Tariff Theories in a Trade War

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Abstract

Tariff theories have been largely overshadowed by politics during the recent trade wars. This study reasserts their relevance by comparing theoretically implied tariffs with those actually implemented by policymakers. We develop a quantitative framework to evaluate the performance of tariff theories under equivalent policy strength. Applying this framework to China, we evaluate four leading tariff theories in both positive and normative terms against the country's actual retaliatory tariffs. As shown, these theories help identify policy options that are considerably less distortive.

Key words: Trade war, lobbying, electoral politics, optimal tariffs, trade sanctions
JEL codes: E39, F13, O24

1 Introduction

After decades of relative peace in international trade, tariff theories have faded from policy discourse. The recent trade wars underscore this neglect, as governments imposed aggressive tariffs with no basis in tariff theories. When a free trade equilibrium is unattainable, tariff theories offer principled policy responses, providing at minimum a coherent foundation and a governing economic rationale. Without them, trade policy can quickly devolve into power struggles or even chaos, exacerbating the economic damage.

A key reason tariff theories were sidelined is their perceived impracticability. Not all tariff theories yield actionable rates. And when they do, the choice between them is complicated by differing objectives, coverage, and scale. What economists have failed to offer the policy world is not only a practical roadmap but, first and foremost, a platform within which tariff theories can be operationalized and compared. Only when such a platform exists can tariff theories become viable policy solutions.

In this paper, we develop a quantitative framework that (i) unifies tariff theories within a single platform, (ii) generates actionable tariff responses, (iii) incorporates data from real-world trade conflicts, and (iv) enables comparisons between actual policies and credible counterfactuals.

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The framework works as follows. Any major tariff policy change can be represented as a linear constraint, defined by the tariff rate structure, the total taxable value, and the initial prices of the affected products. Each tariff theory is modeled as a policymaker guided by a distinct motive, who endogenously selects products to target subject to the same linear constraint. Because all resulting tariff schedules are equivalent in observed strength, consistent comparisons can be made across theories—positively, in terms of product selection, and normatively, using a welfare metric. These comparisons also situate the actual policy within the spectrum of outcomes implied by different theories.

We apply this framework to the 2018 US–China trade war, focusing on China's response. Unlike the US, which explicitly aimed to reduce its trade deficit, Chinese policymakers never articulated an official rationale for enacting retaliatory tariffs. As a trade-dependent economy with a sizable surplus against the US, China lacked a clear economic incentive to escalate the conflict. Therefore, China's response, viewed through the lens of extant tariff theories, serves as a pertinent illustration of our approach in practice.

Our analysis examines four leading tariff theories:

1. **(OT)** The optimal tariff theory rationalizes tariffs with terms-of-trade gains. Since tariffs create a tax incidence between domestic consumers and foreign producers, taxing foreign products with low supply elasticities improves domestic welfare at the cost of foreign exporters (e.g., Bickerdike, 1907; Johnson, 1953; Broda et al., 2008).

2. **(PS)** The protection-for-sale theory argues that governments use tariffs to protect industries with organized lobbying power (e.g., Grossman and Helpman, 1994; Goldberg and Maggi, 1999; Gawande and Bandyopadhyay, 2000). Although China operates without organized lobbies, state-owned enterprises—which directly contribute revenue and influence policy—play a similar role (Benguria and Saffie, 2025). We follow Branstetter and Feenstra (2002) in modeling state-owned enterprises as China's organized lobbies.

3. **(SS)** The political impact of tariffs mainly stems from products originating in electorally competitive regions (e.g., Mayer, 1984; Dutt and Mitra, 2002; Muûls and Petropoulou, 2013; Ma and McLaren, 2018). Given that swing states were pivotal to Trump's 2016 victory and 2020 campaign, China focused its retaliatory tariffs on products from these states (Fetzer and Schwarz, 2021; Kim and Margalit, 2021), which we refer to as the swing-state theory.

4. **(SANC)** The trade sanction theory views trade restrictions as tools for achieving diplomatic objectives through coercion, alienation, and signaling (e.g., Mayer, 1977; Kaempfer and Lowenberg, 1988, 2007; Verdier, 2009). Under this theory, Chinese policymakers targeted US products in sectors where the United States holds comparative advantages.

Our analysis produces six main findings. First, across the four differently motivated tariff schedules, the resulting welfare ranks as follows: **PS** $<$ **SS** $<$ **OT** $<$ **SANC**. We simulate welfare deterioration as the total taxable value increases, from no retaliation to the full strength of China's factual retaliation, and trace four distinct trajectories. The pace of welfare decline follows the same ordering.

Second, the **SS** schedule results in a welfare loss closely mirroring that of the factual retaliation, which is approximately 0.37 percentage points below the pre-retaliation level. In addition, a regression analysis linking the factual tariff schedule to the four alternative tariff schedules shows that the **SS** schedule explains the observed retaliation. Thus, both our normative and positive results lend support to the **SS** theory.

Third, the **OT** schedule yields only modest gains over the factual scenario. Our estimates suggest that China faces a horizontal foreign supply curve, which is similar to findings for the US in prior studies.[1] Nonetheless, according to our estimates, even with upward-sloping supply curves on the US side, the welfare gains from imposing optimal tariffs remain limited, and the net effect is still negative.

Fourth, the **PS** schedule yields the lowest welfare among all four alternatives, and is the only one that results in lower welfare than the factual schedule. Given the well-documented production inefficiencies of state-owned enterprises (e.g., Hsieh and Klenow, 2009), shielding them from competition through tariffs would impose a double burden on domestic welfare.

Fifth, we solve an import-price maximization problem to assign a customized tariff rate to each US product variety, while holding total tariff-ridden trade volume equal to that of China's factual retaliation. This tariff schedule delivers nearly ten times the welfare loss of the factual retaliation, representing the lower-bound welfare of all possible alternative tariff responses.

Lastly, our approach aligns with studies that evaluate trade policies using reduced-form measures such as equivalent variation (EV), compensating variation (CV), and consumer surplus (e.g., Bernhofen and Brown, 2005; Irwin, 2005; Amiti et al., 2019; Bekkers et al., 2025). We show that the welfare impacts of both factual and counterfactual tariffs, which we derive from the CES demand system, can also be derived in terms of EV.

Most studies of trade wars rely on general equilibrium models.[2] These models fully specify the behavior of all representative agents in an economy, enabling researchers to simulate the macroeconomic impacts of trade wars. General equilibrium mechanisms that hold in one regime may break down under market distortions or institutional asymmetries present in other regimes, such as China. Our framework takes a minimally structural approach. It is based on observed prices, tariff rates, and taxable values within a simple trade accounting system. Rather than modeling all agents in an economy, it centers policy response on a government's product-level decisions: which

[1]See Amiti et al. (2019), Amiti et al. (2020), Besedes et al. (2020), Fajgelbaum et al. (2020), and Flaaen et al. (2020), among others.

[2]See Grossman and Helpman (1995), Ossa (2014), Caliendo and Parro (2015), Fajgelbaum et al. (2020), and Chang et al. (2021), among others. For literature reviews, see Ossa (2016) and Caliendo and Parro (2022).

foreign products to target and which domestic sectors to protect. Because modern trade accounting applies to all countries in the world, our framework generalizes across countries with varying market structures and institutional arrangements.

Our minimal structure is especially suitable for comparing tariff theories. This study presents, to our knowledge, the first quantitative comparison of tariff theories. Tariff theories have developed from diverse intellectual traditions, historical contexts, and geopolitical backgrounds. Each emphasizes different dimensions of policymaking, whether economic, political, or both, and the key actors in one theory may be entirely absent from another. What one theory treats as central may be overlooked or completely irrelevant in others. These conceptual divergences are further compounded by the difficulty of applying theories consistently across countries. To enable comparison, we distill the product-selection logic unique to each theory and embed it within a common quantitative platform. Our aim is to bridge the fragmented strands of tariff analysis, foster technical dialogue across them, and enhance their applicability to real-world policy design.

The rest of the paper is organized as follows. Section 2 describes China's retaliatory tariffs, serving as a concise institutional background of the trade policies we analyze. Section 3 presents our quantitative framework. Section 4 reports our main findings. Section 5 discusses the lower-bound welfare in theory. Section 6 discusses the connection between our framework and reduced-form welfare measures. Section 7 concludes.

2 China's 2018 Retaliatory Tariffs

The 2018 US–China trade war unfolded in four rounds, each ending with new tariffs imposed by both countries. In every round, the Trump administration initiated the action, prompting swift retaliation from China's central government. Figure 1 outlines the sequence of events. Below, we review the major developments of the trade war, with a focus on China's retaliatory measures.

On June 15, 2018, the Office of the United States Trade Representative (henceforth, USTR), following directives given by President Trump, released two lists of Chinese products to be levied with 25 percent additional tariffs.[3] These two lists were officially called the 34 billion list (or Tranche 1) and the 16 billion list (or Tranche 2), since the taxable Chinese products in the two lists, if denominated in terms of 2017 US imports from China, were worth 34 billion and 16 billion US dollars, respectively. Tranche 1 was announced to take effect on July 6, 2018, and Tranche 2 on August 23, 2018. In response, the Customs Tariff Commission of the Chinese State Council

[3] President Trump instructed the USTR on August 14, 2017 to investigate whether China "implemented laws, policies, and practices and has taken actions related to intellectual property, innovation, and technology that may encourage or require the transfer of American technology and intellectual property to enterprises in China or that may otherwise negatively affect American economic interests" under Section 301 of the Trade Act of 1974. Having completed an eight-month investigation, the USTR issued a report on March 22, 2018. On the same day, Trump signed a presidential memorandum to announce that punitive tariffs would be applied to Chinese products. The lists were publicized by the USTR on April 3, 2018, revised afterwards, and finally released on June 15, 2018.

Figure 1: The 2018 US–China Trade War

The US side		The Chinese side
6-15-2018: • Tranche 1: **effective 7-6-2018, 34bn USD, rate: 25%**	→	6-15-2018: • Tranche 1: **effective 7-6-2018, 34bn USD, rate: 25%**
• Tranche 2: **effective 8-23-2018, 16bn USD, rate: 25%**	→	• Tranche 2: **effective 8-23-2018, 16bn USD, rate: 25%**
7-10-2018: • Tranche 3: **effective 9-24-2018**, 200bn USD, rate: **10%**	→	9-18-2018: • Tranche 3: **effective 9-24-2018**, 60bn USD, rate: up to **10%**
5-9-2019: • Tranche 3 continued: rate raised to **25%**, effective 5-10-2019	→	5-13-2019: • Tranche 3 continued: rate raised up to **25%**, effective 6-1-2019
8-13-2019: 300bn USD • Tranche 4 (half): **effective 9-1-2019**, rate: 15%	→	8-23-2019: 75bn • Tranche 4 (half): **effective 9-1-2019**, rate: 10%

October to December 2019: both sides disclosed ongoing negotiation
1-15-2020: the two sides signed "Phase One Deal"

Notes: Only actions that became effective as announced are included in the figure. US dollar values are taxable values officially announced by the two governments. Actions of the two sides mirroring each other are **in bold**.

(henceforth, CTC), which is the Chinese counterpart of the USTR, announced its own Tranches 1 and 2 with the same tariff rates (an additional 25 percent), the same taxable value (34 billion and 16 billion US dollars, denominated in terms of China's 2017 imports from the US), and the same effective dates (July 6 and August 23) on the same day as the US announcement (June 15). Subsequently, the two tranches of both countries took effect as announced.

China's retaliation clearly mirrored the structure of US tariffs. The identical taxable values and rate schedules selected by the two countries cannot be plausibly attributed to coincidence. Notably, China adopted the same effective dates as the United States, despite the fact that those dates were determined by US-specific administrative procedures, including domestic review and hearing requirements that are not applicable in China. China's practice of dividing the tariffs into two tranches was also copied from the US. The product lists on the US side were initially published as one single proposal, but some of those products needed a second round of review and hearing, so that the products in the proposal were divided into two tranches bearing separate effective dates.[4]

[4]See "Notice of Action and Request for Public Comment Concerning Proposed Determination of Action Pursuant

Chinese policymakers had no particular reason to divide their tariffs into two tranches mirroring the values imposed by the United States. Taken together, these US-mirroring responses convey a clear tit-for-tat stance.

On July 10, the USTR announced its Tranche 3 tariffs, worth 200 billion US dollars, with a 10 percent rate, to become effective on September 24, 2018. One week before that effective date, the CTC announced a Chinese Tranche 3, worth 60 billion US dollars, with rates up to 10 percent, to become effective on the same date. The Chinese Tranche 3 was weaker than the US Tranche 3, indicating a lack of ammunition on the Chinese side. The third tranche for both sides took effect as announced.

Between September 2018 and May 2019, trade negotiations were conducted between the two countries. The details of those negotiations were not disclosed by either side. There was an informal meeting between the presidents of the two countries when they attended a G20 summit in Argentina in December 2018. Neither the negotiation nor the meeting was productive in terms of resolving the trade war. On May 9, 2019, the USTR raised the rate of its Tranche 3 from 10 percent to 25 percent (effective May 10), and in the following week, the CTC revised the rate of its Tranche 3 from up to 10 percent to up to 25 percent (effective June 1).

The twelve months from July 2018 to June 2019, as detailed above, constituted the prime period of the US–China trade war. On both sides, the first effective date was July 6, 2018 and the last June 1, 2019. In the months prior to July in 2018, despite having bilateral tensions on trade issues, there was no policy confrontation between the two countries.[5] Two months after June 2019, a fourth tranche was announced by both sides, which was substantially lighter than each country's Tranches 1 to 3. Both sides chose lower rates than previous tranches (10 percent set by China, and 15 percent set by the US), as a result of ammunition shortage on both sides. The ammunition shortage was particularly salient on the Chinese side, whose Tranche 4 had a product overlap with its previous Tranches 1 to 3 (i.e., the same product lines were included but with revised rates). Moreover, on both sides, only half of Tranche 4 took effect. The two governments canceled scheduled effective dates as a gesture of good faith before their negotiations held in December 2019.[6] This round of negotiations concluded with the signing of the "Phase One Deal" in January 2020.

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to Section 301: China's Acts, Policies, and Practices Related to Technology Transfer, Intellectual Property, and Innovation" (Docket Number USTR-2018-0018 in the Federal Register).

[5] In 2018, the Trump administration also initiated trade wars pertaining to products including solar panels, washing machines, steel, and aluminum, which targeted multiple trade partners in addition to China. These concurrent trade wars are not examined in this study.

[6] In August 2019, each side announced a Tranche 4 of tariffs that were explicitly divided into two halves, one scheduled to take effect on September 1, 2019 and the other on December 15, 2019. In late 2019, both sides decided to maintain the first half and cancel the second half. The Tranche 4 in Figure 1 refers to the first half scheduled for September.

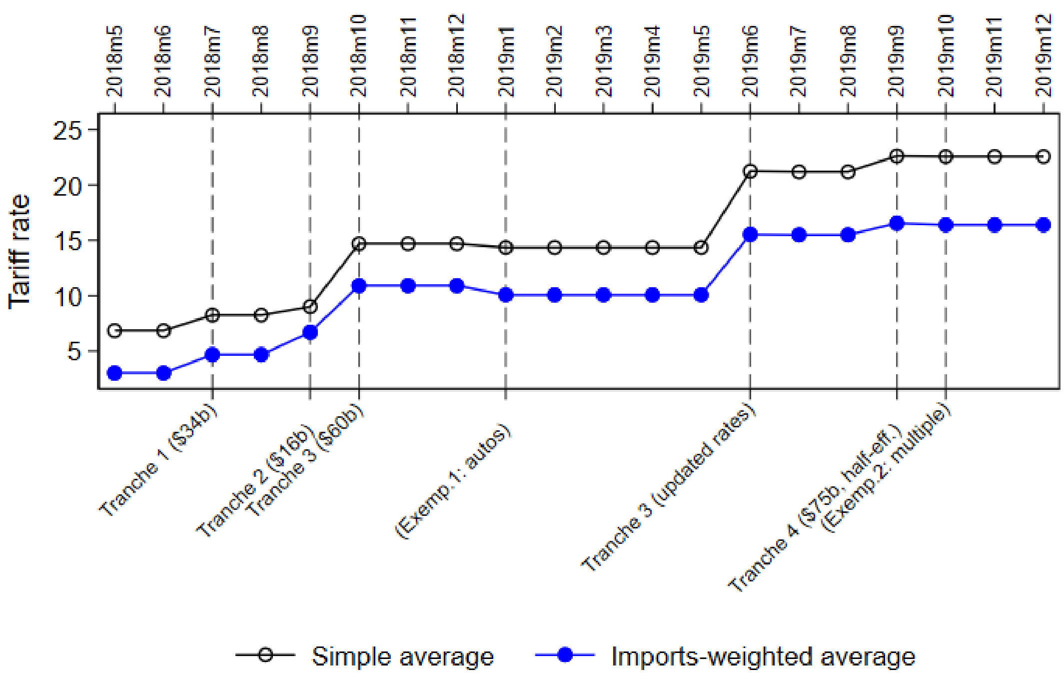
Table 1: China's Pre- and Post-retaliation Tariffs on US Products

	Pre-retaliation	Post-retaliation			
	2017	*Tranche 1*	*Tranche 2*	*Tranche 3*	*Tranche 4*
Simple average	6.98	8.58	9.55	20.88	21.39
(standard deviation)	(5.20)	(8.85)	(10.19)	(12.36)	(12.04)
Increase relative to pre-retaliation		1.59	2.57	13.90	14.40
[p-value]		[0.00]	[0.00]	[0.00]	[0.00]
Increase relative to post-retaliation, Tranche 1			0.97	12.31	12.81
[p-value]			[0.00]	[0.00]	[0.00]
Increase relative to post-retaliation, Tranche 2				11.33	11.84
[p-value]				[0.00]	[0.00]
Increase relative to post-retaliation, Tranche 3					0.51
[p-value]					[0.00]
Weighted average	4.18	8.66	10.54	15.66	15.82
(standard deviation)	(4.75)	(12.72)	(13.58)	(13.35)	(13.20)
Increase relative to pre-retaliation		4.48	6.36	11.49	11.64
[p-value]		[0.00]	[0.00]	[0.00]	[0.00]
Increase relative to post-retaliation, Tranche 1			1.875	7.00	7.16
[p-value]			[0.00]	[0.00]	[0.00]
Increase relative to post-retaliation, Tranche 2				5.13	5.28
[p-value]				[0.00]	[0.00]
Increase relative to post-retaliation, Tranche 3					0.15
[p-value]					[0.00]

Notes: This table compares post-retaliation average tariff rates with pre-retaliation average tariff rates. All tariff rates are at the HS8 level. Pre-retaliation rates refer to those effective by the end of 2017. Post-retaliation rates are effective rates, which have three tranches. Each tranche in the table has included all previous trenches. Simple average tariff rates are arithmetic means. Weighted average tariff rates are computed using 2017 imports values as weights. All t-tests are paired tests. The t-tests for weighted average tariffs first use 2017 imports values to compute weighted means and then compute the point estimates of the linear combination (post-retaliation weighted average − pre-retaliation weighted average).

