From Variety. *The Quarterly Journal of Economics*, 121(2):541–585.

Caliendo, L. and Parro, F. (2014). Estimates of the Trade and Welfare Effects of NAFTA. *The Review of Economic Studies*, 82(1):1–44.

Cavallo, A., Gopinath, G., Neiman, B., and Tang, J. (2021). Tariff pass-through at the border and at the store: Evidence from US trade policy. *American Economic Review: Insights*, 3(1):19–34.

Eaton, J. and Kortum, S. (2002). Technology, geography, and trade. *Econometrica*, 70(5):1741–1779.

Espinosa, C. (2022). The macroeconomic effect of modern protectionism. Working Paper.

Fajgelbaum, P. D., Goldberg, P. K., Kennedy, P. J., and Khandelwal, A. K. (2020). The Return to Protectionism. *The Quarterly Journal of Economics*, 135(1):1–55.

Feenstra, R. C. (1994). New product varieties and the measurement of international prices. *The American Economic Review*, 84(1):157–177.

Feinberg, R. M. and Reynolds, K. M. (2006). The spread of antidumping regimes and the role of retaliation in filings. *Southern Economic Journal*.

Feinberg, R. M. and Reynolds, K. M. (2018). How do countries respond to anti-dumping filings? dispute settlement and retaliatory anti-dumping. *The World Economy*.

Flaaen, A., Hortaçsu, A., and Tintelnot, F. (2020). The production relocation and price effects of us trade policy: The case of washing machines. *American Economic Review*, 110(7):2103–27.

Goldberg, P. K. and Maggi, G. (1999). Protection for sale: An empirical investigation. *American Economic Review*, 89(5):1135–1155.

Grossman, G. M. and Helpman, E. (1994). Protection for sale. *The American Economic Review*, 84(4):833–850.

Grossman, G. M. and Helpman, E. (1995). Trade wars and trade talks. *Journal of Political Economy*, 103(4):675–708.

Head, K. and Mayer, T. (2014). Chapter 3 - gravity equations: Workhorse,toolkit, and cookbook. In Gopinath, G., Helpman, E., and Rogoff, K., editors, *Handbook of International Economics*, volume 4 of *Handbook of International Economics*, pages 131–195. Elsevier.

Johnson, H. G. (1953). Optimum Tariffs and Retaliation. *The Review of Economic Studies*, 21(2):142–153.

Krugman, P. (1980). Scale economies, product differentiation, and the pattern of trade. *The American Economic Review*, 70(5):950–959.

Krugman, P. R. (1979). Increasing returns, monopolistic competition, and international trade. *Journal of International Economics*, 9(4):469–479.

Lake, J. and Nie, J. (2023). The 2020 US presidential election and trump's wars on trade and health insurance. *European Journal of Political Economy*, 78:102338.

Markusen, J. R. and Wigle, R. M. (1989). Nash equilibrium tariffs for the united states and canada: The roles of country size, scale economies, and capital mobility. *Journal of Political Economy*, 97(2):368–386.

Ossa, R. (2014). Trade wars and trade talks with data. *American Economic Review*, 104(12):4104–46.

Ossa, R. (2015). Why trade matters after all. *Journal of International Economics*, 97(2):266–277.

Waugh, M. E. (2019). The consumption response to trade shocks: Evidence from the us-china trade war. Working Paper 26353, National Bureau of Economic Research.

A Appendix A: Proofs

A.1 Proof of Proposition 1

Proof. The Foreign government trades off the marginal benefit of protecting domestic producers with the costs of the tariff's deadweight loss:

$$\frac{\partial \pi^*_{Fsj}}{\partial \tau^*_{sj}} + \frac{1}{2}\frac{\partial \tau^*_{sj} p^*_{Hsj} y^*_{Hsj}}{\partial \tau^*_{sj}} = 0$$

where the first term represents foreign producers' profits, while the second term captures the distortion of tariff revenue from Home exports. The derivative of domestic producers' gains with respect to tariffs, using the envelope theorem, is equal to the percentage change in domestic prices[9]*. This effect can be derived from the foreign price indices (7), (8), and (9), and depends on the upper layer of the Nested CES in equation (3.1):*

$$\frac{\partial \pi^*_{Fsj}}{\partial \tau^*_{s}} = \frac{\psi^*_s}{1 + \omega^*_s \lambda_s}$$

