From Protection to Retaliation: The Welfare Cost of Trade Wars

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This paper explores the welfare costs of trade impediments, which depend on trade elasticities. State-of-the-art literature uses tariffs as instruments to structurally identify them. Studies using Trump tariffs in the U.S. estimate modest elasticities, implying low welfare costs. In this paper, I build a model of political economy to explain these results and introduce a novel identification strategy for estimating them. The model features a selection mechanism for goods chosen for treatment, based on the government's objective function and the state of the economy. When raising revenue, the government imposes tariffs on sectors with low demand elasticity and strong lobbying power. In response, the other country retaliates by targeting goods with high demand elasticity to maximize economic harm on the trade partner. This model provides a framework for two possible instruments: protectionist and retaliatory tariffs. As trade policy targets the extremes of the elasticity distribution, Trump's protectionism aligns with the observed low elasticity estimates. In this paper, I find the demand elasticity for imports ranges between 2.5 and 5.2, while the supply elasticity of exports is zero. This suggests that welfare costs could double, reaching up to $22 billion.

Keywords: Trade Policy, Trade Wars, Welfare Costs, Trade Elasticities
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1 Introduction

The rise of protectionism in recent years has highlighted the importance of measuring the welfare costs of trade shocks. Central to this are trade elasticities, particularly the price elasticity of demand for imports and the price elasticity of supply for exports (see Arkolakis et al. (2012)). State-of-the-art literature use tariffs as instrument to structurally identify elasticities. Papers using Trump tariffs in the US report modest estimates for these elasticities, resulting in low welfare losses. In this paper, I build a model of political economy between two countries to explain these results and provide a novel identification strategy for estimating these elasticities. The model features a selection mechanism for goods chosen for treatment, determined by the government's objective function and the state of the economy. Depending on these, this approach provides a framework for two possible instruments, estimating either the lower or upper bound of the elasticity distribution.

Trade policies, such as import tariffs, create a wedge between domestic consumer prices and foreign producer prices, resulting in a deadweight loss. The size of this depends on the trade elasticities. The literature on the trade war effects in the US has found a demand elasticity of imports around two and a supply elasticity of exports of zero (e.g., Fajgelbaum et al. (2020); Amiti et al. (2019)), implying complete pass-through of tariffs into duty inclusive prices. However, the selection of product subject to tariffs is not random. Protectionist tariffs, like the ones in the US, are imposed on goods with low demand elasticity in industries with strong lobbying power. This minimizes the deadweight loss while also generating government revenue. Therefore, results from Trump tariffs estimate the lower bound of the demand elasticity distribution.

This setting is embedded in a theoretical model of trade wars between two countries. The foreign country is assumed to be in a bad state, characterized by a negative aggregate productivity shock, while the home country remains in normal times. In downturns, the foreign country is more likely to impose tariffs as the marginal utility of government revenue increases. Tariffs also benefit foreign firms in their domestic market by enabling them to raise prices without reducing markups, driving lobbying efforts for protection, which I model as structural noise. The foreign country imposes tariffs on goods with low demand elasticity, though sectors are treated with different probabilities. The home country, in response, commits to a state-contingent retaliation plan to deter prolonged protectionism. The retaliation strategy targets goods with high demand elasticities to divert demand away from foreign competitors in key industries, thereby increasing the likelihood of tariff withdrawal in normal times. As the foreign economy transitions to normal times, retaliation becomes more effective due to higher foreign profits. In this framework, the foreign country's decision to withdraw tariffs in normal times constitutes a subgame perfect Nash equilibrium.

This approach provides a framework for two possible instruments: protectionist tariffs on goods with low demand elasticity and retaliatory tariffs on goods with higher demand elasticity. This implies that trade policy targets the extremes of the demand elasticity distribution, making it impossible to point-identify the average elasticity. Using protectionist Trump tariffs as an instrument yields modest elasticity estimates and low welfare costs, whereas retaliatory tariffs, estimating the upper bound of elasticity, suggest much higher welfare losses. In this paper, I combine both estimates to set bounds on the average demand elasticity. This paper finds that, using the retaliatory instrument, elasticities are twice as high, with the average demand elasticity between 2.5 and 5.2, and the supply elasticity equal to zero. This means that the welfare costs of U.S. tariffs could effectively double, reaching approximately $22 billion.

A supply elasticity of zero implies a flat supply curve, leading to complete pass-through of tariffs into duty-inclusive prices. Consequently, the deadweight loss scales linearly with the demand elasticity, with consumers bearing the full tariff incidence. This result aligns with findings from other studies, such as Fajgelbaum et al. (2020). The estimate of 5.2, which is twice as large as the lower bound, is consistent with results from studies using gravity equation models, where higher elasticity estimates are commonly found (see, e.g., Head and Mayer (2014) for a discussion).

To carry out the estimation, I focus on the 2018 Canadian retaliation against U.S. tariffs on steel and aluminum. Canada's response was evenly split: half targeted the same sectors protected by the U.S., while the other half applied to a range of consumption goods, based on 2017 import values. I use retaliatory tariffs on steel and aluminum (within-sector retaliation) as a proxy for protectionism, aligning with the sectors targeted by the U.S. In contrast, retaliatory tariffs on consumption goods (cross-sector retaliation) serve as the strategic response toward goods with higher demand elasticities. The former provides the estimator for the lower bound, while the latter estimates the upper bound.

The database comprises Canadian administrative records covering the full universe of imports at a monthly frequency from 1988 to 2020. Imports are reported at the ten-digit Harmonized System (HS-10), the highest possible disaggregation. Each observation details monthly imports for a unique trade partner-product pair, or variety. The estimation window is from 2018 to 2019, as these are the years when the majority of tariffs between the U.S. and Canada were imposed. The empirical estimation uses variation between varieties in product-time to structurally identify the demand elasticity. This is equal to the elasticity of substitution across imported varieties and is identified by instrumenting the duty-inclusive price in the IV estimation for the demand curve.

The identifying assumption requires that tariff rates be exogenous with respect to productivity and demand shocks at the variety level. If tariffs are systematically higher on goods with negative idiosyncratic shocks, this induces a correlation between the instrument and the error term, potentially biasing estimates toward zero. For example, this could occur if U.S. protectionism targets goods with low demand elasticity in industries lacking comparative advantage (see Costinot and Rodríguez-Clare (2014)). If true, the within-sector retaliatory instrument would similarly suffer from this issue, since WTO rules constrain retaliatory responses to match the tariff rates imposed by the trade partner while allowing discretion in selecting targeted goods. If the protective tariff correlates with the residual, so will the instrument.

Cross-sector retaliatory tariffs, however, are likely to provide an exogenous variation in duty-inclusive prices. Since the tariff rate—correlated with idiosyncratic shocks in protected sectors—is imposed on different industries, it is orthogonal to shocks in the targeted sectors. The underlying assumption is that, after accounting for aggregate effects, idiosyncratic shocks are orthogonal across sectors. If endogeneity concerns are present in the within-sector instrument, the cross-sector one remains plausibly exogenous. Policy shifts between protection and retaliation allow the identification of the upper bound demand elasticity.

Two key stylized facts emerge from the interaction between these two types of policies: (i) tariffs are countercyclical, and (ii) the types of goods targeted differ significantly between protection and retaliation. The countercyclicality is well established in the trade literature, as tariffs respond to negative economic shocks, inducing a correlation with business cycle fluctuations (e.g., Bown and Crowley (2013, 2014)). Governments use these tariffs discretionarily to raise revenue during economic downturns (see Espinosa (2022)), a pattern that aligns with the state-dependent policy framework in the model. Second, I show evidence that protectionism often targets intermediate inputs, most of which are concentrated in the metal industry and generally exhibit low demand elasticities (around two; see Ossa (2015)). However, when retaliating, around half of the products targeted are consumption goods, which typically have higher elasticities.