Table 1 demonstrates the impacts of China's retaliatory rates on the cumulative tariff rates levied on its imported US products. The simple average of total tariff rates rose from 6.98 to 21.39 percentage points, while the weighted average rose from 4.18 percentage points to 15.82 percentage points. All tranches generated statistically significant rate increases. However, the economic significance of the tariff increases was predominantly driven by Tranches 1 to 3, as Tranche 4 generated only a 0.51 (0.15 if weighted) percentage point increase on average. The contrast is salient in Figure 2, where monthly average tariff rates are plotted against time. Figure 2 also includes the two sets of exemptions made by China for certain products during the trade war, one for automobile products in January 2019 and the other for multiple products with no specific focus (including whey, shrimp, lubricating oils, and nucleic acids) in October 2019. The exemptions, as shown in the figure, have minimal impacts on the average tariff rates. Further details on the data are provided in Appendix A.

Figure 2: China's Tariffs on US Products



Notes: Unit of tariff rate is percentage point. Tariff rates are at the HS8 level. The time span is May 2018 (2018m5) to December 2019 (2019m12). Tariff rates in month t refer to those in effect starting from the 15^{th} day of month t-1 and ending on the 14^{th} day of month t. The 2017 imported values are used to compute imports-weighted average rates.

3 Quantitative Framework

In this section, we present our quantitative framework in three steps. Section 3.1 builds the theoretical environment. Section 3.2 constructs alternative tariffs that are observationally equivalent to the given factual tariffs (i.e., China's retaliatory tariffs in our context). The corresponding tariff theories are discussed in Section 3.3.

3.1 Environment

Our analysis employs a CES demand system, modified from the version used by Fajgelbaum et al. (2020). Since Chinese imports serve both consumption and production purposes, we refer to the bearer of the economic interests in China's imports as *importers*. The economic interests of importers are represented by the utility of a nationally aggregated importer:

$$U = \prod_s \left(\frac{C_s}{\gamma_s}\right)^{\gamma_s}, C_s \equiv \left(\sum_{g\in s} m_g^{\frac{\eta-1}{\eta}}\right)^{\frac{\eta}{\eta-1}}, \text{ and } m_g = \left(\sum_i m_{gi}^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}. \quad (1)$$

Here $\gamma_s \in (0,1)$ is expenditure share of sector s and $\sum_s \gamma_s = 1$. Consumption C_s is an aggregate of imported foreign products in sector s. Consumption m_g is an aggregate of product line g that consists of multiple varieties differentiated by origin country i. The elasticity of substitution is $\eta > 1$ at the product line level, and $\sigma > 1$ at the variety level. Notice that each "US product" is technically a variety, denoted by $gi = gUS$, made by US producers, and imported to China under product line g. Henceforth, we refer to product lines simply as products.

Price indexes can then be derived:

$$P = \prod_s (P_s)^{\gamma_s}, P_s = \left(\sum_{g\in s} P_g^{1-\eta}\right)^{\frac{1}{1-\eta}}, \text{ and } P_g = \left(\sum_i p_{gi}^{1-\sigma}\right)^{\frac{1}{1-\sigma}}, \quad (2)$$

where P, P_s, and P_g represent import price indexes at the national, sector, and product levels, respectively. The tariff-ridden price of an imported variety is

$$p_{gi} = (1 + t_{gi})p_{gi}^*, \quad (3)$$

where p_{gi}^* is the CIF price paid to foreign suppliers. The inverse supply function of foreign suppliers is

$$p_{gi}^* = z_{gi} m_{gi}^{\omega}, \quad (4)$$

where z_{gi} is a foreign marginal cost shifter and ω is the inverse foreign supply elasticity.

The t_{gi} in equation (3) is an ad valorem tariff rate. Denote the pre-retaliation tariff rate by

t^0_{gi}, then we have

$$t_{gi} = \begin{cases} t^0_{gUS} + T_g, & \text{if } i = US, \\ t^0_{gi}, & \text{if } i \neq US, \end{cases} \tag{5}$$

since the retaliation was only against US varieties. The T_g in equation (5) is the retaliatory tariff added on the pre-retaliation rate t^0_{gUS}. Notice that $T_g = 0$ for some g's, because China did not retaliate against all US varieties. China's full post-retaliation tariff schedule can be written as set $\{t_{gi}\}_{\forall g,i}$, composed by an unaffected set and an affected set:

$$\{t_{gi}\}_{\forall g,i} = \{t^0_{gi}\}_{\forall g, i\neq US} \bigcup \{t^0_{gi} + T_g\}_{\forall g, i=US} = \{t^0_{gi}\}_{\forall g,i} \bigcup \{T_g\}. \tag{6}$$

These set notations are convenient. In particular, $\{T_g\}$, which applies only to the US varieties, reflects all new tariff changes due to the retaliation. Henceforth, we refer to $\{T_g\}$ as a *retaliatory schedule*.

Welfare (W) is measured by the inverse of import prices, $W = 1/P$. The estimation of $\{\gamma_s, \sigma, \eta, \omega\}$ is detailed in Appendix A. A summary of γ_s-estimates is provided in Table A1. Our preferred estimates of σ and η are 1.453 and 1.892, respectively. The estimate of ω is not statistically different from zero, suggesting that the tariff burden falls on domestic importers. Our result is broadly in line with prior estimates for the US side (e.g., Amiti et al., 2019, 2020; Besedes et al., 2020; Fajgelbaum et al., 2020; Flaaen et al., 2020).

3.2 Factual tariffs and their theoretical alternatives

Henceforth, we refer to the retaliatory tariffs used by China on its imports from the US as a factual (F) schedule $\{T^F_g\}$. That is, every US product variety $gi = gUS$ imported by China receives an additional rate $T^F_g \geq 0$, and those appearing in Tranches 1 to 3 each receive a positive additional rate $T^F_g > 0$. We exclude Tranche 4 because, as noted in Section 2, only half of the tranche took effect, and its effectiveness lasted only for three months that coincide with the holiday season. With data on $\{T^F_g\}$, pre-retaliation tariffs $\{t^0_{gi}\}$, and CIF prices $\{p^*_{gi}\}$, we are ready to compute the welfare level W^F associated with the factual schedule through the previous price indexes P^F, P^F_s, and P^F_g constructed following equation (2).

The strength of China's retaliatory tariffs is manifested by two margins of $\{T^F_g\}$. First, $\{T^F_g\}$ was applied to a basket of US products imported by China that were, in total, worth 108 billion US dollars in 2017, or

$$\sum_{g\in\{T^F_g>0\}} p^{2017}_{gUS} m^{2017}_{gUS} = \$108\text{bn} \equiv Q^F. \tag{7}$$

Equation (7), or the *taxable value margin*, stems from the fact that both countries announced the sizes of their tariffs in USD values, officially referencing them in 2017 import prices and quantities (i.e., $p_{gUS}^{2017}m_{gUS}^{2017}$).[7] Second, $\{T_g^F\}$ has a rate structure:

$$T_g^F = \begin{cases} 25\%, & \text{if } Q \leq \$58\text{bn}, \\ 20\%, & \text{if } \$58\text{bn} < Q \leq \$73\text{bn}, \\ 10\%, & \text{if } \$73\text{bn} < Q \leq \$89\text{bn}, \\ 5\%, & \text{if } \$89\text{bn} < Q \leq \$108\text{bn}(= Q^F), \end{cases} \tag{8}$$

that assigns a penalty to each product g. Specifically, Tranches 1 and 2 use a rate of 25% while Tranche 3 has rates of 5%, 10%, 20%, and 25%. We build those brackets into piecewise function (8), or the *rate structure margin* of $\{T_g^F\}$. Notice that the rate pattern decreasing with Q in the piecewise function coincides with the chronological order of tranches. That is, 25% is placed at the top not only for clarity in writing but also because it was the earliest rate used by Chinese policymakers. Products penalized earlier were also penalized heavier, indicating their level of priority in China's retaliation.[8] We maintain this observed decreasing rate pattern throughout our analysis.

The two margins (7) and (8) establish the strength of $\{T_g^F\}$ and enable us to construct alternative schedules. We construct alternative tariff schedules as implied by distinct policy motives. Each policy motive ranks US imports according to a distinct product characteristic Λ. These motives, reflecting policymakers' preferences, can be captured by a monotonic ranking function:

$$\Phi : \Lambda_g \to \phi_g, \tag{9}$$

which ranks imported US varieties $\{g\}$ according to product characteristic Λ_g and assigns ranking value ϕ_g. Mathematically, each policy motive is a strict total ordering (i.e., any two varieties can be strictly ranked). Then, given that imported varieties are a finite set, there exists an unambiguous ranking among all the varieties. Without loss of generality, we assume $\Phi(\cdot)$ to be positive monotonic: a greater Λ_g corresponds to a greater ϕ_g, representing a higher ranking in the to-be-penalized product list. Intuitively, $\Phi(\cdot)$ acts as Chinese policymakers who favor US varieties differentially and thus rank them discriminately.

The ranking function $\Phi(\cdot)$ works with conditions (7) and (8) to assign alternative rate T_g to each imported US variety according to its characteristic Λ_g. The assignment works as follows.

[7] The taxable values in China's official announcements in Figure 1 (34 billion, 16 billion, and 60 billion) amount to 110 billion (USD). Those three values were rounded before being announced. For accuracy, we compute the total taxable value and find it to be 108 billion (USD).

[8] Tranches 1 and 2 of China's retaliatory tariffs bore the rate of 25%, and Tranche 4 the rate of 10%. The effective rates of Tranche 3 rose from up to 10% (effective September 24, 2018) to up to 25% (effective June 1, 2019). Either before or after Tranche 3's rate increase, a decreasing rate pattern is continually observed across tranches. That is, Tranche 3's rates were above-bounded by the rate of Tranches 1–2 (i.e., 25%) after the rate increase, and above-bounded by the rate of Tranche 4 before the rate increase.

First, solve ϕ^{25}, ϕ^{20}, ϕ^{10} and ϕ^{5} such that

$$\sum_{g\in\{\Phi(\Lambda_g)\geq\phi^{25}\}} p_{gUS}^{2017} m_{gUS}^{2017} = \$58\text{bn}, \tag{10a}$$

$$\sum_{g\in\{\Phi(\Lambda_g)\geq\phi^{20}\}} p_{gUS}^{2017} m_{gUS}^{2017} = \$73\text{bn}, \tag{10b}$$

$$\sum_{g\in\{\Phi(\Lambda_g)\geq\phi^{10}\}} p_{gUS}^{2017} m_{gUS}^{2017} = \$89\text{bn}, \tag{10c}$$

$$\sum_{g\in\{\Phi(\Lambda_g)\geq\phi^{5}\}} p_{gUS}^{2017} m_{gUS}^{2017} = \$108\text{bn}, \tag{10d}$$

and then assign alternative rate T_g^A to US variety g according to

$$T_g^A = \begin{cases} 25\%, & \text{if } \Phi(\Lambda_g) \geq \phi^{25}, \\ 20\%, & \text{if } \phi^{25} > \Phi(\Lambda_g) \geq \phi^{20}, \\ 10\%, & \text{if } \phi^{20} > \Phi(\Lambda_g) \geq \phi^{10}, \\ 5\%, & \text{if } \phi^{10} > \Phi(\Lambda_g) \geq \phi^{5}, \\ 0, & \text{if } \phi^{5} > \Phi(\Lambda_g). \end{cases} \tag{8$'$}$$

This assignment ensures that $\{T_g^A\}$ has the same rate structure margin (now, condition (8′)) and taxable value margin

$$\sum_{g\in\{T_g^A>0\}} p_{gUS}^{2017} m_{gUS}^{2017} = \$108\text{bn} = Q^F, \tag{7$'$}$$

as $\{T_g^F\}$. Thus, $\{T_g^A\}$ and $\{T_g^F\}$ are observationally equivalent. Consider an alternative tariff schedule $\{T_g^A\}$. As long as $\{T_g^A\}$ meets the two margin conditions, it can be compared with $\{T_g^F\}$ positively in product composition and normatively in welfare impact. The two retaliatory schedules are comparable since they have the same strength in terms of taxable value and rate structure.

The above system can generate an alternative schedule $\{T_g^A\}$ based on any product characteristic Λ_g that is rankable and without ties. It provides a mapping from a set of product characteristics $\{\Lambda_g\}$ to a set of tariffs $\{T_g^A\}$ through equations (9) to (7′), henceforth represented by

$$T_g^A = \Xi\Big(\Lambda_g\Big), \tag{11}$$

for convenience. $\Xi(\cdot)$ is positive monotonic. Through $\Xi(\cdot)$, variety g with a greater Λ_g receives a greater tariff rate T_g^A. The tariff rates $\{T_g^A\}$ are observationally equivalent to the factual schedule $\{T_g^F\}$ à la margins (7′) and (8′). When different types of characteristic Λ_g are used, different alternative schedules are generated.

As a toy example showing how the above system works, consider a fictional policymaker who prefers physically lightweight varieties (i.e., Λ_g is physical weight per unit). Suppose that the 102 heaviest US varieties happen to be worth 58 billion dollars. Then, by equations (10a) and (8′), the tariff rate of 25% is assigned to those 102 heaviest varieties and the tariff rate of 20% to the 103rd heaviest US variety. The assignment continues until condition (7′) is met and thus the set $\{T_g^A | T_g^A > 0\}$ settles. The rest of US varieties (i.e., the even lighter ones) are assigned $T_g^A = 0$ to complete the set $\{T_g^A\}$.

3.3 Tariff theories

Section 3.2 provides a generic alternative schedule $\{T_g^A\}$ that is observationally equivalent to the factual schedule $\{T_g^F\}$. Every such schedule $\{T_g^A\}$ rests on a product characteristic Λ_g. We now examine four product characteristics, each derived from a distinct tariff theory. Estimation details for all four theories are provided in Appendix B.

The first is the optimal tariff (OT) theory (Bickerdike (1907), Johnson (1953), and Broda et al. (2008) among others). According to this theory, tariffs set by an importing country may force foreign suppliers to lower their prices, thereby generating terms-of-trade gains for the importing country. At the core of this theory is tax incidence. That is, the burden of a tax is shared between the demand side and the supply side, and the side with a lower price elasticity bears relatively more of the burden. Thus, the optimal tariff rate for the importing country is in inverse proportion to the supply elasticity of foreign exporters. Thus, Chinese policymakers observed inverse supply elasticities of US products in the prewar era and retaliated by setting

$$T_g^{A,OT} = \Xi\left(\Lambda_g^{OT} \equiv \left[\frac{dm_{gUS}}{dp^*_{gUS}} \cdot \frac{p^*_{gUS}}{m_{gUS}}\right]^{-1}\right). \tag{12}$$

We follow Feenstra (1994) and Broda and Weinstein (2006) to estimate the inverse supply elasticity for each US product variety.[9]

The second is the protection-for-sale (PS) theory (Grossman and Helpman, 1994; Goldberg and Maggi, 1999; Gawande and Bandyopadhyay, 2000). According to this theory, policymakers make a tradeoff between domestic consumption and political contributions from interest groups. A higher tariff levied on a given product harms consumers but meanwhile benefits a domestic interest group who competes with foreign exporters on the product. China does not have Western-style lobbies, but instead has state-owned enterprises (SOEs) that directly contribute to government revenue and thereby influence its trade policies (Benguria and Saffie, 2025). We customize the ranked characteristic Λ_g to the Chinese context by letting it vary by cross-product presence of

[9] Λ_g^{OT} denotes a product-specific inverse supply elasticity, in contrast to the single parameter ω applied uniformly across all products during the trade war. Λ_g^{OT} is continuously observed by policymakers, whereas ω is only revealed after the trade war. This distinction holds for both the US and China. For example, on the US side, Λ_g^{OT} was estimated at the product level by Broda and Weinstein (2006) and Broda et al. (2008), whereas ω was estimated to be zero by Amiti et al. (2019) and Fajgelbaum et al. (2020).

SOEs. Thus, we construct

$$T_g^{A,PS} = \Xi\left(\Lambda_g^{PS} \equiv \frac{I_g - \alpha}{a + \alpha} \cdot \frac{R_g}{\sigma_g}\right), \tag{13}$$

where a is the weight of consideration given by policymakers to domestic consumption, I_g is a lobby indicator for product g, α represents overall prevalence of SOEs, and R_g captures import penetration (domestic production divided by imports). That is, products with higher SOE concentration (i.e., greater values of $I_g - \alpha$) tend to face higher tariff rates.