The second term, tariff revenue, can be computed from the Home counterpart of equations (5) and (6). It corresponds to the tariff's distortion, which the government aims to minimize:

$$\frac{1}{2}\frac{\partial \tau^*_{sj} p^*_{Hsj} y^*_{Hsj}}{\partial \tau^*_{s}} = -\left[\frac{\lambda_s(1+\omega^*_s)}{1+\omega^*_s\lambda_s}\right]\tau^*_{sj}$$

Combine both terms and solve for the tariff to get the final expression in the proposition. □

A.2 Proof of Proposition 2

Proof. By iterating on the value functions, retaliation and withdrawal can be expressed as:

$$V^k_b(\mathcal{S}) = -(ps_{sj} + cs_{b_{s'j'}}) - \frac{\beta}{1-\beta}\left((ps_{sj} + cs_{b_{s'j'}})q + (ps_{sj} + cs_{n_{s'j'}})(1-q)p_n\right),$$

$$V^w_b(\mathcal{S}) = -\frac{ps_{sj}}{1-\beta}.$$

The condition $V^k_b(\mathcal{S}) \geq V^w_b(\mathcal{S})$ requires:

$$p_n \leq \left[\frac{ps_{sj} + cs_{b_{s'j'}}}{ps_{sj} + cs_{n_{s'j'}}}\right] - \left[\frac{cs_{b_{s'j'}}}{ps_{sj} + cs_{n_{s'j'}}}\right]\frac{1}{\beta(1-q)}.$$

[9] In log-deviations, this corresponds to the percentage change in domestic prices. In absolute terms, it is the product of this change and the quantity.

Re-expressing in terms of the withdrawal probability:

$$(1-p_n) \geq \left[\frac{cs_{n_{s'j'}} - cs_{b_{s'j'}}}{ps_{sj} + cs_{n_{s'j'}}}\right] + \left[\frac{cs_{b_{s'j'}}}{ps_{sj} + cs_{n_{s'j'}}}\right] \frac{1}{\beta(1-q)}.$$

Provided $q < 1$, and assuming that in bad times the effect on consumer surplus is negligible given the scale of the shock, $cs_{b_{s'j'}} = 0$, the above expression simplifies to:

$$(1-p_n) \geq \left[\frac{cs_{s'j'}}{ps_{sj} + cs_{s'j'}}\right]$$

Substituting the expressions from equations (18)-(20) and rearranging yields the final expression in the proposition. □

A.3 Proof of Proposition 3

Proof. Express the difference in the foreign value function as:

$$\Delta V_n^{k^*} = (\theta_s^* - \theta_{s'}^*) + \pi_{F_{sj}}^*(\tau_{sj}^*) - \psi_{s'}\pi_{F_{s'j'}}(\tau_{sj}^*)$$

where $z_{s'j'}$ is the ratio of Foreign's exports of product $s'j'$ to sector expenditure. Differentiating with respect to the tariff:

$$\frac{\partial \Delta V_n^{k^*}}{\partial \tau_{sj}^*} = \frac{\partial \pi_{F_{sj}}^*(\tau_{sj}^*)}{\partial \tau_{sj}^*} - \psi_{s'}\frac{\partial \pi_{F_{s'j'}}(\tau_{sj}^*)}{\partial \tau_{sj}^*}$$

The derivative of domestic producers' gains with respect to tariffs is equal to the expression in Proposition 1. The derivative with respect to the profits of foreign competitors can be computed from equation (10), which is equal to $\lambda_{s'}$. Combining both effects, we get:

$$\frac{\partial \Delta V_n^{k^*}}{\partial \tau_{sj}^*} = \frac{\psi_s}{1+\omega_s^*\lambda_s} - \psi_{s'}\lambda_{s'}$$

Rewriting this as:

$$\frac{\partial \Delta V_n^{k^*}}{\partial \tau_{sj}^*} = \frac{\psi_s}{1+\omega_s^*\lambda_s} - (\psi_{s'}\Delta\lambda_{s'} + \psi_{s'}\lambda_s)$$

where the terms in differences are taken with respect to their counterpart in sector s'. Replace this into the expression for the total change in $\tilde{V}_n^{k^*}$:

$$\Delta\tilde{V}_n^{k^*} = -\Delta\theta_{s'}^* + \frac{\theta_s^*\psi_s}{1+\omega_s^*\lambda_s} - (\psi_{s'}\Delta\lambda_{s'} + \psi_{s'}\lambda_s)$$