This pattern is also observed in the most recent trade war. The US imposed tariffs of 25% on steel and 10% on aluminum imports, affecting \$12.4 billion of Canadian exports and raising the average tariff rate by 16%.[1] Canada retaliated within a month, imposing tariffs of the same magnitude on \$12.7 billion of US exports, keeping the average tariff rate at a level equivalent to that of the US. Approximately \$5.5 billion of Canada's retaliatory tariffs targeted consumption goods. Political economy considerations also played an important

[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.

role: in the US, steel production represents a significant share in the swing states, frequently subject to tariffs due to strong lobbying influence, particularly during election cycles (see Waugh (2019) and Fajgelbaum et al. (2020)). Canada in response, targeted iconic US products such as bourbon whiskey—a key industry in Kentucky, a state Trump won in 2016, and one that competes with European whiskey brands (see Lake and Nie (2023) for a broader discussion of similar strategies). These dynamics are captured in the theoretical model.

Related literature

The literature on trade wars is well-established, spanning from mid-20th-century contributions like Johnson (1953), Markusen and Wigle (1989), Bagwell and Staiger (1999), and Broda et al. (2008). Since the Smoot-Hawley Tariff Act, economists have analyzed the effects of unilateral Nash tariffs in the economy. Bagwell and Staiger (1999) shows that a country with significant market power might gain from imposing tariffs by improving its terms of trade. However, after retaliation is factored in, all countries are worse off than under free trade. Their work emphasizes the importance of international cooperation for maximizing global welfare. Similarly, Broda et al. (2008) analyze optimal tariff rates countries could impose assuming others don't retaliate. While tariffs cause efficiency losses, they can create terms-of-trade gains depending on a country's market power. The magnitude of this effect depends on the inverse price elasticity of supply for exports: higher values force trade partners to lower prices in response to tariffs, moderating the drop in import quantities and allowing governments to extract rents from foreign competitors.

Another strand of the literature examines optimal tariffs under political economy considerations, like in Grossman and Helpman (1994, 1995), Goldberg and Maggi (1999), Eicher and Osang (2002), Ossa (2014). Grossman and Helpman (1994) shows how domestic lobby groups can drive tariffs even without international market power. Organized industries offer political contributions in exchange for protection, with governments weighing these against consumer welfare losses. Optimal tariffs depend on protected goods' demand elasticities and lobbying strength—inelastic demand allows higher tariffs due to lower consumer welfare losses, while stronger lobbies secure higher protection through greater contributions. Goldberg and Maggi (1999) provides empirical support for these predictions using data on trade protection in the US.

Trade elasticities are central to determining optimal tariff rates, and are defined as the percentage response of trade flows to trade shocks. Various types of trade elasticities exist, differing by the measure of trade shock, time horizon, or whether they have a structural interpretation. Examples in the literature are Feenstra (1994), Broda et al. (2008), Caliendo and Parro (2014), Ossa (2014), Boehm et al. (2023). Feenstra (1994), building on Krugman (1979, 1980), employs a nested CES model to structurally identify the elasticity of substitution across imported varieties. Broda et al. (2008) and Broda and Weinstein (2006) extend this approach to find this median elasticity is equal to 3.1 in the US. Recently, Boehm et al. (2023) follow an empirical approach to estimate trade flow elasticities to tariffs over different time horizons using Most Favored Nation (MFN) tariffs. They find an elasticity of 0.76 in the short run and 2 in the long run. Finally, Caliendo and Parro (2014), following Eaton and Kortum (2002)'s gravity equations and using variation across industries, find a median elasticity of 4.4.

Gravity equation models originate from the work of Anderson (1979); Anderson and van Wincoop (2003), relating bilateral trade flows to countries' economic sizes and trade costs, with geographic distance serving as a key proxy. Studies such as Eaton and Kortum (2002) and Caliendo and Parro (2014) incorporate gravity equations into general equilibrium models to assess how changes in trade costs, like tariffs, impact trade flows across industries and countries. These elasticities typically range between 4 and 6, with a median estimate of around 5 (see, e.g., Head and Mayer (2014)).

More recently, papers analyzing the effect of the trade war have utilized tariffs as instrument in the context of IV to structurally identify trade elasticities. Fajgelbaum et al. (2020) use US import data at the HS-10 level to estimate these elasticities, using steel and aluminum tariff rates as instruments for the duty-inclusive price. They find the demand elasticity is equal to 2.5, interpreted as the elasticity of substitution across imported varieties, while welfare costs reach $11 billion. Amiti et al. (2019) also estimates the impact of the 2018 US tariffs, regressing import quantities directly on the tariff measure, they estimate a demand elasticity of 1.3. This result is comparable to what Fajgelbaum et al. (2020) obtain in their OLS estimation; however, this OLS result is a downward-biased version of their IV estimate. Most studies find that the export supply elasticity is close to zero, implying a flat supply curve and complete pass-through of tariffs to consumer prices. These findings are consistent with Amiti et al. (2019), Fajgelbaum et al. (2020), Flaaen et al. (2020), and Cavallo et al. (2021).

Retaliatory measures against the US involved tariffs on consumption goods, automobiles, and agricultural commodities. Waugh (2019) shows Chinese retaliatory tariffs were imposed on highly exposed counties, reducing US export capacity. Estimating the elasticity is challenging due to limited data at the HS 6-digit level, which lacks granularity and obscures variations in trade flows. Amiti et al. (2019) estimate the demand elasticity of US export quantities to foreign retaliatory tariffs as 1.2, indicating almost complete pass-through of tariffs to prices. Fajgelbaum et al. (2020) reports something similar, estimating an elasticity of 1.04. Full pass-through to prices means US exporters bear the full cost with minimal price adjustment by foreign producers. These estimates are substantially lower than the upper bound found in this paper, a difference that could be attributed to differences in data granularity.

This paper reconciles two strands of literature. Trade war studies report low elasticity estimates, while this paper shows that when the upper tail of the distribution is targeted, the estimated elasticities align more closely with those from gravity models, albeit for different reasons. The contribution to the literature is twofold: (i) I propose a novel instrument to identify elasticities within a structural model, and (ii) I use these estimates to establish bounds on the average demand elasticity.

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. Section 5 discusses the estimation results, followed by the conclusion.

2 Empirical Evidence

2.1 Data

The dataset includes administrative records from the Canadian International Trade Division, consisting of monthly data on Canadian imports at the HS-10 level from 1988 to 2020. Each observation represents the import of varieties (trade partner-product pair) at the HS-10 level in a given month. The data include information on prices, quantities, and import duties collected at the border.

The strength of this database lies in its detailed reporting on imported products. HS-10 imports represent the most granular level at which trade data are recorded, making it critical for analyzing tariff impacts, as tariffs are applied at this specific tariff line. This level of detail allows for a more precise examination of how prices and quantities respond to tariff changes. Compared to other available databases, such as TRAINS and UN Comtrade, which generally provide data at the HS-6 level, this database offers a significant advantage in terms of granularity. It is more comparable to the U.S. counterpart (USA Trade Online), frequently used in studies analyzing the impact of the U.S. trade war.

For estimation purposes, data from 2018 to 2019 will be used. This period is particularly relevant as it captures Canada's retaliation against U.S. tariffs on steel and aluminum. The next section presents stylized facts that align with the key features discussed in the model section.