The third is the trade sanction (SANC) theory. Penalizing the core exports of a foreign country with tariffs is a common practice in international relations, with the mechanisms of coercion, alienation, and signaling (e.g., Mayer, 1977; Kaempfer and Lowenberg, 1988, 2007; Verdier, 2009). China has emerged as a frequent user of trade sanctions in recent years, notably targeting Australia in 2020 and Lithuania in 2021. Thus, retaliating against the US by taxing its comparative advantage products is a plausible potential motive. By retaliating in this way, Chinese policymakers might maximize the loss on the US side and thereby obtain better terms in future trade negotiations. Thus, we construct

$$T_g^{A,SANC} = \Xi\left(\Lambda_g^{SANC} \equiv \frac{Z_{gUS}/Z_{g^0US}}{Z_{gi^0}/Z_{g^0i^0}}\right), \tag{14}$$

where i^0 denotes a reference country, g^0 denotes a reference product, and Z_{gi} represents the productivity of country i in producing product g. The micro-foundation for using $\frac{Z_{gj}/Z_{g^0j}}{Z_{gi^0}/Z_{g^0i^0}}$ to measure country j's revealed comparative advantage in product g is discussed in Costinot et al. (2012) and French (2017), and we follow their method to estimate $\frac{Z_{gUS}/Z_{g^0US}}{Z_{gi^0}/Z_{g^0i^0}}$ for each US product variety gUS.

The fourth is the swing state (SS) theory. The importance of median/swing voters has long been explored in the trade literature (Mayer, 1984; Muûls and Petropoulou, 2013; Ma and McLaren, 2018). Thus, we construct

$$T_g^{A,SS} = \Xi\left(\Lambda_g^{SS} \equiv \sum_{c \in Swing} \frac{L_{gc}}{L_c} \cdot VotingTrump_c\right), \tag{15}$$

where $c \in Swing$ represents a county in a swing state that voted for Trump in the 2016 US presidential election.[10] $\frac{L_{gc}}{L_c}$ is the share of labor related to US product g. US employment data are only available by industry, so we resort to the product-industry concordance compiled by Pierce and Schott (2012). Consider a swing state county c that voted for Trump ($VotingTrump_c = 1$). The county has its labor employed for producing different products, and we use the share of employment related to product g (L_{gc}) in its total employment (L_c) to weight $VotingTrump_c = 1$ and aggregate such weighted Trump-voting indicators $VotingTrump_c$ for each product g to be its product characteristic Λ_g^{SS}. In short, Λ_g^{SS} is a product-level employment-weighted count of

[10]See Appendix B for the list of swing states and its sources.

Trump-voting swing state counties.

4 Main Results

4.1 Baseline findings

Positive analysis. Table 2 compares, in terms of average tariff rate, the four alternative schedules with each other and against the factual schedule. Each g corresponds to an HS8 product imported by China from the US. The first and second columns reproduce the elevation of factual tariff rates shown in the previous Table 1. Compared with the pre-war (2017) tariff rates, the post-war tariff rates elevated threefold (unweighted, from 6.98 percent to 20.88 percent) to fourfold (2017-imports weighted, from 4.18 to 15.66). Among the four schedules, the SANC schedule penalizes the smallest number of products (12.2 percent of the 6,726 US product lines imported by China). Because the US products with comparative advantages to China have large import volumes, the simple average post-retaliation tariff rate of the SANC schedule (8.27) is far lower than the factual schedule and the other three alternative schedules, while its weighted average rate (16.09) is on par with them.

Table 2: Alternative Tariff Schedules: Rates

	Pre-retaliation	Post-retaliation				
	2017*	Factual*	Alternative			
			OT	PS	SANC	SS
Simple average	6.98	20.88	12.80	17.19	8.27	19.77
(standard deviation)	(5.20)	(12.36)	(10.21)	(11.74)	(6.71)	(12.36)
Relative to pre-retaliation		+13.90	+5.82	+10.20	+1.29	+12.79
[p-value]		[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Weighted average	4.18	15.66	16.90	17.95	16.09	16.27
(standard deviation)	(4.75)	(13.35)	(10.47)	(12.06)	(11.95)	(11.90)
Relative to pre-retaliation		+11.49	+12.72	+13.78	+11.91	+12.10
[p-value]		[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Penalized products		6,085	3,051	4,551	823	5,412
Share§		90.5%	45.4%	67.7%	12.2%	80.5%

Notes: This table reports post-retaliation average tariff rates (factual and alternative) relative to pre-retaliation average tariff rates. Original tariff rates are at the HS8 level. Pre-retaliation rates refer to those effective by the end of 2017. Simple average tariff rates are arithmetic means. Weighted average tariff rates are computed using 2017 imports values as weights. t-tests are paired tests. The t-tests for weighted average tariffs first use 2017 imports values to compute weighted means and then compute the point estimates of the linear combination (post-retaliation weighted average − pre-retaliation weighted average). * Same values as in Table 1. § The share refers to the share of the number of products penalized under each motive out of 6,726 imported US products.

Unlike the factual schedule, which lacks an inherent product ranking, the alternative schedules each rank imported US varieties differently. Depending on which tariff theory is used, the least (most) favored US products are prioritized (deprioritized) for penalization. To provide an overview of the ranking orders, we report in Table 3 the top-five and bottom-five unrepeated HS2 chapters according to the rankings used by each $\{T_g^A\}$. The most prioritized products as per the OT theory are concentrated in transportation and infrastructure, a sector in which China has a large market power due to its large infrastructure investment. In contrast, China has relatively small influence in homogeneous products such as straw, meat, cereals, and fruits. In the metallurgical industries of China, state-owned enterprises have considerable influences owing to the role of metals in industrialization and their large scales in fixed assets and employment. State-owned enterprises are also major players in its sectors related to national defense. These sectors are associated with the most prioritized products following the PS theory. As expected, the most prioritized products following the SANC theory are China's major imports from the US, and those following the SS theory come from traditional manufacturing sectors whose producers expected or received protection or other forms of assistance from the Trump administration.[11]

Comparing products across columns, one can observe different patterns of prioritization and deprioritization varying by theory. The four top-five product lists have little in common. Straw and silk make two bottom-five lists. Some products listed as bottom-five following one theory are listed as top-five following another theory (e.g., cereals, fabrics, and mineral products). Overall, there exist distinct variations across alternative schedules.

Factual welfare. With price indexes (P, P_s, P_g), estimated parameters $(\gamma_s, \sigma, \omega, \eta)$, and factual schedule $\{T_g^F\}$, we compute factual welfare level W^F resulting from China's retaliatory tariffs and compare it with the welfare level if there were no retaliation at all. The latter welfare level, denoted by W^O, is computed using $\{T_g = 0, \forall g\}$. We use China's December 2017 tariff rates for t_{gi}^0, and 2018 average CIF prices for $\{p_{gi}^*\}$.[12] China's CTC issues tariff rates for the coming year every December, so that the 2017 tariff rates are the default import tariff rates for the year 2018. The welfare deterioration turns out to be 0.37 percentage points, namely $\ln W^O - \ln W^F = 0.37$.

The estimated welfare impact above is consistent with what China's contemporary consumer price index (CPI) suggests. As a macroeconomic index constructed with completely different data and method from our import price index P, CPI displays clear rises as China's retaliation proceeded tranche after tranche. In the upper panel of Figure 3, we reproduce the imports-weighted retaliatory tariffs displayed in Figure 2 (solid line), extend the time span to the 24 months of 2018 and 2019, and incorporate contemporary CPI changes (dashed line; January 2018 is the base period).[13] As shown, CPI significantly rose from July 2018 onward. The average ΔCPI between July 2018

[11] The article by Eavis (2018) in *The New York Times* discusses the political importance of the US lumber industry to the Trump administration. The US glass industry was heavily impacted by China's retaliatory tariffs (see their response to the US–China "Phase One Deal" in Thompson (2019)).

[12] In Section 4.5, we conduct robustness checks using different CIF prices.

[13] For example, ΔCPI=0.02 implies a two-percent increase in monthly CPI relative to January 2018.

Table 3: Alternative Tariff Schedules: Products

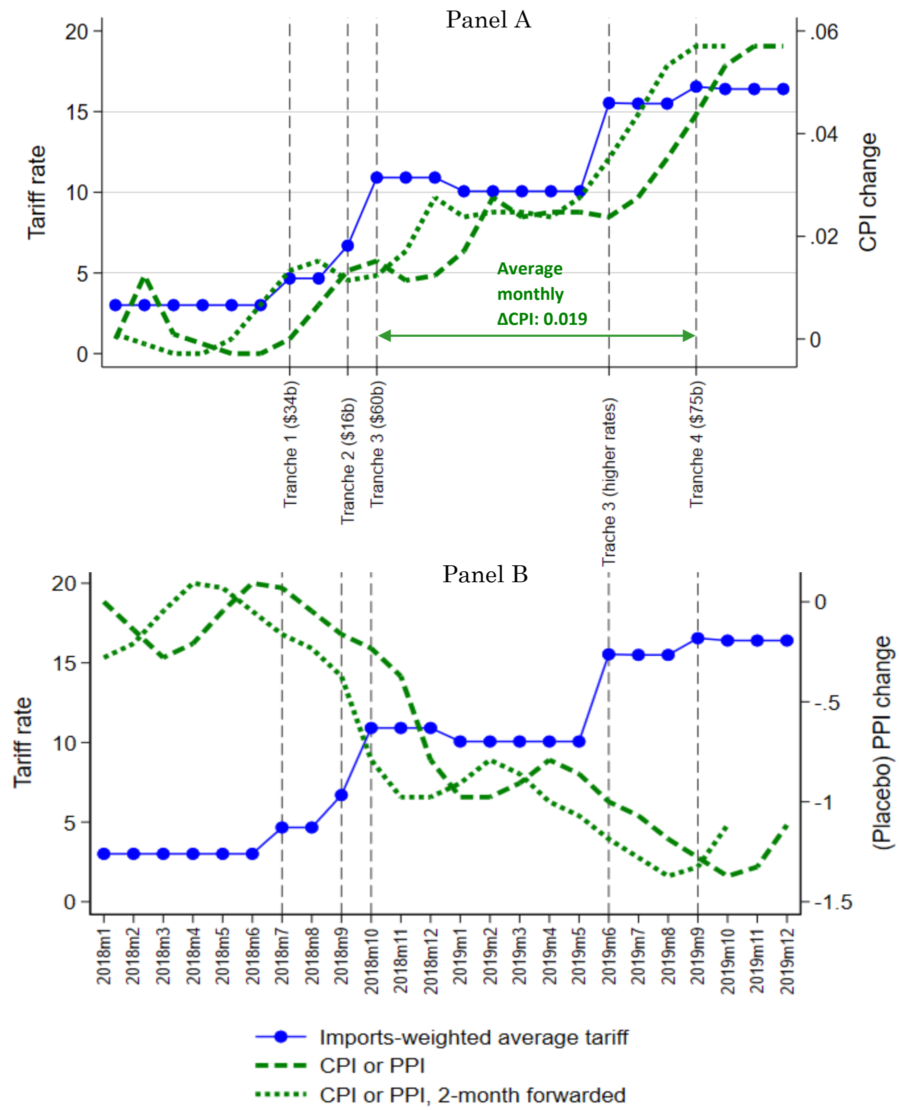
	OT	PS	SANC	SS
Top-5 HS2:				
1	89. Ships, boats and floating structures	72. Iron and steel	88. Aircraft, spacecraft and parts thereof	82. Tools, implements, cutlery, spoons and forks, of base metal
2	60. Fabrics	36. Explosives; etc.	27. Mineral fuels, mineral oils and products of their distillation	70. Glass and glassware
3	71. Natural, cultured pearls; precious, semi-precious stones; etc.	81. Metals; n.e.c., cermets and articles thereof	89. Ships, boats and floating structures	64. Footwear; gaiters and the like; parts of such articles
4	87. Vehicles; etc.	78. Lead and articles thereof	10. Cereals	47. Pulp of wood or other fibrous cellulosic material; recovered paper or paperboard
5	84. Nuclear reactors, boilers, machinery and mechanical appliances; etc.	93. Arms and ammunition; parts and accessories thereof	87. Vehicles	31. Fertilizers
Bottom-5 HS2:				
1	46. Straw, esparto or other plaiting materials	29. Organic chemicals	53. Vegetable textile fibres; etc.	60. Fabrics
2	16. Meat, fish or crustaceans, molluscs or other aquatic invertebrates	27. Mineral fuels, mineral oils and products of their distillation; etc.	46. Straw, esparto or plaiting materials	01. Live animals
3	10. Cereals	85. Electrical machinery and equipment and parts thereof; etc.	51. Wool, fine or coarse animal hair; etc.	18. Cocoa and cocoa preparations
4	50. Silk	7. Edible vegetables and certain roots and tubers.	45. Cork and articles of cork	24. Tobacco and manufactured tobacco substitutes
5	8. Fruit and nuts	31. Fertilizers	50. Silk	69. Ceramic products

Notes : The four columns correspond to the four alternative schedules, respectively. Each column shows top-five and bottom-five unrepeated HS chapters (HS2).

(Tranche 1's effective month) and August 2019 (the last month before Tranche 4 became half-effective) is 0.019. In addition, considering that the passthrough of import tariffs into consumption prices took time, we forward ΔCPI by two months so that month t takes month $t+2$'s ΔCPI value. The forwarded ΔCPI series (dotted line) traces the tariff locus even more closely.[14]

[14] We are not aware of any academic research on the causal effect of China's retaliation on its CPI. Macroeconomic research reports from financial institutions report price-level changes similar to our estimates. For example, Morgan Stanley (2018) estimates the fraction of CPI increase attributed to the US–China trade war to be 0.2 to 0.3 percentage points, while Huachuang Securities (2019) estimates it to be 0.3 percentage points.

Figure 3: China's CPI and PPI during the 2018 US–China Trade War



Notes: The solid line represents monthly imports-weighted tariff changes (same as the solid line in Figure 2 but extending backward to January 2018). Monthly consumer price index (CPI in the upper panel) and producer price index (PPI in the lower panel) are displayed as dashed lines for the period (January 2018 to December 2019). CPI and PPI forwarded by two months, which concern delayed impacts of retaliatory tariffs, are displayed as dotted lines. Month t's forwarded CPI and PPI take their month $t + 2$'s values.

In the lower panel of Figure 3, we compare the contemporary producer price index (PPI), as a placebo for CPI, against the backdrop of retaliatory tariffs. The PPI locus (dashed line) actually declined from June 2018 onward. The decline may be associated with the US tariffs on Chinese exports, as well as macroeconomic factors such as weakened domestic aggregate demand. In relation to our research focus, two key observations merit attention. First, the association between retaliatory tariffs and CPI shown above is not spuriously driven by all-around inflation, as the production respect appears deflationary. Second, the import price index we use to measure welfare covaries with consumer prices rather than producer prices, supporting our practice to treat imports primarily as a demand-side phenomenon.

Alternative welfare. We next construct welfare measures for alternative schedules. Each alternative schedule m has its own $W^{A,m}(Q)$, which quantifies the welfare level when the total taxable value is Q billion USD. We increase Q product by product rather than dollar by dollar. That is, following the rankings associated with each $\{T_g^{A,m}\}$, we include one additional HS8 product line each time to increase Q. As Q increases, $W^{A,m}(Q)$ displays the locus of welfare deterioration. The four $W^A(Q)$ loci can be compared with one another, and also with the factual welfare loss estimated earlier.

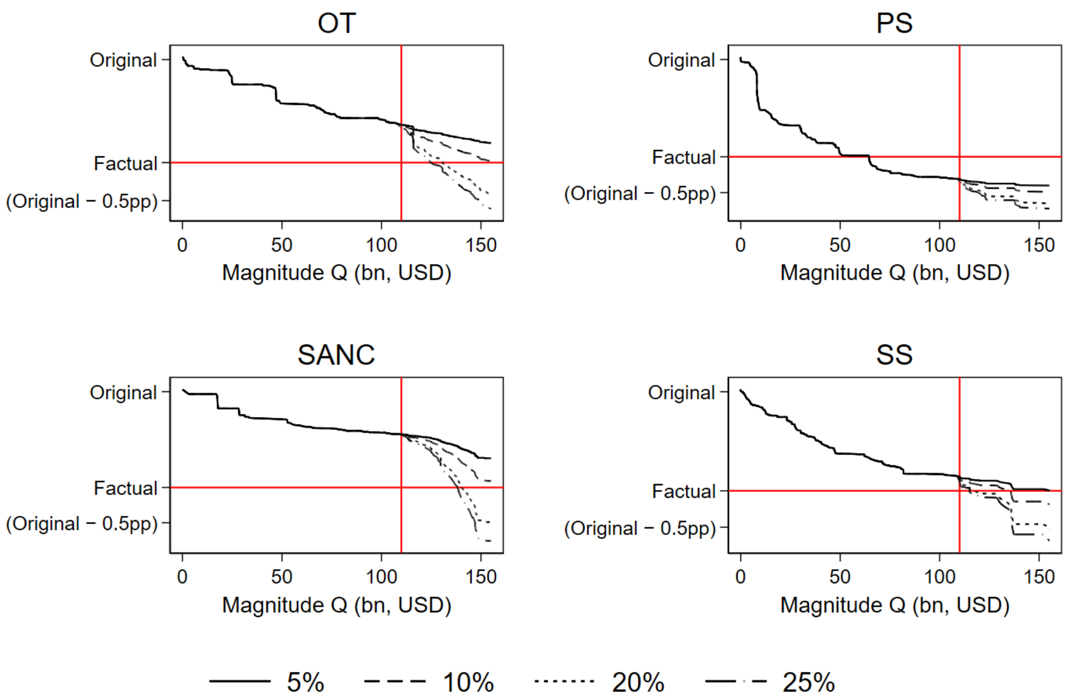
The comparisons are demonstrated in Figure 4. In all four plots of the figure, we mark the previously estimated welfare levels W^F (generated by factual schedule $\{T_g^F\}$) and W^O (assuming no retaliation) with horizontal red lines. We also annotate the welfare level lower than W^O by 0.5 percentage points on the vertical axis as a reference level. In addition, a horizontal line (factual welfare after retaliation) and a vertical line (factual magnitude of retaliation, $Q = Q^F \equiv$ \$108bn) divide each plot into four quadrants. The intersection of the horizontal and vertical red lines signify the factual scenario ($Q = Q^F, W = W^F$). We also extend total taxable value Q beyond \$108bn by assuming each of the four existing brackets 5%, 10%, 20% and 25%, and graph the resulting welfare impacts as four separate tails.