With this definition, cutoff $\tilde{\eta}$ is equal to:

$$\tilde{\eta} = \frac{1}{1+\exp(\Delta\tilde{V}_n^{k^*})}$$

If $\Delta\lambda_{s'} > 0$ and $\Delta\theta_{s'}^* > 0$, $\Delta\tilde{V}_n^{k^*}$ is strictly decreasing in these arguments, lowering the cutoff for $\tilde{\eta}$. □

A.4 Proof of Lemma 1

Proof. Condition from Proposition 2 requires the withdrawal probability to be above the cutoff:

$$\left(\frac{1}{1+\exp\left[\Delta V_n^{k^*}(\psi_{s'})\right]}\right) \geq 1-\tilde{p}_n$$

From Proposition 3, rewrite this by expressing $\Delta V_n^{w^*}$ in terms of $z_{s'j'}$:

$$\psi_{s'} \geq \frac{1}{\pi_{F_{s'}}}\left[\pi_{F_s}^* - \ln\left(\frac{1}{1-\tilde{p}_n} - 1\right)\right]$$

Cutoff $\tilde{\psi}_{s'}$ corresponds to the right-hand side of this equation. □

A.5 Proof of Proposition 4

Proof. If k represents each of the SOEs, define $\psi_k = \max\{\psi_{s'k}\}$, such that for each economy, this is the largest sector-level expenditure in s'. Assume that ψ_k follows a particular distribution. The threshold for Ψ is defined as follows:

$$\Psi = \inf\left(\psi_k \geq \tilde{\psi}_{s'}\right)$$

If Ψ follows a CDF denoted by $F(\cdot)$, the share of countries retaliating is equal to:

$$\alpha = 1 - F(\Psi_{s'})$$

where α is the portion of SOEs for which it is optimal to take this action. □

B Appendix B: Other Tables and Figures

B.1 Decomposition between protective and retaliatory tariffs

Series	Indicator	Coefficient	SE
Import tariffs	Contraction (levels)	6.1 (*)	3.49
	Contraction (probability)	0.09	0.08
Protective tariffs	Contraction (levels)	9.7 (***)	3.72
	Contraction (probability)	0.18 (**)	0.08
Retaliatory tariffs	Contraction (levels)	-2.6	2.66
	Contraction (probability)	-0.12	0.08

Notes: Table taken from Espinosa (2022). (***): $p < 0.01$, (**): $p < 0.05$, (*): $p < 0.1$. Standard errors are calculated using Newey West estimator with four lags. For efficiency reasons, time dummies are used to control for the tariffs of the top 5% upper tail. Results remain robust to their inclusion.

B.2 First stage results

Table 10: First stage results of IV Estimations

	IV All Tariffs		IV within-sector		IV cross-sector	
	λ_s	ω_s^*	λ_s	ω_s^*	λ_s	ω_s^*
$\hat{\beta}$	1.12***	-2.67***	1.27***	-2.37***	0.65***	-3.42***
se($\hat{\beta}$)	(0.09)	(0.33)	(0.1)	(0.35)	(0.14)	(0.69)
Product x time FE	Yes	Yes	Yes	Yes	Yes	Yes
Country x time FE	Yes	Yes	Yes	Yes	Yes	Yes
Country x sector FE	Yes	Yes	Yes	Yes	Yes	Yes
N	2,073,856	2,073,856	2,073,856	2,073,856	2,073,856	2,073,856

Notes: (***): $p < 0.01$, (**): $p < 0.05$, (*): $p < 0.1$. Standard errors clustered by trade partner and product at the HS-8 level. The sample period is monthly data from 2017:1 to 2019:12. The IV within-sector approach uses retaliatory tariffs imposed on steel and aluminum as instrument to estimate λ_s and ω_s^*. The IV cross-sector uses retaliatory tariffs on products in sectors other than steel and aluminum as instrument. The first-stage coefficient is from a regression of the duty-inclusive price on the instrument for λ_s, and of the quantity imported on the instrument for ω_s^*.