Stylized facts

This section addresses three empirical facts present in the literature: (i) tariffs exhibit a countercyclical profile, (ii) they are predominantly imposed on intermediate inputs, and (iii) retaliation matches the tariff rates imposed by the counterpart but shifts toward consumption goods. To show some of these facts, I will also use historical data on Canadian temporary trade barriers. The tariffs in this database are expressed as a percentage of prices rather than values, as is typically reported.[2]

I will decompose these tariffs into protective and retaliatory components, following the definitions used in Feinberg and Reynolds (2006, 2018)[3]. This decomposition is used to analyze the behavior of episodes where a country imposed tariffs discretionarily, compared to when the tariffs were a reaction to a trade partner's tariffs. First, to address the countercyclical profile, I focus on Canada's two most recent recessions. During these periods, I will analyze the timing of tariffs from the quarter at the peak and the two surrounding quarters. Figure 1 illustrates this relationship:

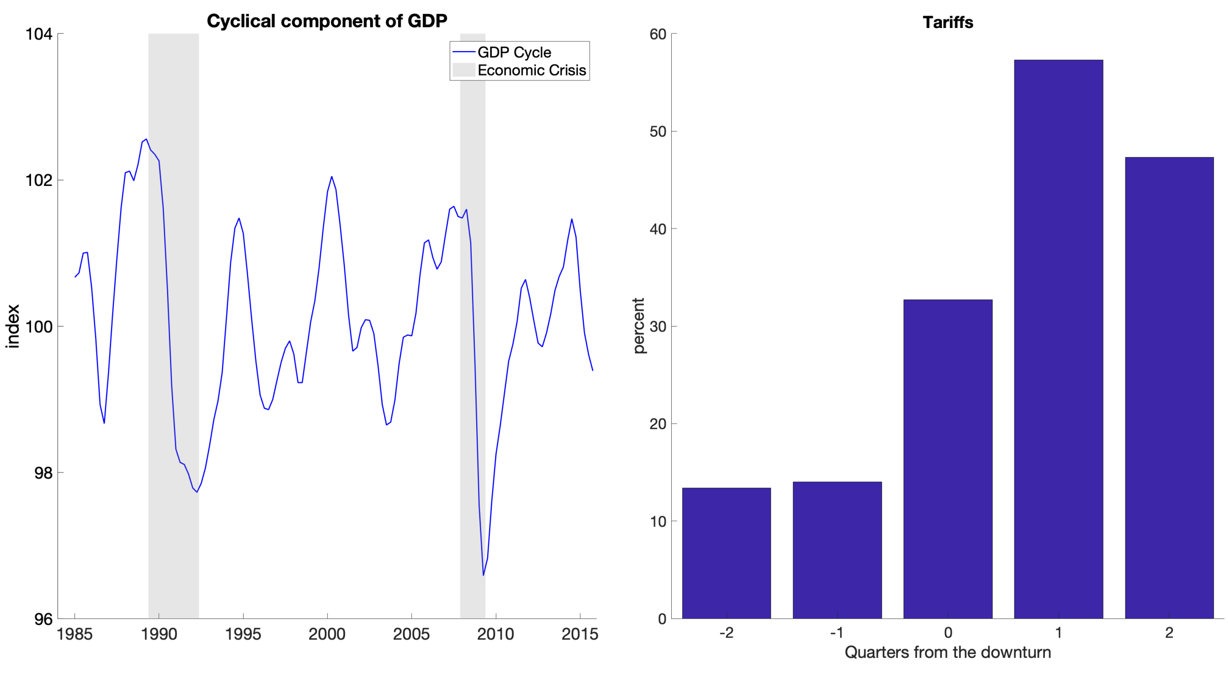

Figure 1: Countercyclical tariffs

[2]Information taken from Bown (2016), covering Canada's antidumping and countervailing duties between 1985 and 2016. The most common tool for temporary trade barriers is antidumping policies. These are measured by the dumping margin, defined as the difference between the normal value and the export price, expressed as a percentage of the export price. This margin is applied to specific products to counteract dumping practices by trade partners.

[3]Retaliation is defined as an action taken within a year of the original tariff increase by a trading partner. This allows for a distinction between protective and retaliatory measures.

It is important to note that, in this graph, 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.

Appendix B.1 examines the decomposition between the intensive and extensive margins. To do this, I classify periods as expansions or contractions, following the OECD's definition, which is based on the cyclical component of quarterly GDP.[4]

The results of regressing tariffs on the contraction dummy indicator, both using 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 supports the conventional view that protective tariffs are used as a stabilizing tool during economic downturns.

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.

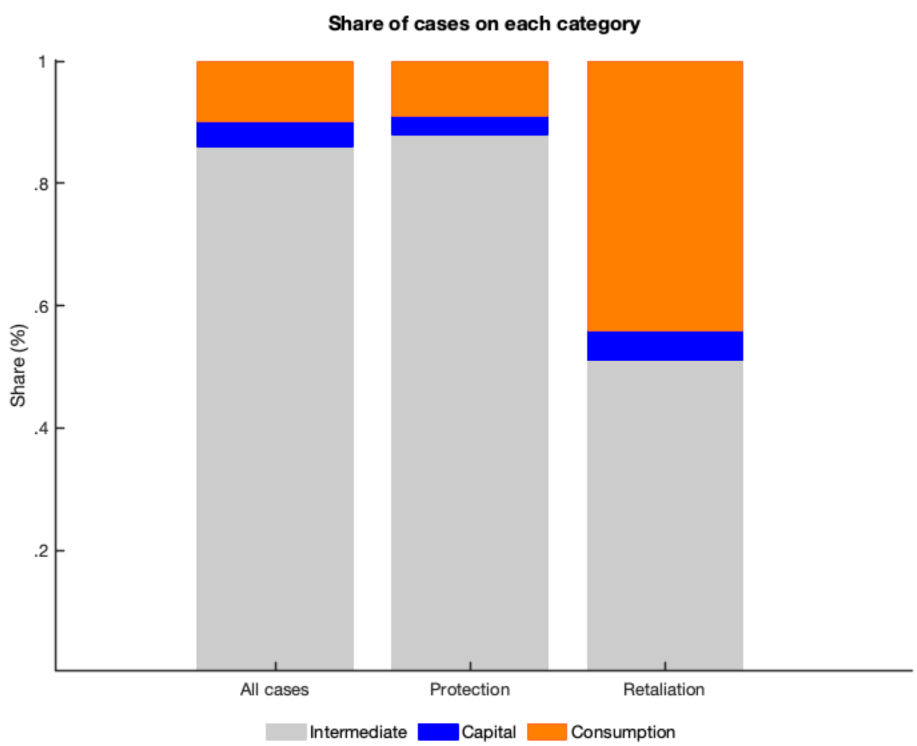

Figure 2: Composition of tariff's cases in Canada

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

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

90% of the cases in the sample. However, this sharply contrasts with retaliation cases, where half of the tariffs are imposed on consumption goods. Compared to these, intermediate goods are harder to substitute in the short run since they are used as inputs for other industries. Long-term supply contracts between firms 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. Third, during retaliation, tariff rates are matched with those of the counterpart. As the retaliatory response is regulated by the WTO, tariffs are set reciprocally to those imposed by the trading partner. For example, during the trade war, Canada mirrored the 25% and 10% tariffs imposed by the U.S., while maintaining a similar average rate—16% in the U.S. and 15% in Canada. The left panel of Figure 3 illustrates this:

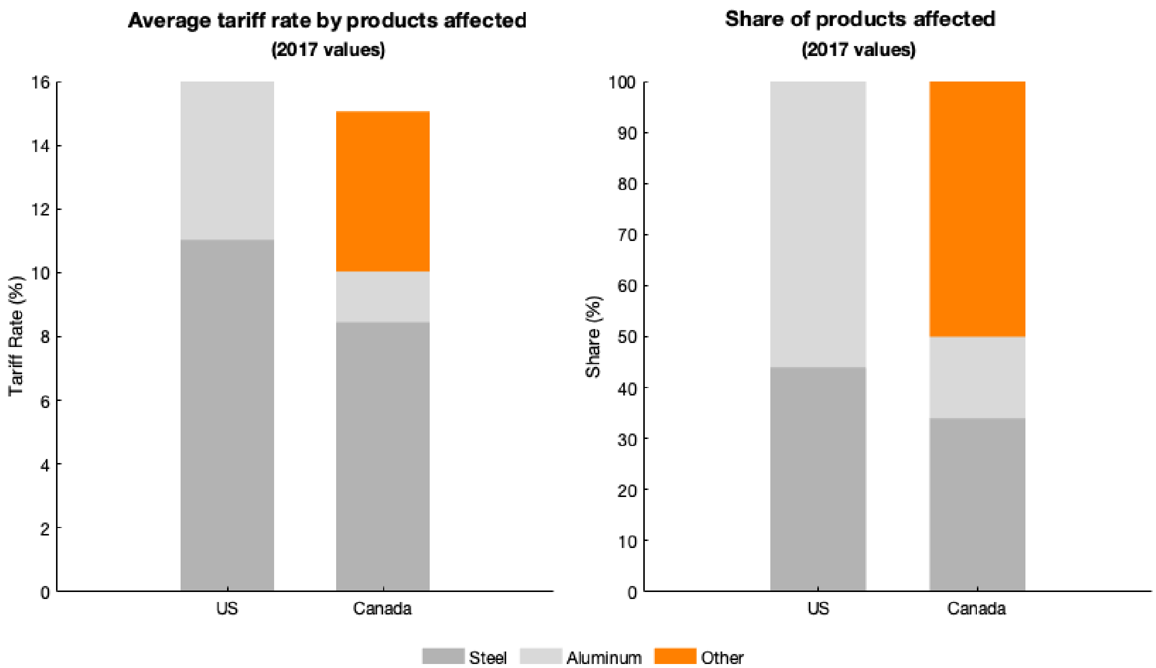

Figure 3: Canadian retaliation against US protective tariffs

Each bar reflects the contribution to the average tariff by type of good, weighted by the 2017 import share value. 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 U.S. protectionism. However, half of the retaliation was directed at sectors different from those protected. This leads to the fourth and final empirical fact. 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 U.S.-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.2 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

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 and 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:

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

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, include import values, quantities, duty-inclusive prices, and duty-exclusive prices. Figure 4 illustrates these results:

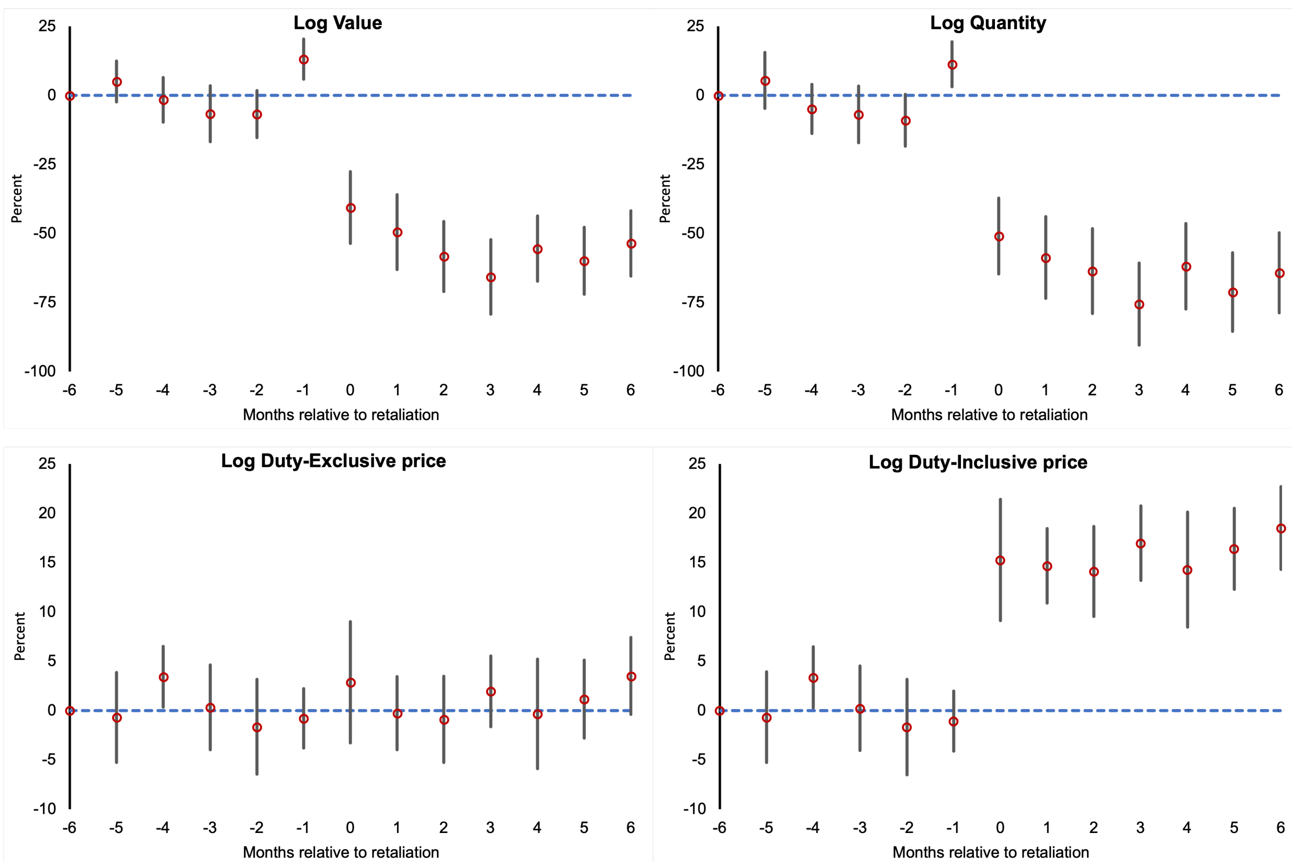

Figure 4: Event study

The results show 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.3 decomposes the dynamics of these variables into within-sector and cross-sector retaliatory tariffs.

From this analysis, it is evident that the anticipation effect is 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.

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 across all goods within a chosen 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[5]. Both tiers are:

$$
\begin{aligned}
C_s &= \left((1-\psi_s)^{\frac{1}{\rho_s}} Y_{Hs}^{\frac{\rho_s - 1}{\rho}} + \psi_s^{\frac{1}{\rho_s}} Y_{Fs}^{\frac{\rho_s - 1}{\rho_s}} \right)^{\frac{\rho_s}{\rho_s - 1}} \\
Y_{Fs} &= \left(\sum_j d_{Fsj}^{\frac{1}{\lambda_\mathbf{s}}} Y_{Fsj}^{\frac{\lambda_\mathbf{s} - 1}{\lambda_\mathbf{s}}} \right)^{\frac{\lambda_\mathbf{s}}{\lambda_\mathbf{s} - 1}}
\end{aligned}
\tag{2}
$$

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:

$$
Y_{Fsj} = d_{Fsj} \left(\frac{(1+\tau_{sj}) P^*_{Fsj}}{P_{Fs}} \right)^{-\lambda_s} Y_{Fs} \tag{3}
$$

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. Demand elasticities are identical across the two countries.