As shown, the OT schedule generates moderate welfare deterioration as Q rises. When Q reaches $Q = Q^F$, the welfare level is higher than W^F. If all remaining Chinese imports from the US are also imposed a tariff rate of 5 to 10 percent, the welfare would still be higher than W^F. This finding also applies to the SANC schedule, which gives even slower welfare deterioration. In a CES setting such as ours, a potent price position does not necessarily mean low prices but reflects the lack of alternatives. That is, the products in which the US has comparative advantages have a strong market standing, and thus a retaliatory schedule targeting them turns out to be less detrimental in welfare terms.

The PS schedule is the only one outperformed by the factual schedule. The production inefficiency of state-owned enterprises has long been known (e.g., Hsieh and Klenow, 2009), such that shielding state-owned enterprises from competition with tariffs is expected to cause a double jeopardy for domestic consumer welfare. As a result, $W^{A,PS}(Q)$ decreases to the factual level as early as Q reaches 50 billion US dollars (that is, right after the alternative Tranche 2 became effective). Afterwards, $W^A(Q)$ is outperformed by W^F.

The SS schedule generates a $W^{A,SS}(Q)$ locus approaching W^F when Q reaches Q^F. Notice that

Figure 4: Factual vs. Alternative Welfare: Baseline



Notes: The four plots correspond to the four alternative schedules, respectively. The vertical axis represents welfare level. On the vertical axis of each plot, three welfare levels are marked: (i) the original (without retaliation) welfare level W^O, (ii) the welfare level resulting from the factual retaliation W^F (0.37 percentage points lower than W^O), and (iii) the welfare level 0.50 percentage points lower than W^O (serving as a reference level). W^F is also indicated by a red horizontal line. The welfare loci $W^A(Q)$ of the four alternative schedules are displayed in the four plots, with total taxable value (magnitude Q) as the horizontal axis. The total taxable value of the factual retaliation (108bn USD) is indicated by a red vertical line. $W^A(Q)$ beyond the 108bn USD is graphed with four hypothetical rates (5%, 10%, 20%, and 25%) in each plot.

if the rest of Chinese imports from the US continue to be imposed a tariff rate of 5 to 10 percent—10 percent is indeed the rate used by China for the half of Tranche 4 that took effect—the welfare level would further approach the factual level. Considering the high similarity in welfare impact, we conjecture that targeting the swing states important to Trump's reelection largely explains the design of China's factual schedule $\{T_g^F\}$. The next subsection is an econometric investigation into this conjecture.

4.2 Motive forensics

The policy motive underpinning China's factual schedule is not directly observable. In order to infer that motive, we econometrically examine how the previous motive measures (i.e., Λ_g) fit the observed schedule. Our regression is specified as

$$T_g^F = \sum_m \beta_m \Lambda_g^m + M_g \Gamma + \delta_{g2} + \epsilon_g, \tag{16}$$

where g is defined as an HS6 product line and T_g^F is averaged to the HS6 level. δ_{g2} is an HS2 fixed effect and control variables M_g include pre-retaliation tariff rate t_{gUS}^0, a Rauch classification dummy (=1 if product g is a differentiated product), and a Made-in-China 2025 dummy (=1 if product g is covered by the industry policy).[15] These control variables hold constant other policy-related product characteristics that may covary with the retaliatory tariffs. Our parameters of interest are the β's, which isolate the effect of each motive measure Λ_g^m with other motives and product characteristics held the same.

The regression results are reported in Table 4. Panel A shows that only the coefficient of the SS measure is statistically significant. That is, all else held equal, products with a greater relevance to Trump's swing-state support base are taxed at a higher retaliatory rate. The significance holds when the dependent variable is converted to a binary indicator $\mathbb{I}[T_g > 0]$ (Panel B) and when different combinations of control variables are used (Panel C). Products related to China's Made-in-China 2025 Initiative turn out to have lower retaliatory tariffs, which is likely due to China's strategic use of high-technology parts and components produced by the US. As a placebo check, we replace the dependent variable with the pre-retaliation tariff rates $\{t_{gUS}^0\}$ (Panel D). Then the statistical significance of the SS measure disappears. Meanwhile, in contrast, the coefficient of the SANC measure becomes statistically significant. Prior to the trade war, China actually applied lower tariffs to the products in which the US has comparative advantages.

[15] Details of China's Made-in-China 2025 Initiative are provided in Appendix A.

Table 4: Tariff Motive: Forensic Regressions

		Panel A: Benchmark results					Panel B: Binary dependent variable				
		Dep. Variable: retaliatory tariff rate (unit: percentage point)					Dep. Variable: Indicator[retaliatory tariff rate>0]				
OT		0.008				0.008	-0.000				-0.000
		(0.113)				(0.111)	(0.008)				(0.007)
PS			0.960			0.925		0.150			0.148
			(5.241)			(5.264)		(0.218)			(0.218)
SANC				0.002		0.003			0.000		0.000
				(0.006)		(0.006)			(0.000)		(0.000)
SS					0.057**	0.058**				0.003***	0.003***
					(0.025)	(0.025)				(0.001)	(0.001)
Control variables:	Pre-war tariff rate	1.068***	1.068***	1.068***	1.066***	1.067***	0.001	0.001	0.001	0.001	0.001
		(0.033)	(0.033)	(0.033)	(0.033)	(0.033)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
	Rauch classification dummy§	0.077	0.084	0.081	0.023	0.030	0.029	0.030	0.029	0.027	0.028
		(0.539)	(0.533)	(0.540)	(0.530)	(0.519)	(0.022)	(0.021)	(0.022)	(0.022)	(0.021)
	Made-in-China 2025 dummy	-1.423***	-1.429***	-1.429***	-1.350***	-1.363***	-0.070***	-0.071***	-0.071***	-0.067***	-0.068***
		(0.452)	(0.448)	(0.440)	(0.446)	(0.434)	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)
Observations		4,267	4,267	4,267	4,267	4,267	4,267	4,267	4,267	4,267	4,267
R-squared		0.530	0.530	0.530	0.530	0.530	0.169	0.170	0.169	0.170	0.171
		Panel C: Different control variable combinations					**Panel D: Pre-war tariffs**				
		Dep. Variable: retaliatory tariff rate (unit: percentage point)					Dep. Variable: pre-war tariff rate (unit: percentage point)				
OT		0.008	0.007	0.008	-0.000	0.000	-0.188				-0.188
		(0.097)	(0.097)	(0.111)	(0.008)	(0.007)	(0.183)				(0.182)
PS		0.741	0.753	0.921	0.139	0.144		-0.371			-0.354
		(5.377)	(5.365)	(5.277)	(0.224)	(0.218)		(0.475)			(0.421)
SANC		0.002	0.002	0.003	0.000	0.000			-0.011**		-0.010**
		(0.006)	(0.006)	(0.006)	(0.000)	(0.000)			(0.005)		(0.005)
SS		0.065**	0.065**	0.058**	0.003***	0.003***				0.048	0.045
		(0.027)	(0.027)	(0.025)	(0.001)	(0.001)				(0.043)	(0.043)
Control variables:	Pre-war tariff rate	1.069***	1.068***	1.067***	0.001	0.001					
		(0.033)	(0.033)	(0.033)	(0.001)	(0.001)					
	Rauch classification dummy§		0.082		0.031		1.461***	1.423***	1.410***	1.377***	1.397***
			(0.524)		(0.022)		(0.446)	(0.431)	(0.430)	(0.418)	(0.434)
	Made-in-China 2025 dummy			-1.365***		-0.070***	-0.522	-0.524	-0.498	-0.464	-0.434
				(0.440)		(0.023)	(0.491)	(0.520)	(0.523)	(0.474)	(0.458)
Observations		4,267	4,267	4,267	4,267	4,267	4,267	4,267	4,267	4,267	4,267
R-squared		0.529	0.529	0.530	0.167	0.171	0.467	0.466	0.466	0.467	0.468

Notes: HS2 fixed effects are included in all regressions. § Rauch classification dummy: 1 for differentiated products and 0 otherwise. Robust standard errors in parentheses, clustered by HS2. *** p<0.01, ** p<0.05.

The findings from Table 4, resulting from a reduced-form forensic analysis, are consistent with the structural welfare analysis reported earlier. Evidently, the factual schedule $\{T_g^F\}$ targeted products related to the swing states important to Trump. There have been anecdotes (e.g., Helmore, 2018; Arends, 2019) and studies (e.g., Fetzer and Schwarz, 2021; Kim and Margalit, 2021) noting that China targeted US swing states that voted for Trump in the 2016 presidential election and thus were likely to vote for him again in the 2020 presidential election. Our product-level analysis supports this thesis. Unlike Fetzer and Schwarz (2021) and Kim and Margalit (2021), we provide direct evidence that China's retaliatory tariffs are, on average, higher for products linked to swing states. All else held equal, a one standard deviation in the SS measure (6.01) is associated with a 0.35 percentage points higher (i.e., $0.058 \times 6.01 = 0.349$) additional tariff.[16]

4.3 Alternative factuals

In this subsection, our interest remains on the factual schedule $\{T_g^F\}$. We ask the following question: how would the factual schedule be implemented if policymakers followed the four theories? The factual schedule does not have a directly observed motive, such that we could not prioritize its products to build its welfare locus against $Q \in [0, Q^F]$ in Figure 4 as we did for alternative schedules. Now, suppose that $\{T_g^F\}$ were implemented by a policymaker who reasoned with the four theories respectively. Then she could "rehearse" each of the four alternative ways to prioritize US varieties to be penalized. This thought experiment helps illustrate how trade theories may affect policy-implementation when policy-making itself (here, $\{T_g^F\}$) is unalterable.

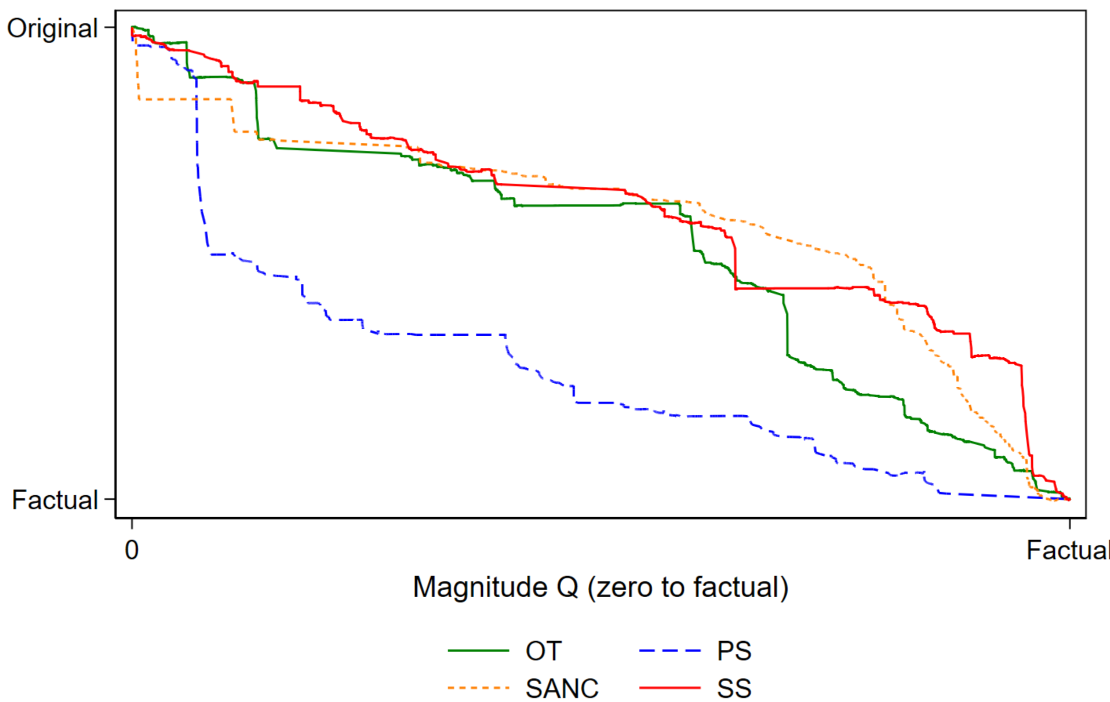
The results are reported in Figure 5, where all four welfare loci share the same beginning W^O and ending W^F. The upper envelope of the four loci is primarily composed by the locus associated with SS, a finding that corroborates the retaliatory motive we inferred from Table 4. That is, the SS theory not only explains the product composition of $\{T_g^F\}$ but also provides a relatively slow declining path of welfare when it is used to prioritize the factually taxed products. In practical terms, this way of implementation is the most flexible among the four: if $\{T_g^F\}$ were implemented in a continuous fashion—for instance, product after product, or (billion) dollar by (billion) dollar—the implementation following the SS theory could then stop any time in response to external changes such as negotiations and keep caused welfare losses limited.

4.4 Potential terms-of-trade effects

Terms-of-trade (TOT) effects are not considered in Section 4.1 because the estimate of ω is statistically indistinguishable from zero. In other words, the tariff burden falls entirely on domestic

[16] Fetzer and Schwarz (2021) examine whether voters who switched from Obama in 2012 to Trump in 2016 had a higher exposure to China's retaliation. They find that those areas most exposed to retaliatory tariffs of China exhibited an up to five percent greater swing to Trump relative to the performance of the 2012 Republican candidate. Kim and Margalit (2021) examine whether swing congressional districts had a larger employment in industries targeted by China. They find that swing districts had 0.59 percentage points more of that type of employment.

Figure 5: Factual Schedule Implemented in Alternative Ways



Notes: The four lines are all based on the factual schedule. The products in the factual schedule are prioritized according to four different tariff theories, and then subsequentially taxed with their factual tariff rates. Since the products and rates come from the factual retaliatory tariff schedule, the maximal Q here is equal to the factual Q (i.e., Q^F), and the lowest welfare level in this figure coincides with the factual welfare level in Figure 4.

importers, leaving no scope for TOT gains.[17] In this subsection, we examine how our previous welfare analysis would change if TOT effects existed. We refer to such *potential* TOT effects as PTOT effects.

In theory, given a retaliatory tariff rate T_g, the burden falling on importers equals

$$\breve{T}_g = \frac{\omega^{-1}}{\sigma + \omega^{-1}} T_g. \tag{17}$$

ω^{-1} is known as the optimal tariff. When ω approaches zero (as in our setting), $\breve{T}_g$ approximates T_g and therefore, the tariff burden all falls on importers. Otherwise, $\breve{T}_g$ is smaller than T_g, indicating that the tariff burden is shared by Chinese importers and foreign exporters. That is, the new $\breve{T}_g$

[17] Ma et al. (2021) find very limited terms-of-trade effects resulting from China's retaliatory tariffs.

carries only part of the retaliatory tariff burden T_g, alleviating the welfare losses. The delivery price then equals

$$\breve{p}_{gUS}(T_g, \omega, p^*_{gUS}, t^0_{gUS}) = \left(1 + \frac{\omega^{-1}}{\sigma + \omega^{-1}}(t^0_{gUS} + T_g)\right) \underbrace{\left(1 - \frac{\sigma}{\sigma + \omega^{-1}}(t^0_{gUS} + T_g)\right) p^*_{gUS}}_{\text{observed CIF price}}, \tag{18}$$

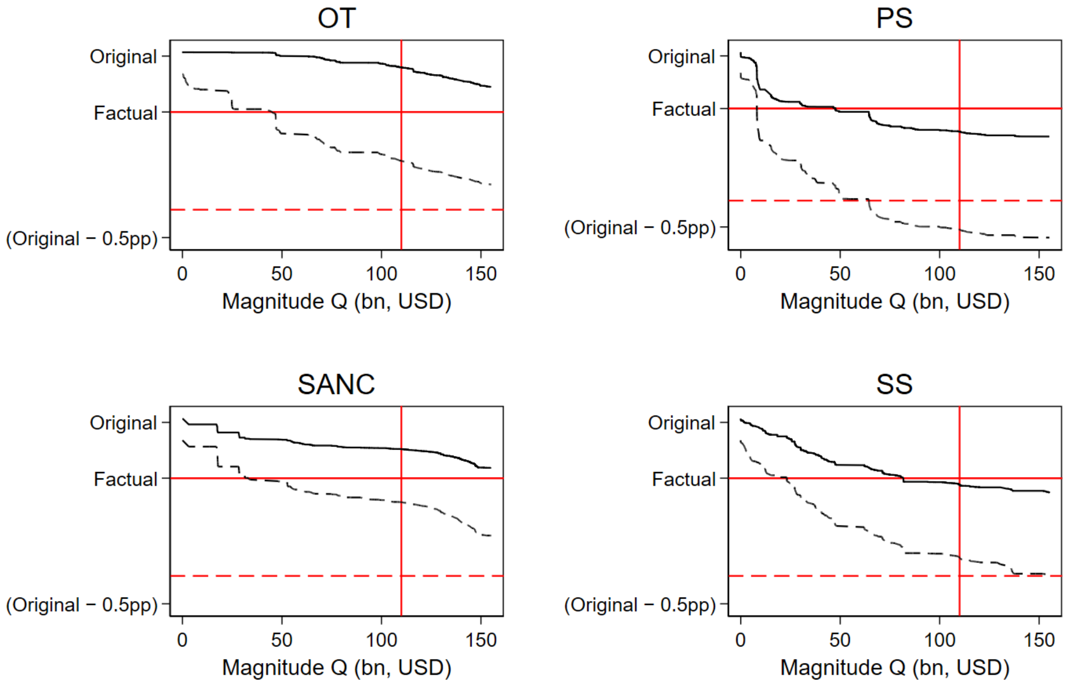
where CIF prices observed in the data now correspond to the entire second term rather than merely p^*_{gUS} in the term. In other words, the observed CIF price has two alternative interpretations: (i) p^*_{gUS} if TOT effects are absent, and (ii) $\left(1 - \frac{\sigma}{\sigma+\omega^{-1}}(t^0_{gUS} + T_g)\right) p^*_{gUS}$ if TOT effects are present. Our previous welfare analysis is based on interpretation (i), whereas we now switch to interpretation (ii). The term $\left(1 - \frac{\sigma}{\sigma+\omega^{-1}}(t^0_{gUS} + T_g)\right)$ in equation (18), which is less than or equal to one, represents the PTOT effect. Under interpretation (ii), the observed US producer prices already reflect the PTOT effect, as part of the tariff burden has been absorbed by exporters.