B.3 Robustness checks

B.3.1 Canada and US split sample

Table 11: Robustness - Canada and US split sample

	IV within-sector		IV cross-sector	
	λ_s	ω_s^*	λ_s	ω_s^*
$\hat{\beta}$	-1.76***	-0.05	-7.1**	0.10*
se($\hat{\beta}$)	(0.35)	(0.04)	(3.38)	(0.06)
Time FE	Yes	Yes	Yes	Yes
Sector FE	Yes	Yes	Yes	Yes
Product FE	Yes	Yes	Yes	Yes

Notes: (***): $p < 0.01$, (**): $p < 0.05$, (*): $p < 0.1$. Standard errors clustered by product at the HS-8 level. The sample period is monthly data from 2017:1 to 2019:12. The IV within-sector approach uses retaliatory tariffs imposed on steel and aluminum as instrument to estimate λ_s and ω_s^*. The IV cross-sector uses retaliatory tariffs on products in sectors other than steel and aluminum as instrument.

B.3.2 Estimation using different sector definition

Table 12: Robustness - Estimation with NAICS2 Sectors

	IV within-sector		IV cross-sector	
	λ_s	ω_s^*	λ_s	ω_s^*
$\hat{\beta}$	-1.87***	-0.12***	-5.2***	0.10**
se($\hat{\beta}$)	(0.28)	(0.04)	(1.50)	(0.05)
Product x time FE	Yes	Yes	Yes	Yes
Country x time FE	Yes	Yes	Yes	Yes
Country x sector FE	Yes	Yes	Yes	Yes
1st-stage F	162	47	20	24
R2	.	.	.	.
N	2,073,856	2,073,856	2,073,856	2,073,856

Notes: (***): $p < 0.01$, (**): $p < 0.05$, (*): $p < 0.1$. Standard errors clustered by trade partner and product at the HS-8 level. The sample period is monthly data from 2017:1 to 2019:12. The IV within-sector approach uses retaliatory tariffs imposed on steel and aluminum as instrument to estimate λ_s and ω_s^*. The IV cross-sector uses retaliatory tariffs on products in sectors other than steel and aluminum as instrument. The first-stage F-statistic is from a regression of the duty-inclusive price on the instrument for λ_s, and of the quantity imported on the instrument for ω_s^*.

Table 13: Robustness - Estimation with NAICS6 Sectors

	IV within-sector		IV cross-sector	
	λ_s	ω_s^*	λ_s	ω_s^*
$\hat{\beta}$	-1.88***	-0.12***	-5.3***	0.10**
se($\hat{\beta}$)	(0.29)	(0.04)	(1.49)	(0.05)
Product x time FE	Yes	Yes	Yes	Yes
Country x time FE	Yes	Yes	Yes	Yes
Country x sector FE	Yes	Yes	Yes	Yes
1st-stage F	162	45	21	24
R2	.	.	.	.
N	2,073,856	2,073,856	2,073,856	2,073,856

Notes: (***): $p < 0.01$, (**): $p < 0.05$, (*): $p < 0.1$. Standard errors clustered by trade partner and product at the HS-8 level. The sample period is monthly data from 2017:1 to 2019:12. The IV within-sector approach uses retaliatory tariffs imposed on steel and aluminum as instrument to estimate λ_s and ω_s^*. The IV cross-sector uses retaliatory tariffs on products in sectors other than steel and aluminum as instrument. The first-stage F-statistic is from a regression of the duty-inclusive price on the instrument for λ_s, and of the quantity imported on the instrument for ω_s^*.

Table 14: Robustness - Estimation without country-sector FE

	IV within-sector		IV cross-sector	
	λ_s	ω_s^*	λ_s	ω_s^*
$\hat{\beta}$	-1.87***	-0.12***	-5.2***	0.10**
se($\hat{\beta}$)	(0.28)	(0.04)	(1.50)	(0.05)
Product x time FE	Yes	Yes	Yes	Yes
Country x time FE	Yes	Yes	Yes	Yes
1st-stage F	163	47	20	24
R2	.	.	.	.
N	2,073,856	2,073,856	2,073,856	2,073,856

Notes: (***): $p < 0.01$, (**): $p < 0.05$, (*): $p < 0.1$. Standard errors clustered by trade partner and product at the HS-8 level. The sample period is monthly data from 2017:1 to 2019:12. The IV within-sector approach uses retaliatory tariffs imposed on steel and aluminum as instrument to estimate λ_s and ω_s^*. The IV cross-sector uses retaliatory tariffs on products in sectors other than steel and aluminum as instrument. The first-stage F-statistic is from a regression of the duty-inclusive price on the instrument for λ_s, and of the quantity imported on the instrument for ω_s^*.