[5] 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)

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:

$$Y_{Fsj} = A^*_{sj}(L^*_{Fsj})^{\sigma^*_s} \tag{4}$$

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 (3) and (4), which yields the optimal pricing function:

$$P^*_{Fsj} = \left(\frac{\lambda_s}{\lambda_s - 1}\right)\left(\frac{W^*}{\sigma^*_s A^*_{sj}}\right)\left(\frac{Y_{Fsj}}{A^*_{sj}}\right)^{\omega^*_s}, \text{ where } \omega^*_s = \left(\frac{1-\sigma^*_s}{\sigma^*_s}\right) \tag{5}$$

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:

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

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

The price and quantity equilibrium for imported products can be obtained by solving equations (3) and (5) given the tariff rate. Expressing the variables in log deviations (denoted by lowercase letters) yields:

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

$$p^*_{Fsj} = \left[\frac{1}{(1+\omega^*_s\lambda_s)}\right]\left(-\omega^*_s\lambda_s(1+\tau_{sj}) - (1+\omega^*_s)\varepsilon_{A^*_{sj}} + \omega^*_s\varepsilon_{d^*_{Fsj}} + \phi^*_{p^*_{sj}}\right) \tag{7}$$

where ϕ^*_{sj} denotes a linear combination of variables at the sectoral and aggregate levels in each equation[6]. The rest of the equations follow from (6) and (7):

$$p_{Fsj} = (1 + \tau_{sj}) + p^*_{Fsj} \tag{8}$$

$$p_{Fs} = \sum_j [d_{Fsj} p_{Fsj}] \tag{9}$$

$$p_s = \sum_s [(1 - \psi_s) p_{Hs} + \psi_s p_{Fs}] \tag{10}$$

$$\pi_{Fsj} = (p^*_{Fsj} + y_{Fsj}) \tag{11}$$

$$r_{sj} = \tau_{sj} + \pi_{Fsj} \tag{12}$$

$$w = \sum_{sj} \beta_s \pi_{sj} \tag{13}$$

$$\ell = \kappa[w + (1 - \tau_L)] \tag{14}$$

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-

[6]These are variables that involve general equilibrium effects at higher levels of aggregation. In the empirical section, I will use fixed effects to control for them.

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:

$$\tau_{s'j'}(\mathcal{S}^*_{sj}) : \; \tau_{s'j'} = \tau_{sj} \tag{15}$$

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's tariff withdrawal.

3.4.1 Foreign Government

The government's budget constraint is defined as:

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

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.[7] At time zero, the foreign country has uniform tariffs in place to exploit its market power. These tariffs are set to maximize welfare and are equal to the inverse export supply elasticity, $\tau^*_s = \omega$.[8] Discretionary tariffs are equal to zero before the realization of the shock.

The bad state implies a drop in government revenue and, consequently, of the budget constraint, $\partial G^* / \partial \mathcal{S}^*_{sj} < 0$.[9] 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 (14), consequently affecting firms profits and production:

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

Import tariffs sharply increase the marginal benefit of government revenue. However, they

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

[8] The aggregate inverse export supply elasticity if equal to $\omega = \sum_s \beta_s \omega_s$. A tariff equal to ω 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.

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

also reduce the consumer surplus in the affected market:

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

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:

$$\tilde{\mathcal{W}}^* = \sum_s (\theta^*_s + \tilde{\mathcal{W}}^*_s) \tag{16}$$

where $\tilde{\mathcal{W}}^*_s = \pi^*_{Fs} + \delta_b r^*_s$. 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 $\tilde{\mathcal{W}}^*$, or a combination 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. The government chooses

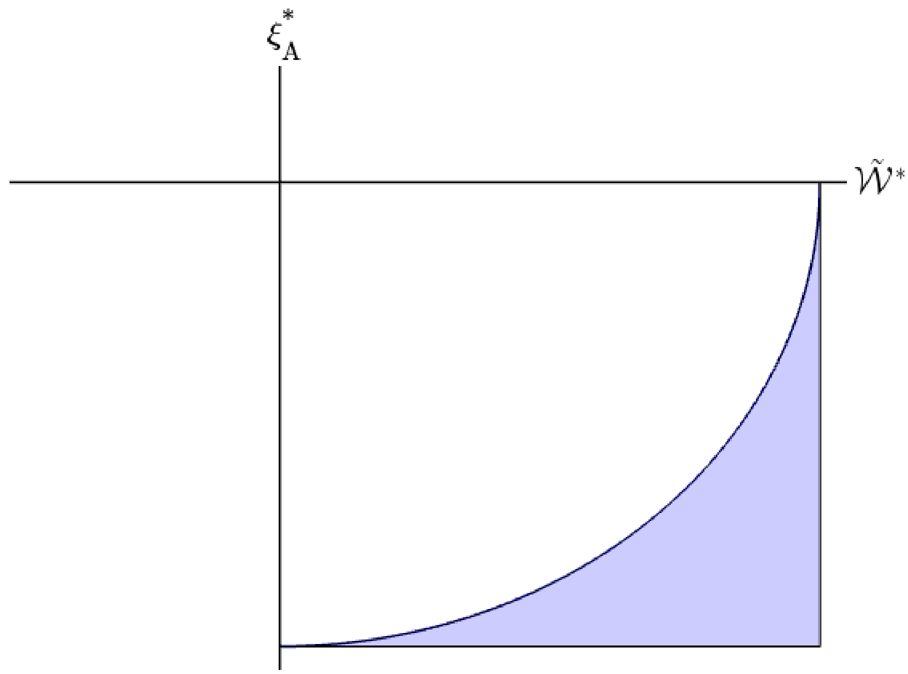

Figure 5: Bad state region

tariffs to maximize the following value function:

$$V_b^*(\mathcal{S}) = \max_{\tau^*_{sj}} \tilde{\mathcal{W}}^*(\mathcal{T}^*_{sj}, \mathcal{S}) + \beta \left[qV_b^*(\mathcal{S}') + (1-q)V_n^*(\mathcal{S}') \right] \tag{17}$$

Proposition 1. *Given the government's value function (17), subject to (6)-(14) and (16), the tariff rate 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 both the demand and supply elasticities 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.

Protectionism

The industry on which the tariff is imposed depends not only on how inelastic its demand is, but also on the lobby strength, 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 (16) and the result in Proposition 1 to express the government's decision problem as:

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

where D_s^* 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:

$$P\left(\xi_s - \xi_{s'} > \tilde{\mathcal{W}}_{s'}^*(\tau_{s'j'}^*) - \tilde{\mathcal{W}}_s^*(\tau_{sj}^*)\right) \tag{18}$$

Industries with stronger lobby influence are more like to be treated. This probability depends on the functional form of $\Delta\theta_s^*$, the difference with respect to sector s', taken as 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.

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:

$$V_b(\mathcal{S}) = \max_{\tau_{s'j'}} \mathcal{W}(\mathcal{T}_{s'j'}, \mathcal{S}) + \beta\left[qV_b(\mathcal{S}') + (1-q)p_n V_n(\mathcal{S}')\right] \tag{19}$$

Home maximizes welfare subject to (15). 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.

The game is represented in Figure 6. 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.