We now compute the above $\breve{p}_{gUS}(T_g, \omega, p^*_{gUS}, t^0_{gUS})$ for US products imported by China and use them in the welfare analysis, where ω^{-1} is replaced by our previous OT measure Λ^{OT}_g, a product-level parameter that we estimated following Feenstra (1994) and Broda and Weinstein (2006) (see Section 3.3 and Appendix B). Here, T_g can be either a factual T^F_g or an alternative T^A_g. In theory, $\breve{p}_{gUS}(T_g, \Lambda^{OT}_g, p^*_{gUS}, t^0_{gUS})$ can be lower than p^*_{gUS}. Thus, with price $\breve{p}_{gUS}(T_g, \Lambda^{OT}_g, p^*_{gUS}, t^0_{gUS})$ instead of p^*_{gUS} used as the price in welfare analysis, the post-retaliation welfare decreases less and may even be higher than the pre-retaliation level.

Figure 6 demonstrates both the factual and alternative welfare impacts of retaliation with PTOT effects. Three observations emerge. First, as expected, the W^F with PTOT effects is higher than the previous W^F without PTOT effects (both marked in the figure). Second, the ranking order of the four alternative schedules and their comparison with the factual schedule remain the same as before, except that the OT schedule now outperforms the SANC schedule. Third and most importantly, even with PTOT effects taken into account, China's retaliation does not generate welfare gains. That is, the PTOT effects are outweighed by the consumers' losses such that the net welfare effect continues being negative.

It should be noted that the TOT adjustments in equation (18) consider only the tax incidence related to US products (i.e., $gi = gUS$). In theory, the tax incidence related to product varieties made by other countries should also be taken into account. We are unable to conduct Feenstra-Broda-Weinstein estimation for those numerous country-specific varieties (gi duplets) as we did for US products. However, the welfare impact of the third-country tax incidence omission, if having a significant magnitude, would appear in the market share of US varieties within their product-level market shares: $\lambda_{gUS} = p^{1-\sigma}_{gUS}/P^{1-\sigma}_g$. Technically, we decompose the price index of each given

Figure 6: Factual vs Alternative Welfare: With PTOT Effects



Dashed lines reproduce the results in Figure 4 (i.e., without PTOT effects)

Notes: The four plots correspond to the four alternative schedules, respectively. The vertical axis represents welfare level. On the vertical axis of each plot, three welfare levels are marked: (i) the original (without retaliation) welfare level W^O, (ii) the welfare level resulting from the factual retaliation W^F (0.37 percentage points lower than W^O), and (iii) the welfare level 0.50 percentage points lower than W^O (serving as a reference level). W^F is also indicated by a red horizontal line. The welfare loci $W^A(Q)$ of the four alternative schedules are displayed in the four plots, with total taxable value (magnitude Q) as the horizontal axis. The total taxable value of the factual retaliation (108bn USD) is indicated by a red vertical line. $W^A(Q)$ beyond the 108bn USD is graphed with hypothetical rate 5% in each plot. Factual and alternative welfare levels have all included PTOT effects, except the dashed lines as noted above.

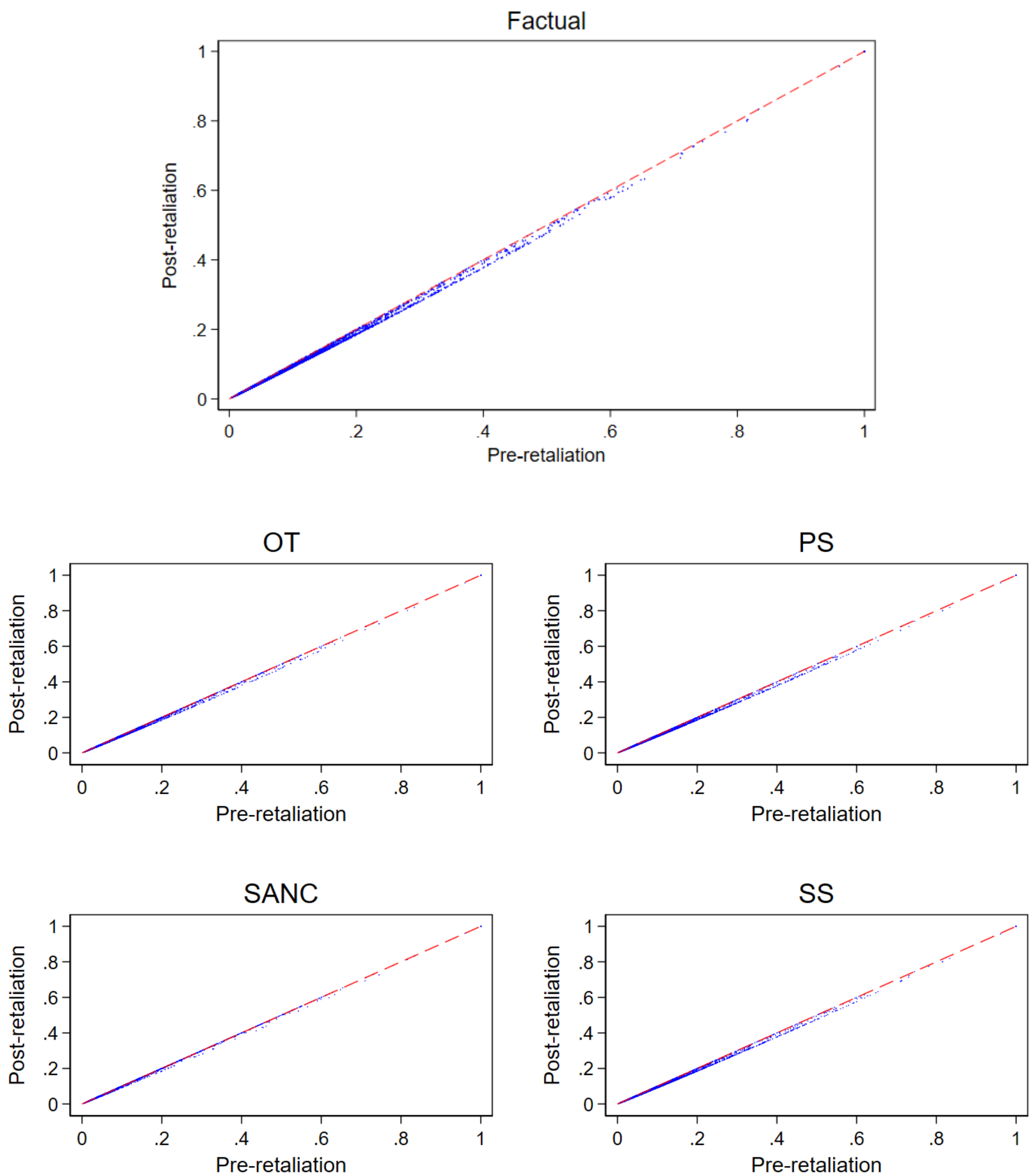
product g containing a US variety into two terms:

$$d \ln P_g = \frac{1}{\sigma - 1} d \ln \lambda_{gUS} + \Omega_{gUS}, \tag{19}$$

where Ω_{gUS} refers to the welfare implications with PTOT effects displayed in the above Figure 6.[18] That is, with Ω_{gUS} partialled out, the market shares $\{\lambda_{gUS}\}$ serve as a sufficient statistic for all the omitted tax incidence. We compare $\{\lambda_{gUS}\}$ of US products between the pre-retaliation setting (i.e., $p_{gUS} = (1 + t^0_{gUS})p^*_{gUS}$) and the post-retaliation setting, the latter of which includes the

[18]The derivation of equation (19) follows Arkolakis et al. (2012). See Appendix C for details.

Figure 7: Market Shares: Pre-retaliation and Post-retaliation



Notes: The market share of US varieties within their HS8 product lines is compared between the pre-retaliation schedule and the post-retaliation schedule. The post-war schedule includes retaliatory tariffs, which come from either the factual schedule (upper panel) or alternative schedules (lower panel). Each dot represents an HS8 product line. The diagonal (dashed) represents no change in market share.

factual $\breve{p}_{gUS}(T_g^F, \Lambda_g^{OT}, p_{gUS}^*, t_{gUS}^0)$ and the alternative $\breve{p}_{gUS}(T_g^A, \Lambda_g^{OT}, p_{gUS}^*, t_{gUS}^0)$. The results from the comparison are displayed in Figure 7, where the diagonals represent no difference between the pre-retaliation market share and the post-retaliation market share of a given product g. As shown, the market share changes are minor, whether factual or alternative schedules are considered. Thus, we consider the omission of third-country tax incidence unlikely to materially affect the conclusions drawn from Figure 6.

4.5 Additional robustness checks

We conduct two additional robustness checks on the welfare analysis reported in Section 4.1. First, average CIF import prices from the year 2018 are used as $\{p^*_{gi}\}$ therein, and we experiment with alternative 12-month prices.[19] As the retaliation continued until the end of 2019, we use average CIF import prices from (i) the year 2019 and (ii) the year from July 2017 to June 2018. The year 2019 is distant from the pre-trade war base year 2017, and the year from July 2017 to June 2018 overlaps with the base year. Nonetheless, they remain informative: the former captures the partially effective Tranche 4, while the latter serves as a more immediate pre-trade war benchmark. The results reported in Appendix D are consistent with our main findings in Section 4.1.

Second, the raw import data provide no information on the intended use of imported products. As noted in Section 3.1, the bearer of welfare in our welfare analysis is a nationally aggregated importer. For robustness, we check whether these findings (both factual and alternative ones) vary by trade regime, and find no remarkable difference across trade regimes. The results of these checks are reported in Appendix E.

5 The Lower-bound Welfare

We quantify the worst welfare impact of China's retaliation on itself in this section. The worst welfare impact arises from the following hypothetical tariff-setting problem. A fictional policymaker maximizes the increase in import price index P subject to a V-dollar worth of tariff-ridden imports from the US by setting retaliatory tariff rate T_{gUS} on each US variety g. To obtain the retaliatory tariff rates, she solves the following optimization problem:

$$\begin{aligned} \underset{\{T_{gUS}\}}{\text{maximize}} \quad & \ln P \\ \text{subject to} \quad & \sum_{s}\sum_{g\in s}(1+t^0_{gUS}+T_{gUS})p^0_{gUS}m_{gUS}=V. \end{aligned} \tag{20}$$

Here $m_{gUS}=[(1+t^0_{gUS}+T_{gUS})p^0_{gUS}]^{-\sigma}X_g/P_g^{1-\sigma}$, representing the demand for US product variety g in sector s when tariff T_{gUS} is applied to the variety. Intuitively, the policymaker should equalize the marginal increase in China's import price index P across US varieties when tariff-ridden total imports from the US rise by one dollar. In the end, she determines a set of flexible tariff rates,

[19] Full-year (i.e., 12 month) averages are used, in order to address seasonality in product composition and prices.

T^{+}_{gUS}, that maximize $\ln P$. The concavity of the logarithmic function ensures that this is a global maximum.

The tariff-ridden import value V in problem (20) can be linked to the total taxable value Q used in the previous welfare analysis. Recall that Q is denominated in terms of 2017 prices and quantities $p^{2017}_{gUS}m^{2017}_{gUS}$ to match official descriptions of the retaliatory actions. The sum of any Q-value and its corresponding tariffs can serve as a V-value, which later enables us to compare schedule $\{T^{+}_{gUS}\}$ with schedule $\{T^{F}_{gUS}\}$ in welfare.[20]

We solve problem (20) in Appendix F. A key step in the solving process is

$$\gamma_s \frac{\left(\frac{P_g}{P_s}\right)^{1-\eta}}{\left[1-\left(\frac{(1+t^0_{gUS}+T^{+}_{gUS})p^0_{gUS}}{P_g}\right)^{1-\sigma}\right]X_g} = \gamma_k \frac{\left(\frac{P_h}{P_k}\right)^{1-\eta}}{\left[1-\left(\frac{(1+t^0_{hUS}+T^{+}_{hUS})p^0_{hUS}}{P_h}\right)^{1-\sigma}\right]X_h}, \tag{21}$$

a condition that must hold for any two US varieties g in sector s and h in sector k. Here X_g and X_h represent product-level expenditures. Intuitively, in order to maximize the upward pressure on the national import price index P, an additional unit of tariff-ridden US import value should keep the marginal index increases through product g and product h equal to each other. The intuition can be further illustrated with a thought experiment. Consider two products h and g in the same sector (i.e., set k to s) and assume that the two products have the same price index and expenditure (i.e., set P_h to P_g and X_h to X_g). Then,

$$(1+t^0_{gUS}+T^{+}_{gUS})p^0_{gUS} = (1+t^0_{hUS}+T^{+}_{hUS})p^0_{hUS}. \tag{22}$$

That is, the US variety with a lower producer price or initial tariff rate should be given a higher retaliatory tariff rate. In essence, because of the CES demand structure, the solved tariffs are conducive to a relatively symmetric consumption pattern.

The solution to problem (20) is

$$p^0_{gUS}T^{\triangle}_{gUS} = \frac{V}{X}\left[\sum_i \left((1+t^0_{gi})T^{\triangle}_{gi}p^0_{gi}\right)^{1-\sigma}\right], \tag{23}$$

for US product variety g, where X is China's total expenditure on imports, and

$$T^{\triangle}_{gi} = \begin{cases} 1+\frac{T^{+}_{gUS}}{1+t^0_{gUS}}, & \text{if } i = US, \\ 1, & \text{if } i \neq US. \end{cases}$$

When $T^{\triangle}_{gi}$ is solved, the flexible tariff rate T^{+}_{gUS} can be recovered. As the right side of equation (23)

[20] The constraint and V in problem (20) have to be tariff-ridden; otherwise, the problem is not a convex optimization problem.

also contains $T^{\triangle}_{gi}$, $T^{\triangle}_{gi}$ does not have a closed-form solution. Intuitively, a higher $T^{\triangle}_{gUS}$ departing from the optimal level reduces the market share of US variety gUS, thereby forming a force to push $T^{\triangle}_{gUS}$ back to the optimal level. Because of the pushback force, an optimal $T^{\triangle}_{gUS}$ exists. Notice that the absence of a closed-form solution to $T^{\triangle}_{gi}$ is not caused by the power $1-\sigma$, but stems from the presence of third-country varieties. If the US variety gUS is the only variety of product g, a closed-form solution exists:

$$T^{\triangle}_{gUS} = \frac{1}{p^0_{gUS}} \left(\frac{V}{X}\right)^{1/\sigma}. \tag{24}$$

Unsurprisingly, $T^{\triangle}_{gUS}$ (and thus T^{+}_{gUS}) would be higher if either the US variety has a lower price, or V/X rises (i.e., a larger magnitude of retaliation).

With data on $\{p^{2017}_{gUS}\}$ and $\{t^0_{gUS}\}$, we numerically solve for $\{T^{\triangle}_{gi}\}$ and thus $\{T^{+}_{gUS}\}$. We select V-values of \$45 billion, \$63 billion, and \$131 billion, each corresponding to a previously analyzed tariff-ridden Q. For example, the cumulative Q by Tranche 3 (i.e., $Q_F \equiv$ \$108bn in equation (7)), when tariff-ridden, equals

$$\sum_{g\in\{T^F_g>0\}} (1 + t^0_{gUS} + T^F_g)p^{2017}_{gUS} m^{2017}_{gUS} = \$131\text{b}. \tag{25}$$

In Figure 8, we plot the post-retaliation welfare level resulting from the flexible schedule, along with the welfare level resulting from the factual schedule, tranche after tranche against V. The flexible schedule turns out to perform far worse than the factual schedule. The cumulative welfare loss by Tranche 3 is 3.5 percentage points lower than the no-retaliation level, which is nearly ten times worse than the factual retaliation (0.37 percentage points lower).

The method presented in this section is not specific to China's retaliatory tariffs. It can be applied to any multi-origin taxation problem that takes the form of problem (20). The resulting $P(\{T^{\triangle}_{gi}\})^{-1}$ gives the lower-bound welfare conditional on the prices, the existing taxes of targeted and non-targeted varieties, and V.