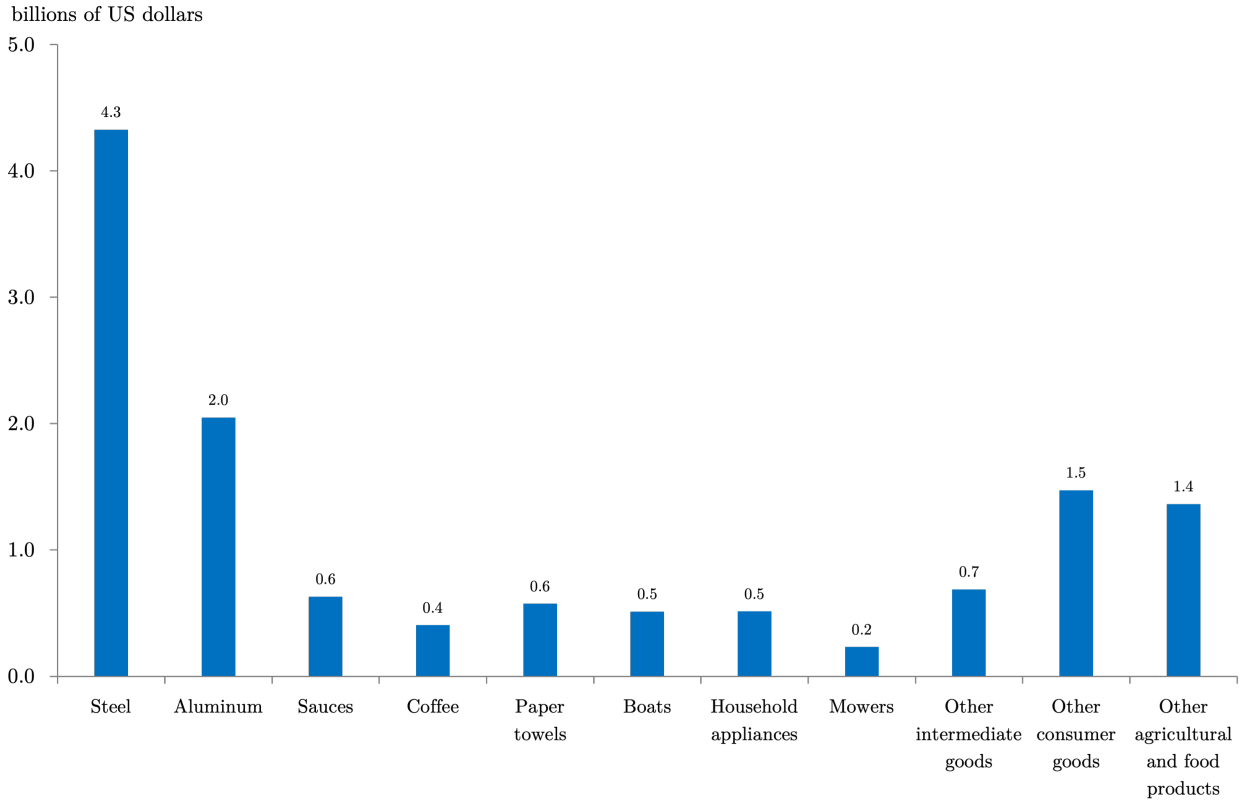
B.3.3 Sensitivity to outliers in the sample

Table 15: Robustness - Sensitivity to Outliers

	IV within-sector		IV cross-sector	
	λ_s	ω_s^*	λ_s	ω_s^*
$\hat{\beta}$	-1.78***	-0.06	-4.6***	0.39
se($\hat{\beta}$)	(0.29)	(0.04)	(1.13)	(0.32)
Product x time FE	Yes	Yes	Yes	Yes
Country x time FE	Yes	Yes	Yes	Yes
Country x sector FE	Yes	Yes	Yes	Yes
1st-stage F	202	65	69	4
R2	.	.	.	.
N	1,863,337	1,862,994	1,863,337	1,862,994

Notes: (***): $p < 0.01$, (**): $p < 0.05$, (*): $p < 0.1$. Standard errors clustered by trade partner and product at the HS-8 level. The sample period is monthly data from 2017:1 to 2020:12. The IV within-sector approach uses retaliatory tariffs imposed on steel and aluminum as instrument to estimate λ_s and ω_s^*. The IV cross-sector uses retaliatory tariffs on products in sectors other than steel and aluminum as instrument. The first-stage F-statistic is from a regression of the duty-inclusive price on the instrument for λ_s, and of the quantity imported on the instrument for ω_s^*.

B.4 Retaliation decomposition by products



B.5 Event study decomposition