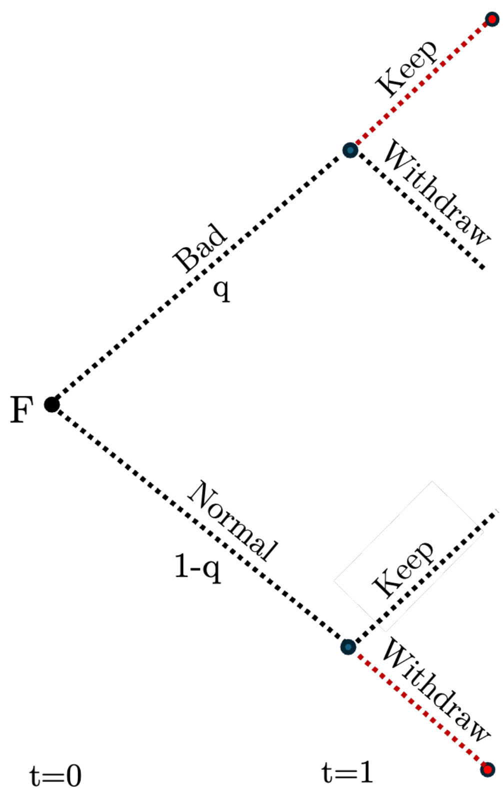

Figure 6: Sequential game

Strategic Interactions

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

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

Table 2: Payoffs Matrix in bad times

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[10], and therefore, the SPNE is to keep tariffs during bad times. In normal times, payoffs are:

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

Table 3: Payoffs Matrix in normal times

Compared to the bad state, retaliation has a significant impact. However, Home must weight 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 have depends on the model's solution in equations (6)-(14):

$$cs_{s'j'} = -\lambda^*_{s'}(1 + \tau^*_{sj}) \tag{20}$$

$$ps_{s'j'} = -\lambda_{s'}(1 + \tau^*_{s'j'}) \tag{21}$$

$$ps_{sj} = \left[\frac{\lambda^*_s(1 + \omega_s)}{1 + \lambda^*_s\omega_s}\right](1 + \tau^*_{sj}) \tag{22}$$

Proposition 2. *Given the value function in (19) and equations (20)-(22), 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.

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

Stochastic choice model

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

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

The withdrawal decision occurs when the utility of withdrawing is higher, with the probability:

$$P\left(\varepsilon^{w^*} - \varepsilon^{k^*} > V_n^{k^*}(\mathcal{S}) - V_n^{w^*}(\mathcal{S})\right) \tag{23}$$

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

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

where $\Delta V_n^{k^*} = (V_n^{k^*} - V_n^{w^*})$. Home actions reduce the value of $V_n^{k^*}$, 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.

Withdrawal Probability

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

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

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

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

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 Foreign more inclined to withdraw in this state.

Retaliation

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:

$$(D_{s'} = 1 | D_s^* = 1) = \Delta\lambda_{s'}(1 + \tau_{sj}^*) + \Delta\theta_{s'}^*$$

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:

$$P\left(\Delta\theta_{s'}^* > -\Delta\lambda_{s'}(1 + \tau_{sj}^*)\right) \tag{24}$$

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.

4 Identification strategy

The import demand and export supply equations can be described by:

$$\begin{aligned} y_{Fsjit} &= \phi_{jt} + \phi_{it} + \phi_{is} - \lambda_s p_{Fsjit} + \xi_{sjit}^d \\ p_{Fsjit}^* &= \phi_{jt} + \phi_{it} + \phi_{is} + \omega_s^* y_{Fsjit} + \xi_{sjit}^s \end{aligned}$$

Subscript i refers to imports from multiple trade partners, so these equations describe the import and export of varieties (i.e., trade partner-product pairs). The error terms in each equation can be correlated within varieties in the same sector and across countries, but they are orthogonal across industries.

The terms ϕ represent a collection of fixed effects that control for product-level seasonal effects, aggregate shocks, and industry characteristics. These fixed effects are essential for capturing general equilibrium effects, accounting for variables such as exchange rate fluctuations, wages, sector-level disturbances, and foreign tariffs.

The identification of the demand elasticity, λ_s, interpreted as the elasticity of substitution across imported varieties, and the inverse export supply elasticity, ω_s^*, can be achieved through Instrumental Variables (IV) estimation. The instrument is, retaliatory tariffs imposed on sector s' in response to tariff rates on sector s. The IV approach must satisfy the relevance and exogeneity conditions:

$$\mathbb{E}\left[\tau^*_{sjit} \times \{p_{Fs'j'it}, y_{Fs'j'it}\}\right] \neq 0$$
$$\mathbb{E}\left[\tau^*_{sjit} \times \{\xi^d_{s'j'it}, \xi^s_{s'j'it}\}\right] = 0$$

First, the tariff rate increases the duty-inclusive price and reduces imports of sector s'. Second, and as in the theoretical model, import tariffs are correlated with idiosyncratic shocks, i.e., $\tau^*_{sjit} = \psi^*_s \xi_{sjit}$[11]. However, when imposed on sector s', they are orthogonal to the error term in these equations. To identify each elasticity, estimate the following:

$$\begin{aligned} \mathbb{E}\left[\tau^*_{sjit} \times y_{Fs'j'it}\right] &= -\lambda_{s'}\mathbb{E}[\tau^*_{sjit} \times p_{Fs'j'it}] + \mathbb{E}\left[\tau^*_{sjit} \times \xi^d_{s'j'it}\right] \\ \mathbb{E}\left[\tau^*_{sjit} \times p^*_{Fs'j'it}\right] &= \quad \omega^*_{s'}\mathbb{E}[\tau^*_{sjit} \times y_{Fs'j'it}] + \mathbb{E}\left[\tau^*_{sjit} \times \xi^s_{s'j'it}\right] \end{aligned}$$

If exogeneity holds in both equations, the IV estimator identifies $\lambda_{s'}$ and $\omega^*_{s'}$. It is crucial, however, to control for $(D_{s'j'}|D^*_{sj} = 1)$, which reflects the likelihood of targeting demand-elastic varieties during retaliation. Since this depends on differences in elasticities and industry lobby weights, sector-level fixed effect captures this source of variation.

5 Results

This section presents the baseline results for the elasticity estimation, 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, the welfare costs of tariffs are analyzed.

The estimations control for fixed effects at the product-time, country-time, and country-sector levels. The first controls for seasonal patterns and product-specific dynamics, the second for aggregate variables such as exchange rates, and the third accounts for sector characteristics at the country level, including those relevant for selection. All variables are expressed in log differences, and the duty-inclusive price is instrumented using tariff changes. Table 4 presents the baseline estimation:

[11] The tariff rate depends on the product's expenditure. In equilibrium, this is influenced by the idiosyncratic shocks to demand and supply at the variety level.

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
R2	0.27	0.27	.	.
N	2,409,339	2,409,339	2,409,339	2,409,339

Notes: Standard errors clustered by trade partner and product at the HS-8 level.

The OLS coefficient is -0.76, biased towards zero due to endogeneity. When using tariffs as an instrument, the coefficient increases (in absolute terms) to -2.37, which is larger than the OLS estimate. As for the supply elasticity, it is negative and marginal in both cases and becomes insignificant in the IV estimation. This suggests an elastic supply curve, implying a complete pass-through of tariffs into duty-inclusive prices. Using the model's results, the average effect on trade values can be expressed as:

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

Applying the average Canadian tariff increase and the estimates from the table above leads to an average drop of 33%, driven primarily by the demand side, given that the supply elasticity is zero.

When comparing these results with the existing literature, the IV coefficients are close to the commonly reported -2.5 for demand elasticity and zero for supply elasticity. Consequently, the drop in trade values is similar, suggesting that this analysis, using Canadian data, replicates the findings from studies on the U.S. experience.

However, import tariffs may obscure the effect of the cross-sector retaliatory component. To address this, the decomposition is used to run the same regressions. Table 5 presents the results:

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
R2	.	.	.	.
N	2,409,339	2,409,339	2,409,339	2,409,339

Notes: Standard errors clustered by trade partner and product at the HS-8 level.