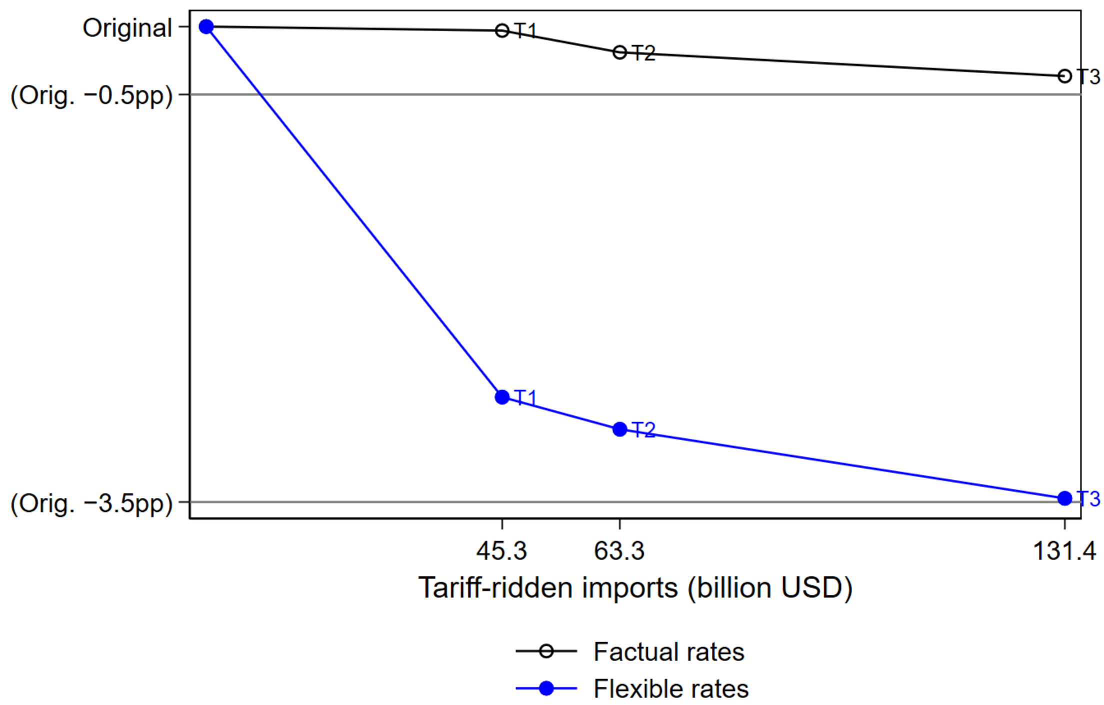
6 Reduced-form Welfare Analysis

Our welfare analysis has so far been conducted based on a CES demand system. In this section, we use equivalent variation (EV) to conduct both factual and alternative welfare analysis. The measure takes the following form:

$$EV = -\mathbf{m^0} \cdot \mathbf{p}^* \cdot \mathbf{T}. \tag{26}$$

Here, $\mathbf{m^0}$ is the vector of pre-retaliation import quantities, namely $\{m_{git^0}\}$ (in our case, the 2017 quantities of imports by China from the US). $\mathbf{p}^*$ is the vector of post-retaliation observed CIF

Figure 8: Flexible Rates vs. Factual Rates: Welfare



Notes: The horizontal axis shows tariff-ridden import value (V). The V-values 45.3, 63.3, and 131.4 are tariff-ridden equivalents of the Q-values 34, 16, and 108, respectively, in the previous welfare analysis. Each of the three V-values (Q-values) pertains to the conclusion of one tranche of retaliation. The resulting welfare levels are graphed as lines: black (hollow-circle connected) for the factual schedule $\{T_g^F\}$ and blue (solid-circle connected) for the flexible schedule $\{T_g^+\}$.

prices, namely $\{p_{gi}^*\}$. $\mathbf{T}$ is the vector of retaliatory tariffs, namely $\{T_{gi}\}$, where

$$T_{gi} = \begin{cases} 0, & \text{if } i \neq US, \\ T_g, & \text{if } i = US. \end{cases} \tag{27}$$

Here, $\{T_g\}$ can be either factual $\{T_g^F\}$ or alternative $\{T_g^A\}$.

EV represents the hypothetical income change needed to reach the pre-retaliation importers' welfare level anchored by pre-retaliation import quantities. Its value is in pecuniary terms (US dollars) and implies that the importers would be equally worse off as they would from losing EV dollars if the retaliatory tariffs were applied on importers as a lump-sum tax rather than on imports as sales taxes.

EV has two notable merits in our context. First, it entails only pre-retaliation quantity and post-retaliation prices. The previous equation (5) gives alternative post-retaliation prices but no alternative post-retaliation quantities. Thus, *EV* meets our need to estimate post-retaliation welfare without post-retaliation quantities. Second, it is a plain accounting measure that does not rely on any theoretical structure. The only element we borrow from the previous welfare analysis is the alternative schedules.

Table 5: Reduced-form Welfare Reduction (EV)

	Factual	Alternative			
		OT	PS	SANC	SS
Value, billion USD	-62.8	-30.4	-63.0	-27.5	-27.9
(s.e.)	(27.2)	(5.9)	(23.4)	(7.8)	(4.7)
[95% c.i.]	[-116.1, -9.5]	[-42.0, -18.9]	[-108.9, -17.0]	[-42.8, -12.2]	[-37.2, -18.7]
% points of GDP*	-0.51	-0.25	-0.51	-0.22	-0.23
[95% c.i.]	[-0.94, -0.08]	[-0.34, -0.15]	[-0.88, -0.14]	[-0.35 -0.10]	[-0.30, -0.15]

Notes : The four columns under "Alternative" correspond to the four alternative schedules, respectively. Standard errors (s.e.) and confidence intervals [95% c.i.] are based on boostrapped product lists (1,000 times). * Points and interval estimates are based on the values above divided by China's 2017 GDP (12.31 trillion US dollars).

Our *EV* estimates are reported in Table 5. The factual welfare loss is estimated to be 62.8 billion US dollars (s.e. 27.2), accounting for 0.51 percent of China's pre-retaliation (2017) GDP. The ranking order of the factual and alternative schedules follows the one we obtained from the structural approach. The only exception is that the SS schedule now performs better than the OT schedule, though their estimates remain in each other's one standard error. As before, the factual retaliation performs worse than three of the four alternative schedules and only outperforms the PS schedule.

7 Concluding Remarks

The recent US–China trade war presents a rare opportunity to observe real-world trade conflict and evaluate the relevance of extant tariff theories. We assess four such theories as potential motivations for China's retaliatory tariffs. Holding the rate structure and taxable value constant, we find that two theoretically motivated responses—optimal tariffs (OT) and trade sanctions (SANC)—lead to smaller welfare losses than China's actual retaliation, whereas one—protection-for-sale (PS)—results in greater losses. A response targeting US swing states (SS) yields a welfare loss most similar to that of China's observed retaliation, consistent with findings from our forensic analysis of China's tariff decisions.

A key strength of our quantitative framework is its applicability to any major tariff changes. The alternative tariff schedules it generates are observationally equivalent to the actual tariff changes. This allows for direct, side-by-side comparison with the factual schedule as well as among the alternatives themselves.

Our approach abstracts from general equilibrium effects. Incorporating general equilibrium analysis in this context would require, at a minimum, assumptions about political institutions and the redistribution of tariff revenues. Policymakers motivated by terms-of-trade gains, trade sanctions, lobbying interests, and electoral considerations would allocate tariff revenues in fundamentally different ways. In light of the stark political differences across countries revealed by recent trade wars, we adopt a trade accounting approach that is institution-neutral, enabling comparison of tariff theories across varied policymaking environments.

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“Tariff Theories in a Trade War”
Online Appendices

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Online data sources in the appendices are hyperlinked

A Data and Parameters

Data. China's import tariff rates of 2017 were extracted from *The Customs Import and Export Tariff of the People's Republic of China* published by the Customs Tariff Commission of the Chinese State Council (henceforth, CTC). The CTC publishes tariff rates by HS code and country on the website of the Ministry of Finance in .pdf format (web link) and on the website of the Ministry of Commerce (Mofcom) in web-form format (web link). During the US–China trade war, the CTC published retaliatory tariffs as follows:

- Tranches 1 and 2: See web link (Announcement Number: Mofcom-2018-55) for announcements, product lists, and tariff rates.
- Tranche 3: See web link (Announcement Number: Mofcom-2018-69) for the announcement. The product list and tariff rates are provided as attachments at web link (original version, September 18, 2018) and web link (escalated version, May 13, 2019).
- Tranche 4: See web link (Announcement Number: CTC-2019-4) for announcements, product lists, and tariff rates.

Two exemptions are mentioned in the main text of this paper. One was for automobile products, announced in December 2018 (see web link for both announcement and product list, Announcement Number: CTC-2018-10), effective January 1, 2019. This exemption was announced in August 2019 to end on December 15, 2019 (see web link, Announcement Number: CTC-2019-5). The other was for a list of products with no specific focus, announced in August 2019 (see web link for both announcement and product list, Announcement Number: CTC-2019-6), effective September 17, 2018. Import price and quantity data can be purchased from the Data Services Department of the Hong Kong Trade Development Council (HKTDC, web link).

We include a *Made in China 2025* dummy (HS4) indicator in Table 4 as a control variable. The dummy variable was constructed by us. The Made-in-China 2025 Initiative (henceforth, MIC2025) was released by the State Council of China on May 19, 2015. The full text of the MIC2025 document is publicly available on the Chinese Central Government's website (web link). The initiative encourages the use of private and state funds to conduct research and development (R&D) and purchase global firms. We manually match the initiative to product lines through the similarities between the industry descriptions in the MIC2025 document and the product descriptions of the four-digit HS codes (publicly available on the UN Statistics Division's website, web link).

Parameters. The sector-level expenditure shares $\{\gamma_s\}$, as Cobb-Douglas parameters, can be directly computed using China's imports data (see Table A1 for summary statistics). Our estimation of σ, ω, and η follows the method in Fajgelbaum et al. (2020). To estimate σ and ω, we use

$$\Delta \ln m_{git} = \pi_{gt} + \pi_{it} + \pi_{si} - \sigma \Delta \ln p_{git} + \epsilon_{git}, \tag{A.1a}$$
$$\Delta \ln p^*_{git} = \pi^*_{gt} + \pi^*_{it} + \pi^*_{si} + \omega \Delta \ln m_{git} + \epsilon^*_{git}, \tag{A.1b}$$

where t indexes month. σ and ω are identified by instrumenting $\Delta \ln p_{git}$ and $\Delta \ln m_{git}$ with

$$\tilde{T}_{gt} = \begin{cases} T_{gt}, & \text{if } i = US, \\ 0, & \text{if } i \neq US. \end{cases}$$

Here, T_{gt} is a monthly varying version of the previous T_g. That is, product lines are assigned varying retaliatory tariff rates over time, following the time frame described in Section 2. This instrumental strategy, following Romalis (2007) and Zoutman et al. (2018), rests on the fact that tariffs shift down (up) the demand (supply) curve to make the segment of the supply (demand) curve around the equilibrium identifiable.

To estimate η, we use

$$\Delta \ln S_{gt} = \chi_{st} + (1 - \eta)\Delta \ln p_{gt} + \epsilon^S_{gt}, \tag{A.2}$$

where $S_{gt} \equiv \frac{p_{gt} m_{gt}}{P_{st} M_{st}}$ is the import share of product g in sector s. η is identified by instrumenting $\Delta \ln p_{gt}$ with its tariff-ridden counterpart $\Delta \ln H_{gt} \equiv \ln\left(\sum_i \exp(\Delta \ln(1 + t_{git}))/N_{gt}\right)$, where N_{gt} is the set of continuing varieties into the next period, and Feenstra-style variety correction is applied to both $\Delta \ln p_{gt}$ and $\Delta \ln H_{gt}$.[1]

The estimation results are reported in Table A2. Our sample begins in January 2017 and ends in December 2019. Our full-sample results are reported in Panel A, serving as our main

[1] The Feenstra-style variety correction refers to a method developed by Feenstra (1994) for adjusting variety changes in price index construction. In our context,

$$\Delta \ln p_{gt} = \frac{1}{1-\sigma} \ln \left(\sum_{i \in \mathcal{C}_{gt}} s_{git} e^{(1-\sigma)\Delta \ln\left(p^*_{git}(1+t_{git})\right) + \Delta \ln \hat{\epsilon}_{git}} \right) - \frac{1}{1-\sigma} \ln \left(\frac{S_{g,t+1}(\mathcal{C}_{gt})}{S_{g,t}(\mathcal{C}_{gt})} \right). \tag{A.3}$$

The last term in equation (A.3) is a Feenstra-style variety correction that addresses the changes in the composition of varieties between time t and time $t+1$. Here $s_{git} \equiv \frac{p_{git} m_{git}}{\sum_{i' \in \mathcal{C}_{gt}} p_{gi't} m_{gi't}}$ is the share of continuing variety i among all continuing varieties, $\mathcal{C}_{gt}$ is the set of continuing imported varieties in product g between the two periods, and $S_{g,t}(\mathcal{C}) \equiv \frac{\sum_{i' \in \mathcal{C}} p_{i'gt} m_{i'gt}}{\sum_{i' \in \mathcal{I}} p_{i'gt} m_{i'gt}}$ is the share of the varieties in set $\mathcal{C}$ within the imports of all product g varieties (set $\mathcal{I}$) at time t. σ and $\hat{\epsilon}_{git}$ are estimated from equation (A.1a). The instrumental variable for $\Delta \ln p_{gt}$ is

$$\Delta \ln H_{gt} = \ln \left(\frac{1}{N_{gt}} \sum_{i \in \mathcal{C}_{gt}} e^{\Delta \ln\left(1+t_{git}\right)} \right), \tag{A.4}$$

where N_{gt} is the set of continuing varieties from the previous period.

estimates. Their robustness is checked in Panels B to C using various subsamples. Considering that only half of Tranche 4 took effect (lasting from September 2019 to December 2019), we exclude those four months in Panel B. Panel C excludes the pre-retaliation periods, lasting from January 2017 to June 2018 (recall that Tranche 1 took effect in July 2018). Panel D uses the intersection of the subsamples included in Panels B and C, keeping only the months when Tranches 1 to 3 were effective. The estimated coefficients show high stability across panels within each column, all remaining within one standard error of each other. The following parameters reported in the table are used in our welfare analysis.

- $\hat{\sigma} = 1.453$ (s.e. 0.547). σ is the elasticity of substitution across origin-differentiated varieties within a product line. To our knowledge, the only counterpart estimate in the literature is the one in Fajgelbaum et al. (2020), which is 2.53 (s.e. 0.26). Our elasticity is smaller in magnitude than theirs. The two estimates for the two countries, respectively, are not strictly comparable. That being said, we speculate that the difference between them is at least partly related to the foreign supply chains that ship certain product varieties to China for further processing, final assembly, and other manufacturing activities that aggregate the values of imported parts. For that reason, the quantity demanded of single varieties may respond inactively or modestly to price variations.

- $\hat{\eta} = 1.892$ (s.e. 0.751), which resembles the estimate 1.53 (s.e. 0.27) in Fajgelbaum et al. (2020). $\hat{\eta}$ exceeds $\hat{\sigma}$, according to our estimates, suggesting lower substitutability among imported varieties than among product lines within a sector. This is also in line with the fact that a large fraction of foreign varieties imported to China are for processing and assembly.[2] The first and second observations, taken together, indicate (i) a similar substitutability across products in the Chinese case and the US case, which is explained by both countries being large and comprehensive importers, and meanwhile (ii) a smaller substitutability across varieties in the Chinese case than in the US case, which is explained by China's role in the global manufacturing network.

- $\hat{\omega}$ does not have a statistically significant difference from zero, a finding that resembles the findings on the US side made by Fajgelbaum et al. (2020), Amiti et al. (2019, 2020), Besedes et al. (2020), and Flaaen et al. (2020). Given that a horizontal foreign supply curve cannot be rejected, the tariff burdens all fall on the importers. Notice that we also estimate $\hat{\omega}$ using only US products (column (3), Table A2) and reach the same finding. In our view, the similarity in this estimated parameter between US and China is not a coincidence. The estimates for both countries, covering only one to three recent consecutive years, are short-run estimates specifically for the trade war. Amiti et al. (2019) note that the found horizontal supply curves may stem from policy uncertainties. The US–China trade war was accompanied by

[2] Since our setup is different from the conventional nested CES functions, $\hat{\eta} > \hat{\sigma}$ is unrelated to, and thus not contradicting, the conventional assumption that varieties are more substitutable than products in the previous trade literature.

various strategic maneuvers and tentative confrontation undertaken by both sides. Therefore, Chinese producers, as well as US producers, might maintain their original prices before they ascertained the final tariff rates applicable to their products. In our context, the supply chain complexity mentioned above might exacerbate the stickiness in export prices.

In addition, we experiment with two other empirical exercises conducted in Fajgelbaum et al. (2020). First, according to our estimates, the average change in import values of targeted varieties is -17.5%, while the average change in import values of targeted products is -1.2%. The two average changes are -31.7% and -2.5%, respectively, in their study.[3] The average changes are expected to be somewhat smaller in our context, possibly owing to global supply chains as discussed above.

Second, the parameter estimation through regressions (A.1a) and (A.1b) assumes the absence of preexisting trends. That is, tariff changes must be uncorrelated with import demand and export supply shocks. Following Fajgelbaum et al. (2020), we test for preexisting trends using

$$\overline{\Delta \ln y_{gi,2017}} = \zeta_g + \zeta_{is} + \rho \Delta \ln(1 + t_{ig}) + \epsilon_{gi}, \tag{A.5}$$

where the dependent variable is average monthly change in imported values, quantities, exporter prices, or import prices in 2017. Each of these average monthly changes, denoted by y, is regressed against the changes in the import tariff rates between 2017 and 2018. ζ_g and ζ_{is} are (HS8) product fixed effects and country-sector fixed effects, respectively. As shown in Table A3, no statistically significant relationship is found between these import outcomes and the import tariff changes, indicating that targeted product varieties were not driven by preexisting trends that differ from non-targeted product varieties.[4] When the sample is limited to US product varieties, the same finding applies.

[3] Our calculation of the two average changes follows their formulas. For the average change of targeted varieties, the formula is $\overline{\Delta \ln p^*_{git} m_{git}} = -\hat{\sigma} \frac{1+\hat{\omega}^*}{1+\hat{\omega}^*\hat{\sigma}} \overline{\Delta \ln(1 + \tau_{git})}$. It is the solution to the system of equations (A.1a) and (A.1b). For the average change of targeted products, the formula is $\Delta \ln p_{gt} m_{gt} = -(\hat{\eta} - 1)\Delta \ln H_{gt}$.

[4] The last two columns display the same coefficients because their dependent variables, when written in first-order differences, are equivalent to each other. The same finding was made in their study (see columns (3) and (4) in their Table III).

Table A1: Estimates of γ_s

Variable	Obs	Mean	Std. Dev.	Median	Min*	Max**
γ_s	96	0.010	0.030	0.016	3.99E-06	0.221

* γ_s-min: HS2=93
Arms and ammunition; parts and accessories thereof.

** γ_s-max: HS2=85
Electrical machinery and equipment and parts thereof; sound recorders and reproducers, television image and sound recorders and reproducers, and parts and accessories of such articles.

Table A2: Estimates of σ, ω, and η

	(1)	(2)	(3)	(4)
Countries	All	All	US	All
Unit of observation	Country-HS8-month	Country-HS8-month	HS8-month	HS8-month
Parameter identified	-σ	ω	ω	η
Dependent variable	Δln(quantity)	Δln(exporter price)	Δln(exporter price)	Δln(S)
Panel A: Main results (the full sample)				
Δln(tariff-ridden price, variety level)	-1.453***			
	(0.547)			
Δln(quantity, variety level)		0.521	0.270	
		(0.430)	(0.211)	
Δln(price, product level)				1.892***
				(0.751)
Fixed effects	Product × time, Country × time, Product × sector	Product × time, Country × time, Product × sector	Sector, time†	Sector × time
N	2,109,798	2,109,798	133,931	205,492
Panel B: Post-Tranche 3 months excluded (the January 2017 to August 2019 subsample)				
Coefficient§	-1.635**	0.502	0.243	2.089***
	(0.623)	(0.363)	(0.175)	(1.507)
N	1,858,060	1,858,060	118,838	181,117
Panel C: Pre-Tranche 1 months excluded (the July 2018 to December 2019 subsample)				
Coefficient§	-1.483**	0.576	0.289	1.891***
	(0.599)	(0.476)	(0.222)	(0.750)
N	1,188,855	1,188,855	73,962	115,246
Panel D: Tranches 1 to 3 (the July 2018 to August 2019 subsample)				
Coefficient§	-1.656**	0.586	0.273	2.089***
	(0.699)	(0.433)	(0.193)	(1.507)
N	937,115	937,115	58,868	90,871

Notes: The 2SLS estimation of parameters σ, ω, and η follows the identification strategy in Fajgelbaum et al. (2020) (see text for details). † Column (3) applies the specification of column (2) to the US-only subsample. The US-only subsample has only product and time dimensions, so that the product × time and country × time fixed effects collapse to the time fixed effects while the product × sector fixed effects collapse to the sector fixed effects. Using sector × time fixed effects instead of the two separate fixed effects gives similar results. § The four coefficients correspond respectively to -σ, ω, ω (US sample only), and η. Their regression specifications are identical with those used in Panel A but pertain to different time periods. Robust standard errors in parentheses, clustered by HS2. ** $p<0.05$, *** $p<0.01$.

Table A3: Testing for Pretrends

	(1)	(2)	(3)	(4)
	$\Delta\ln(p_{gi}^{*}m_{gi})$	$\Delta\ln(m_{gi})$	$\Delta\ln(p_{gi}^{*})$	$\Delta\ln(p_{gi})$
Panel A: All Imports				
$\Delta\ln(1+\tau_{ig})$	0.983	0.259	0.724	0.724
	(0.689)	(0.825)	(0.457)	(0.457)
Country-sector fixed effect	Yes	Yes	Yes	Yes
Product fixed effect	Yes	Yes	Yes	Yes
N	85,002	85,002	85,002	85,002
R-squared	0.239	0.232	0.238	0.238
Panel B: Imports from the US only				
$\Delta\ln(1+\tau_{ig})$	0.623	-0.370	0.994	0.994
	(1.096)	(1.112)	(0.622)	(0.622)
Sector fixed effect	Yes	Yes	Yes	Yes
N	4,846	4,846	4,846	4,846
R-squared	0.064	0.064	0.055	0.055

Notes : Standard errors in parentheses, clustered by country and HS8 in Panel A and by HS8 in Panel B. None of the coefficients in the table is statistically significant at conventional significance levels.

B Auxiliary Estimation Details

The estimation details of Λ_g^m are provided in this section. We keep notations consistent with those in their original studies whenever confusion does not arise. Thus, notations used in the estimation of one Λ_g (such as X or Y) may not apply to another Λ_g.

Optimal tariffs. We follow Feenstra (1994) and Broda and Weinstein (2006) to estimate the inverse supply elasticity

$$\Lambda_g^{OT} \equiv \left[\frac{dm_{gUS}}{dp^*_{gUS}} \cdot \frac{p^*_{gUS}}{m_{gUS}}\right]^{-1}.$$

Note that the data and method do not permit the estimation of US supply elasticities perceived specifically by China as an importer. The supply elasticities we estimate are in the eyes of the rest of the world (i.e., an aggregate importer of US products). Below is a concise description of their method. First, estimate the following model over a period of time:

$$\bar{Y}_{ngi} = \theta_{ng1}\bar{X}_{1,ngi} + \theta_{ng2}\bar{X}_{2,ngi} + \bar{u}_{ngi}, \tag{B.1}$$

where the overbars denote averages and the variables are defined as follows:

$$Y_{ngit} = \left(\Delta^* \ln p_{ngit}\right)^2, \tag{B.2}$$

$$X_{1,ngit} = \left(\Delta^* \ln s_{ngit}\right)^2, \tag{B.3}$$

$$X_{2,ngit} = \left(\Delta^* \ln p_{ngit} \Delta^* \ln s_{ngit}\right). \tag{B.4}$$

Here, n is the importer, while g, i, and t index product, exporter, and time, respectively, as in the main text. s_{ngit} is the share of variety gi within product g in country n. Δ^* denotes a time-difference operation specific to duplet ng: $\Delta^* x_{ngit} = \Delta x_{ngit} - \Delta x_{ngk^*_{ng}t}$ for any variable x_{ngit}, where k^*_{ng} is a reference product g imported by n. By estimating equations (B.1), we obtain $(\hat{\theta}_{ng1}, \hat{\theta}_{ng2})$, which is in turn informed by structural parameters

$$\hat{\theta}_{ng1} = \frac{w_{ng}}{(1 + w_{ng})(o_{ng} - 1)}, \tag{B.5}$$

$$\hat{\theta}_{ng2} = \frac{w_{ng}(o_{ng} - 2) - 1}{(1 + w_{ng})(o_{ng} - 1)}. \tag{B.6}$$

As solutions to the system of equations (B.5)-(B.6), w^*_{ng} and o^*_{ng} have theoretical interpretations in the background. w^*_{ng} is inverse supply elasticity perceived by importer n, while o^*_{ng} is import demand elasticity of importer n.[5]

As noted above, in our setting, the importer is the entire world except the US. We downloaded

[5]The system of equations (B.5)-(B.6) is not linear. We follow Broda et al. (2008) to conduct grid searches to ensure $w^*_{ng} > 0$ and $o^*_{ng} > 1$.

the import data of 227 countries from COMTRADE for the years 2012-2017, covering 1,224 HS4 products. By setting n as the aggregate of all 227 countries, we estimate equation (B.1) and solve $w^*_{China,g}$ as our estimate of Λ_g^{OT} for US HS4 product g. Notice that the operation of margins (7′) and (8′) does not hinge on the (dis)aggregatedness of product line g. Policymakers can assign alternative tariffs at the HS4, HS6, or HS8 level, depending on the HS-level of product line g.

Protection for sale (PS). We follow Goldberg and Maggi (1999) to construct

$$\Lambda_g^{PS} \equiv \frac{I_g - \alpha}{a + \alpha} \cdot \frac{R_g}{\sigma_g},$$

where, for a given product g, I is a dummy variable reflecting whether interest groups are organized (= 1 if they are), import penetration R is equal to the domestic output divided by imports EX/IM, and σ_g is the import demand elasticity. The data on IM and EX come from the Annual Industrial Surveys of China (AISC). Their original data are at the industry level (four-digit industry code), which we convert to HS6 codes using the concordance table in Upward et al. (2013). To construct I_g for industry g, we employ the enterprise list published by the State-owned Assets Supervision and Administration Commission (SASAC) of the Chinese State Council. Industries with (respectively, without) state-owned enterprises mentioned by the SASAC are given $I_g = 1$ (respectively, $I_g = 0$).[6] σ_g is estimated using the method of Feenstra (1994) and Broda and Weinstein (2006), as described above, for estimating optimal tariffs—recall o^*_{ng} as a solution to the system of equations (B.5)-(B.6). When the method is applied to Chinese imports from the rest of the world, o^*_{ng} implies China's product-specific import demand elasticity and can be estimated following the same procedure as we conducted for w^*_{ng}. We extract Chinese imports data from COMTRADE (2012-2017, 217 countries, 5,042 HS4 products) to estimate o^*_{ng} as the value of σ_g.

In the formula for Λ_g^{PS}, α refers to the share of employment related to organized lobbies (state-owned enterprises). It is a constant scalar appearing in both the numerator and the denominator. We do not normalize it but estimate it using the aggregated AISC data ($\hat{\alpha} = 0.179$). a as a constant scalar appearing only in the denominator is normalized to zero.

Trade sanctions (SANC). Costinot et al. (2012) and French (2017) propose a parametric system $\{Z_{gi}\}$ that can characterize product-level comparative advantages of countries in a micro-founded fashion.[7] Z_{gi} is a technology parameter in inverse proportion to the cost of producing product g in country i. By definition, country j has a comparative advantage in product g if

$$\frac{Z_{gj}}{Z_{gi}} > \frac{Z_{g'j}}{Z_{g'i}}, \tag{B.7}$$

[6] Only state-owned enterprises controlled by the central government are considered. The list of enterprises is provided on the SASAC website (web link).

[7] French (2017) shows that the underlying micro-foundation can be an Eaton-Kortum, Armington, Bertrand competition, or monopolistic competition (with and without free entry and firm heterogeneity) trade model.

for any country i and product g'. Define bilateral trade flows $X_{ngi} = p^*_{ngi} m_{ngi}$ in product g between countries n (destination) and i (origin). French (2017) shows that

$$\frac{X_{ngj}}{X_{ngi}} > \frac{X_{ng'j}}{X_{ng'i}} \text{ if and only if } \frac{Z_{gj}}{Z_{gi}} > \frac{Z_{g'j}}{Z_{g'i}}, \tag{B.8}$$

for any destination country n. Thus, with reference country i^0 and reference product g^0 given, $\frac{Z_{gj}/Z_{g^0j}}{Z_{gi^0}/Z_{g^0i^0}}$ is a measure of country j's comparative advantage in producing product g. This comparative advantage measure can be constructed using trade flow data. Both Costinot et al. (2012) and French (2017) note that this measure can be estimated using the fixed effect δ_{gj} in the following regression

$$\ln X_{n,gj} = \delta_{nj} + \delta_{gn} + \delta_{gj} + \epsilon_{n,gj}. \tag{B.9}$$

In our context, $j = US$. We use US exports to 222 countries to run regression (B.9).[8] The estimated $\hat{\delta}_{gj}$ serves as our motive measure Λ_g^{SANC} in equation (14), which is defined at the HS6 level.

Trump swing state index (SS). As noted in the text, the Trump swing state index was constructed as

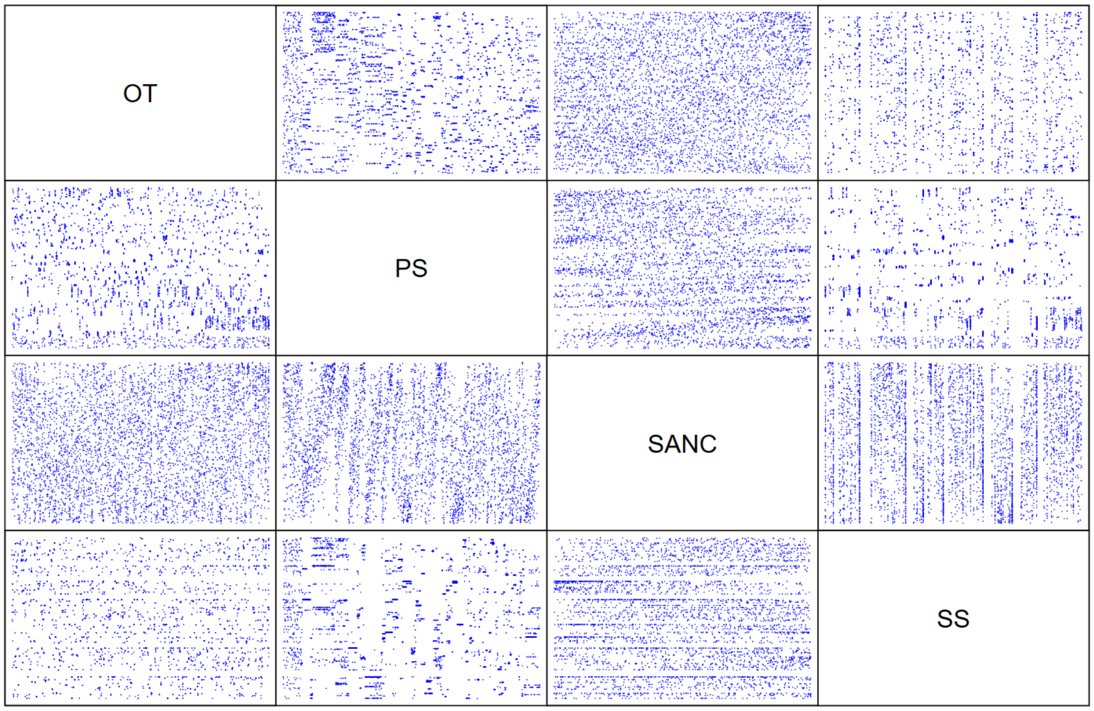
$$\Lambda_g^{SS} \equiv \sum_{c \in Swing} \frac{L_{gc}}{L_c} \cdot VotingTrump_c,$$

where $c \in Swing$ represents a county in a swing state that voted for Trump in the 2016 US presidential election. The swing states in 2016 were the 11 states (Colorado, Florida, Iowa, Michigan, Nevada, New Hampshire, North Carolina, Ohio, Pennsylvania, Virginia and Wisconsin) designated by Politico (web link). Among them, Florida, Iowa, Michigan, North Carolina, Ohio, Pennsylvania, and Wisconsin voted for Trump. The county-level voting data were purchased from *Dave Leip's Atlas of US Presidential Elections* https://uselectionatlas.org). $\frac{L_{gc}}{L_c}$ is the share of labor employment related to US product g. The data on employment across counties were downloaded from the County Business Patterns (CBP) database maintained by the US Census Bureau. The latest data available for downloading are for the year 2016. The CBP data are published by the US Census Bureau at the county-industry level. Notice that CBP reports industry (NAICS) level data. To convert the CBP data to the HS6 level, we followed the steps taken by Autor et al. (2013), available on this page (https://www.ddorn.net/data.htm) of David Dorn's website. Our Λ_g^{SS} is at the HS6 level.

The pairwise correlations among the four motive measures are demonstrated in Figure B1.

[8] The US exports data were downloaded from COMTRADE for the year 2017, covering 5,131 products.

Figure B1: Pairwise Correlation among Motives



Notes: This figure is a graphical summary of the four Λ-measures. Plots in the figure present pairwise correlation.

C Derivation of Equation (19)

The tariff-ridden delivery price of an imported variety in China can be generally written as

$$p_{gi} = \Upsilon_{gi} p^X_{gi}. \tag{C.1}$$

When TOT effects are absent, $\Upsilon_{gi} = 1 + t_{gi}$ and $p^X_{gi} = p^*_{gi}$. When TOT effects are present, $\Upsilon_{gi} = 1 + \frac{1/\Lambda^{OT}_{gi}}{\sigma+1/\Lambda^{OT}_{gi}}(t^0_{gi} + T_{gi})$ and $p^X_{gi} = [1 - \frac{\sigma}{\sigma+1/\Lambda^{OT}_{g}}(t^0_{gi} + T_g)]p^*_{gi}$. The latter case is an application of equation (18), with $T_{gi} = 0$ if $i \neq US$. The derivation below holds whether TOT effects exist or not.

Define $\lambda_{gi} = p^{1-\sigma}_{gi}/P^{1-\sigma}_g$. The CES demand m_{gi} equals $\lambda_{gi}X_g$, where X_g is China's expenditure on imported product g. By equation (C.1),

$$d\ln\lambda_{gi} - d\ln\lambda_{gUS} = (1-\sigma)\left((d\ln\Upsilon_{gi} + d\ln p^X_{gi}) - \underbrace{(d\ln\Upsilon_{gUS} + d\ln p^X_{gUS})}_{\equiv\Omega_{gUS}}\right), \tag{C.2}$$

for any $i \neq US$. The previously conducted welfare analysis, either the one with TOT effects (Figure 6) or the ones without TOT effects (see Figure 4), is concerned only with the US and thus corresponds to the Ω_{gUS} in equation (C.2).