The result of -2.37 is largely driven by the elasticity of the within-sector component, estimated at -1.87. This suggests that the selection toward inelastic varieties dominates the aggregate measure. This value represents the lower bound estimate ($\hat{\lambda}_L$) in 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, 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:

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

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, indicating that endogeneity concerns may still be present when using these tariffs as an instrument. In contrast, retaliatory tariffs provide a positive, though small, estimate, suggesting that supply factors are not central to explaining average trade effects.

Regarding the relevance condition, the instrument exceeds the rule of thumb threshold of 10 in all specifications. However, it is somewhat lower in panel data estimations, likely because the instrument is relevant only for US imports and not for those from the rest of the world. This suggests that in split samples focused solely on US trade, the instrument would be much stronger.

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 estimated demand elasticities remain significant in both cases. To illustrate the results, Figure 7 portrays a visual representation of the estimates:

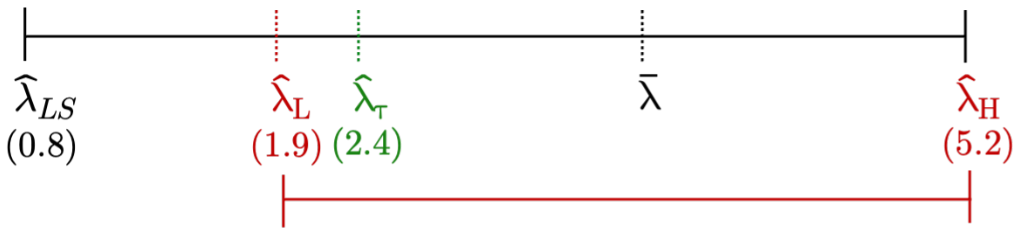

Figure 7: Average elasticity bounds

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 the unknown distribution. The OLS estimate, which is heavily downward biased, lies outside this interval.

Welfare Effects

The welfare implications are a nonlinear function of trade elasticities. Averaging between the two bounds could lead to overestimation or underestimation of the welfare consequences of tariffs.

This calculation incorporates the model's equations and the estimated elasticities of demand and supply. Since the export supply elasticity approaches zero, the average deadweight loss has a linear relationship with the import demand elasticity. Figure 8 illustrates this relationship.

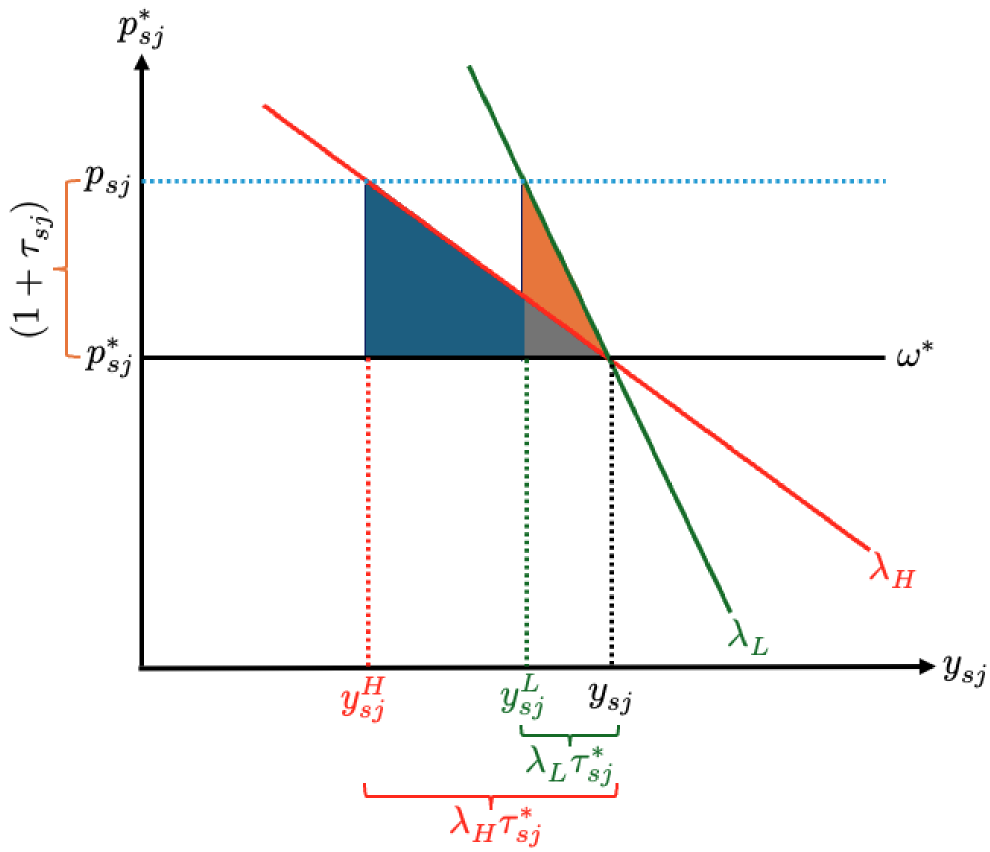

Figure 8: Welfare cost of tariffs

The deadweight loss (DWL) in the case of low demand elasticity (λ_L) is represented by the sum of the gray and orange areas. In the case of high demand elasticity (λ_H), it corresponds to the gray and blue areas. Since λ_H is twice as large as λ_L, the welfare cost is doubled.

To calculate this, the model's equations and the estimated elasticities of demand and supply are used. The DWL, in levels, can be expressed as:

$$DWL = \frac{1}{2}\left(P^*_{sjit} \times Y_{Fsjit}\right)\tau_{sjit}y_{Fsjit} = -\frac{1}{2}\lambda_s\tau^2_{sjit}\left(P^*_{sjit} \times Y_{Fsjit}\right)$$

Since the elasticity estimate is approximately three times higher under retaliation compared to protection, holding other factors constant, the welfare cost is proportional to this difference. As a result, if tariff rates are identical in both cases, the deadweight loss is \$7.6 billion compared to \$2.7 billion.

However, in this case, Canada imposed an average tariff rate of 20% on the protected industries and 10% on the others. Accounting for these differences, the deadweight loss remained the same across the two scenarios. Table 6 summarizes these findings:

Table 6: Tariff's welfare costs

Imports	$\hat{\lambda}$	$\Delta\tau$	DWL
12.4b	-2.5	16.6	11b
12.4b	-5.2	16.6	22b

In the U.S., the value of imports affected by tariffs, based on 2017 figures (prior to the trade war), totaled $12.4 billion. The Trump administration's tariff policies led to an average tariff rate increase of 16.6%. To assess the impact, we use the estimated demand elasticity for both the lower and upper bounds.

These findings suggest that the welfare losses in the United States resulting from the Trump administration's tariffs may be significantly larger than previously reported in the literature—potentially twice as high. Using a lower bound elasticity of 2.5, and an upper bound elasticity of 5.2, I estimate the deadweight loss to increase from $11 billion to $22 billion.

While the estimated welfare losses show a substantial increase, they remain relatively modest at the aggregate level. Relative to total U.S. imports in 2017, the impact reflects an increase from 0.4% to 0.8% of total import value. However, at the industry level, these changes can be quite significant. For example, in the metal industry, the impact rises from 20% to 40% of the sector's output.

Robustness checks

The result remain robust to several specifications. One of them is that if these effects are driven by trade between Canada and the US. Certainly, tariff rates were raised towards this trade partner, keeping the remaining ones unchanged. To isolate this, interact the variables with a US dummy indicator and re-run the regressions:

Table 7: Robustness - Estimation using US tariffs

	IV within-sector		IV cross-sector	
	λ_s	ω_s^*	λ_s	ω_s^*
$\hat{\beta}$	-1.69	-0.11	-5.6	0.10
se($\hat{\beta}$)	(0.22)	(0.04)	(1.67)	(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	217	55	24	26
R2	.	.	.	.
N	2,409,339	2,409,339	2,409,339	2,409,339

Notes: Standard errors clustered by trade partner and product at the HS-8 level.

Table 7 shows that the estimates are very close to the ones obtained in the result. Moreover, the null hypothesis $H_0 : \hat{\lambda}_L = \hat{\lambda}_H$ is rejected: F = 5.3 ($P_v = 2.2\%$).

This suggests that the estimations using the whole sample are driven by the retaliation against the US. Tariffs against other trading partners remained unchanged during the trade war, and tariffs on targeted HS-10 products increased only for the US. This explains why the results are entirely driven by this counterpart.

To explore if tariffs against the rest of the world play a role in the results, I will run the regressions using these and controls. Table 8 illustrates this:

Table 8: Robustness - Estimation using US tariffs with controls

	IV - Protective		IV - Retaliatory	
	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	2,409,339	2,409,339	2,409,339	2,409,339

Notes: Standard errors clustered by trade partner and product at the HS-8 level.

The estimation for the elasticities remains roughly the same with respect to the previous results. The standard error however, are improved marginally. Tariffs against the rest of competitors are therefore not relevant for explaining the elasticity estimations. This is in line with the argument made before, as the dynamics are entirely explained by Canada and the US.

6 Conclusion

This paper examines the impact of tariffs on Canada's trade volumes and prices, using retaliatory tariffs as a novel instrument to address identification concerns. The main finding is a demand elasticity of 5.2, significantly higher than the typical estimate of 2.5 reported in the literature. Retaliatory tariffs, which target elastic goods, provide an upper bound of the elasticity distribution, while protective tariffs reflect the lower bound. By differentiating between these two, the paper estimates an average elasticity range between 2.5 and 5.2. This elasticity range leads to an interval for welfare costs, estimated between \$11 billion and \$22 billion.

Using a political economy model, this paper illustrates the strategic behavior of countries in their tariff imposition and retaliation. The foreign country's decision to impose tariffs during recessions is driven by the increased marginal utility of government revenue, while the home country's retaliatory strategy is designed to dissuade prolonged protectionism and restore free trade in the long run.

Trade policies target the extremes of the elasticity distribution. Protective tariffs are imposed on industries with low demand elasticity, as this raises revenue while also protecting domestic producers. Retaliatory tariffs, on the contrary, are designed to maximize economic damage by focusing on elastic goods. When analyzing the broader effects of tariffs, it is essential to consider the selection in the policy design. This heterogeneity significantly influences welfare costs, and neglecting it can understate the true economic impact. Accounting for this, suggests that actual welfare costs are likely higher, as higher elasticities imply greater deadweight losses.

Potential areas for further research include a detailed analysis of the distribution of elasticities. Expanding the focus beyond Canada's retaliation to include data from other trade partners, such as the European Union and Mexico, could provide a more comprehensive measure of the average elasticity interval, especially if the range of products covered varies significantly across these countries.

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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[12]*. This effect can be derived from the foreign price indices (8), (9), and (10), and depends on the upper layer of the Nested CES in equation (2):*

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

The second term, tariff revenue, can be computed from the Home counterpart of equations (6) and (7). 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:

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

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

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

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

[12] 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, 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 (20)-(22) 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:

$$\Delta V_n^{k^*} = \theta^*_{sj}\pi^*_{F_{sj}}(\tau^*_{sj}) - z_{s'j'}\theta^*_{s'}\pi_{F_{s'j'}}(\tau^*_{sj})$$

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

$$\frac{\partial \Delta V_n^{k^*}}{\partial \tau^*_{sj}} = \frac{\theta^*_s \partial \pi^*_{F_{sj}}(\tau^*_{sj})}{\partial \tau^*_{sj}} - z_{s'j'}\frac{\theta^*_{s'}\partial \pi_{F_{s'j'}}(\tau^*_{sj})}{\partial \tau^*_{sj}}$$

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 (11), which is equal to $\lambda_{s'}$. Combining both effects, we get:

$$\frac{\partial \Delta V_n^{k^*}}{\partial \tau^*_{sj}} = \frac{\theta^*_s z_{sj}}{1+\omega^*_s\lambda_s} - z_{s'j'}\theta^*_{s'}\lambda_{s'}$$

Rewriting this as:

$$\frac{\partial \Delta V_n^{k^*}}{\partial \tau^*_{sj}} = \frac{\theta^*_s z_{sj}}{1+\omega^*_s\lambda_s} - z_{s'j'}\left(\Delta\lambda_{s'}\theta^*_{s'} + \Delta\theta^*_{s'}\lambda_s + \lambda_s\theta^*_s\right)$$

where the terms in differences are taken with respect to their counterpart in sector s'. Denote this derivative as $\Delta\tilde{V}_n^{k^*}$ such that 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 express $\Delta V_n^{w^*}$ 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. The threshold above which sector-level expenditures exceed the cutoff is:

$$\Psi_{s'} = \inf\left(\max\{\psi_{s'}\} \geq \tilde{\psi}_{s'}\right)$$

If $\Psi_{s'}$ 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. □

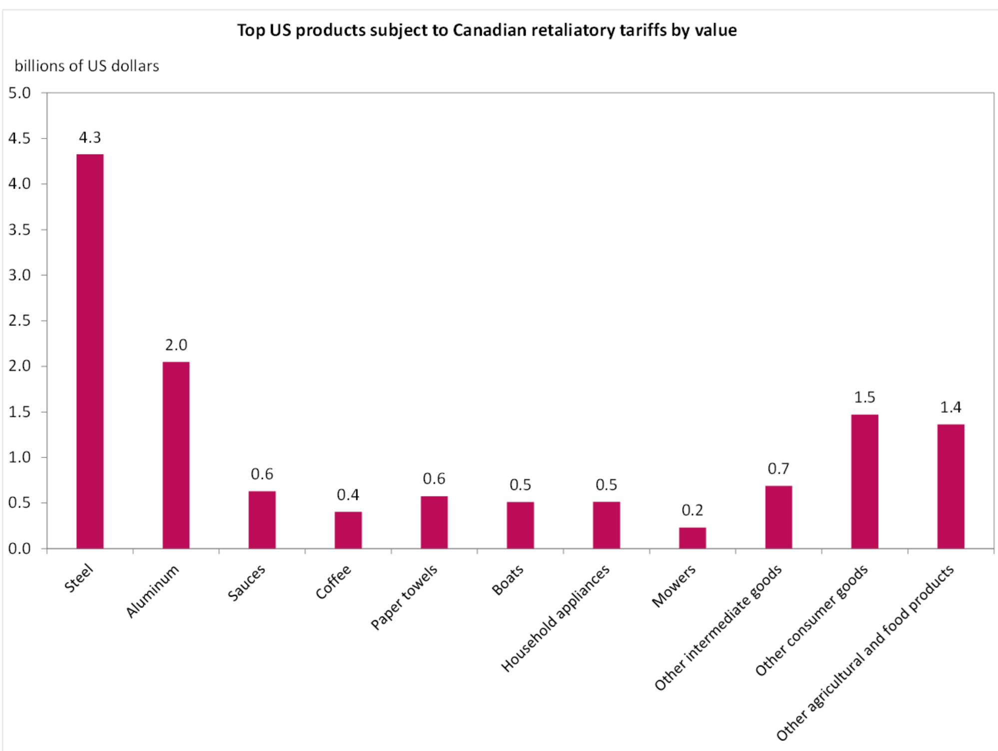
B Appendix B: Other Tables and Figures

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: (***): $p < 0.01$, (**): $p < 0.05$, (*): $p < 0.1$. 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 Retaliation decomposition by products



B.3 Event study decomposition