The percentage change in the price index associated with product g is

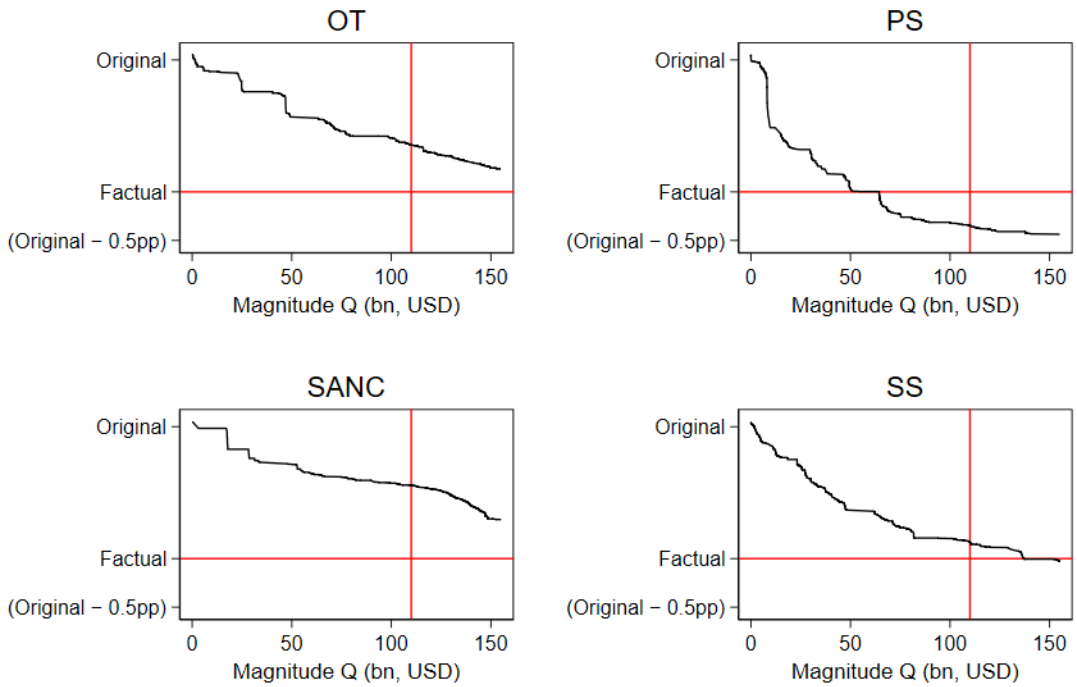
$$d\ln P_g = \sum_i \lambda_{gi}(d\ln\Upsilon_{gi} + d\ln p^X_{gi}) = \sum_i \lambda_{gi}\left(\frac{1}{1-\sigma}(d\ln\lambda_{gi} - d\ln\lambda_{gUS}) + \Omega_{gUS}\right), \tag{C.3}$$

which can be simplified as $\frac{1}{\sigma-1}d\ln\lambda_{gUS} + \Omega_{gUS}$ ($\sum_i \lambda_{gi} = 1$) and give equation (19). The algebra used here follows the spirit of the baseline (i.e., Armington-CES) case in Arkolakis et al. (2012).

D Robustness Checks (Time Periods)

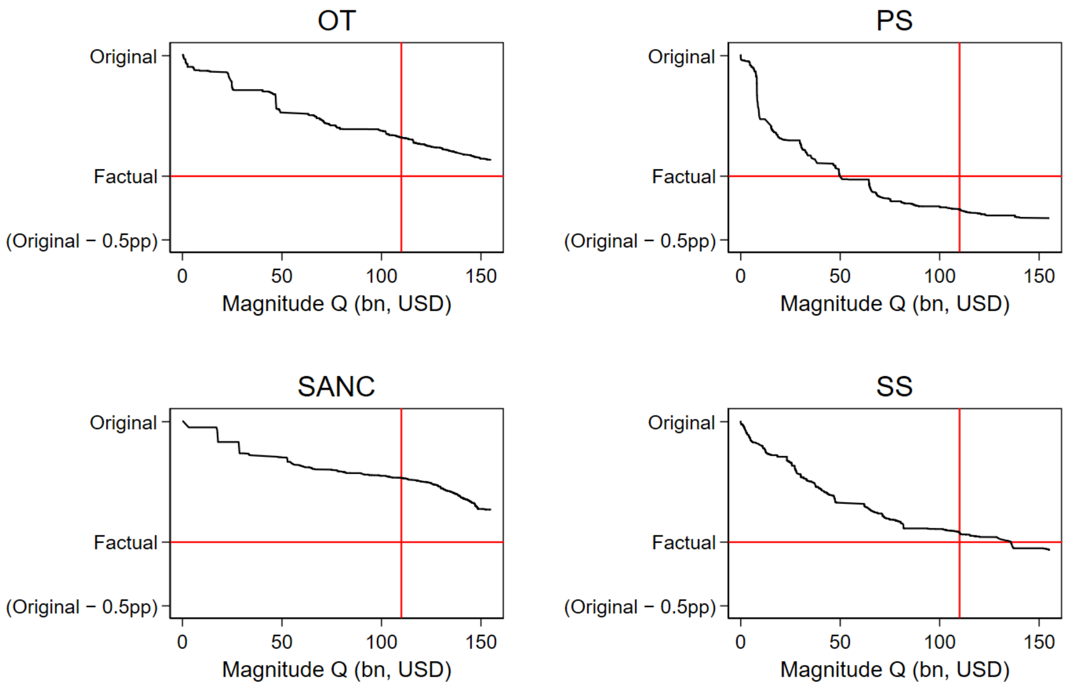
This appendix consists of Figure D1 and Figure D2. They were mentioned in Section 4.5 of the main text. In the main text, 2018 yearly average CIF import prices are used for $\{p^*_{gi}\}$. To check whether the choice of the price data influenced the welfare analysis, the yearly averages from July 2017 to June 2018 (the 12 months right before Tranche 1 took effect) are used in Figure D1 for $\{p^*_{gi}\}$, and the yearly averages of 2019 are used in Figure D2. Both figures show similar results, including factual and alternative ones, to Figure 4 in the main text.

Figure D1: Welfare Analysis (CIF Prices: July 2017 to June 2018)



Notes: This figure displays the results from welfare analysis using the yearly average CIF prices from July 2017 to June 2018 for $\{p_i^*\}$. The main text uses the calendar year (2018) to compute yearly averages. The four plots correspond to the four alternative schedules, respectively. The vertical axis represents welfare level. On the vertical axis of each plot, three welfare levels are marked: (i) the original (without retaliation) welfare level W^O, (ii) the welfare level resulting from the factual retaliation W^F (0.37 percentage points lower than W^O), and (iii) the welfare level 0.50 percentage points lower than W^O (serving as a reference level). W^F is also indicated by a red horizontal line. The welfare loci $W^A(Q)$ of the four alternative schedules are displayed in the four plots, with total taxable value (magnitude Q) as the horizontal axis. The total taxable value of the factual retaliation (108bn USD) is indicated by a red vertical line. $W^A(Q)$ beyond the 108bn USD is graphed with hypothetical rate 5% in each plot.

Figure D2: Welfare Analysis (CIF Prices: 2019)



Notes: This figure displays the results from welfare analysis using the yearly average CIF prices from 2019 for $\{p_i^*\}$. The main text uses the calendar year (2018) to compute yearly averages. The four plots correspond to the four alternative schedules, respectively. The vertical axis represents welfare level. On the vertical axis of each plot, three welfare levels are marked: (i) the original (without retaliation) welfare level W^O, (ii) the welfare level resulting from the factual retaliation W^F (0.37 percentage points lower than W^O), and (iii) the welfare level 0.50 percentage points lower than W^O (serving as a reference level). W^F is also indicated by a red horizontal line. The welfare loci $W^A(Q)$ of the four alternative schedules are displayed in the four plots, with total taxable value (magnitude Q) as the horizontal axis. The total taxable value of the factual retaliation (108bn USD) is indicated by a red vertical line. $W^A(Q)$ beyond the 108bn USD is graphed with hypothetical rate 5% in each plot.

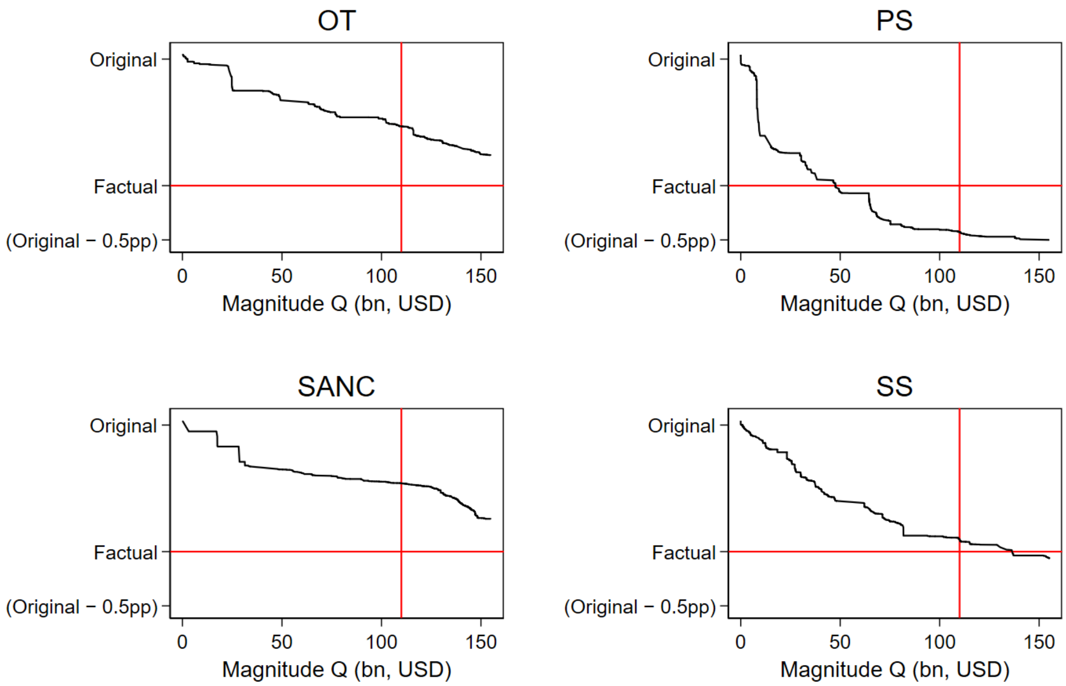
E Robustness Checks (Trade Regimes)

In addition to standard import trade statistics, Chinese Customs report the products imported by firms for the purpose of further processing and then exporting (known as *processing trade*) separately from other products (known as *ordinary trade*). The welfare analysis reported in the main text does not distinguish the two trade regimes from each other, because the trade regimes chosen by importers for their imported products in customs filings mainly reflect their tax considerations (China's corporate tax collection uses a VAT system). Products imported under processing trade may serve purposes other than processing trade, such as ordinary production and consumption, after necessary VAT adjustments are made. Likewise, products imported under ordinary trade can also be used in processing trade. Thus, we use the trade regime dichotomy only as a robustness check. In addition, we also run a robustness check using only the *intermediate goods* specified by the Classification of Broad Economic Categories (BEC).[9] The welfare analysis in the main text is rerun using only these products as a robustness check.

The results from the processing regime, the ordinary trade regime, and the intermediate goods are reported in Figure E1 to Figure E3. The findings, including factual and alternative ones, are highly similar to those from Figure 4 in the main text.

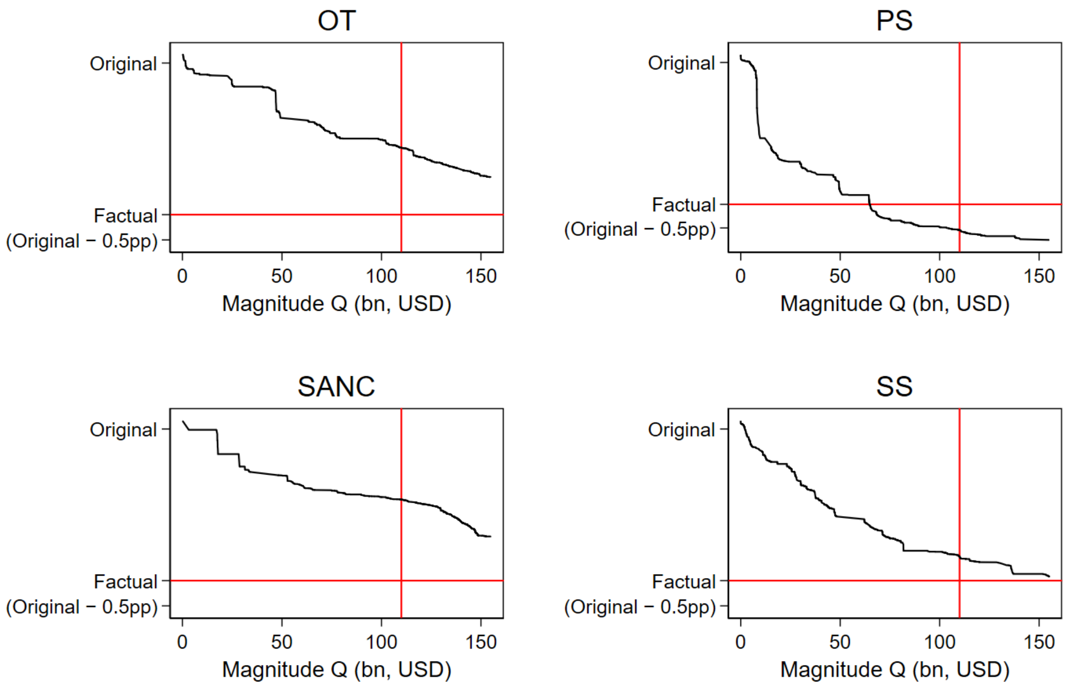
[9]See the UNSTATS website (web link, including the concordance table).

Figure E1: Welfare Analysis (Processing Trade Only)



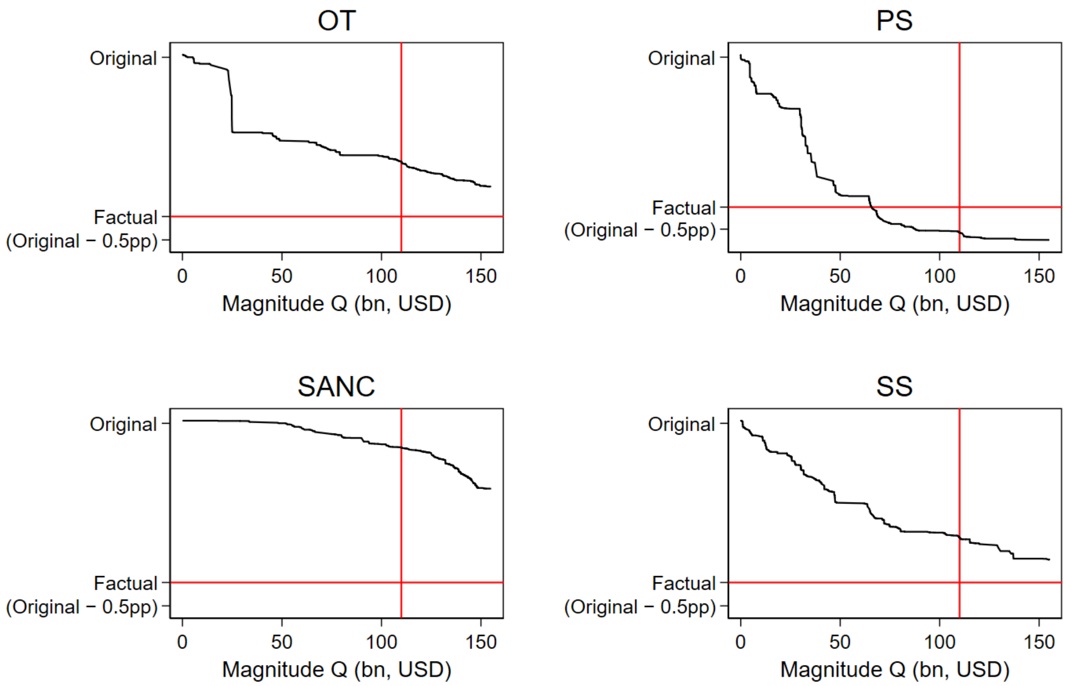
Notes: The four plots correspond to the four alternative schedules, respectively. The vertical axis represents welfare level. On the vertical axis of each plot, three welfare levels are marked: (i) the original (without retaliation) welfare level W^O, (ii) the welfare level resulting from the factual retaliation W^F (0.37 percentage points lower than W^O), and (iii) the welfare level 0.50 percentage points lower than W^O (serving as a reference level). W^F is also indicated by a red horizontal line. The welfare loci $W^A(Q)$ of the four alternative schedules are displayed in the four plots, with total taxable value (magnitude Q) as the horizontal axis. The total taxable value of the factual retaliation (108bn USD) is indicated by a red vertical line. $W^A(Q)$ beyond the 108bn USD is graphed with hypothetical rate 5% in each plot.

Figure E2: Welfare Analysis (Ordinary Trade Only)



Notes: The four plots correspond to the four alternative schedules, respectively. The vertical axis represents welfare level. On the vertical axis of each plot, three welfare levels are marked: (i) the original (without retaliation) welfare level W^O, (ii) the welfare level resulting from the factual retaliation W^F (0.37 percentage points lower than W^O), and (iii) the welfare level 0.50 percentage points lower than W^O (serving as a reference level). W^F is also indicated by a red horizontal line. The welfare loci $W^A(Q)$ of the four alternative schedules are displayed in the four plots, with total taxable value (magnitude Q) as the horizontal axis. The total taxable value of the factual retaliation (108bn USD) is indicated by a red vertical line. $W^A(Q)$ beyond the 108bn USD is graphed with hypothetical rate 5% in each plot.

Figure E3: Welfare Analysis (Intermediate Goods Only)



Notes: The four plots correspond to the four alternative schedules, respectively. The vertical axis represents welfare level. On the vertical axis of each plot, three welfare levels are marked: (i) the original (without retaliation) welfare level W^O, (ii) the welfare level resulting from the factual retaliation W^F (0.37 percentage points lower than W^O), and (iii) the welfare level 0.50 percentage points lower than W^O (serving as a reference level). W^F is also indicated by a red horizontal line. The welfare loci $W^A(Q)$ of the four alternative schedules are displayed in the four plots, with total taxable value (magnitude Q) as the horizontal axis. The total taxable value of the factual retaliation (108bn USD) is indicated by a red vertical line. $W^A(Q)$ beyond the 108bn USD is graphed with hypothetical rate 5% in each plot.

F Solution to Problem (20)

We first set up the following Lagrangian:

$$L = -\ln P + \mu[V - (1 + t^0_{gUS} + T_{gUS})p^0_{gUS}m^0_{gUS}], \tag{F.1}$$

where the import price index is defined as before: $P = \prod_s (P_s)^{\gamma_s}$ (see equation (2) in the main text). μ is the Lagrange multiplier. Derive the first-order conditions for US product variety g in sector s and US product variety h in sector k and divide the former condition with the latter, we obtain

$$\gamma_s \frac{\left(\frac{P_g}{P_s}\right)^{1-\eta}}{\left[1 - \left(\frac{(1+t^0_{gUS}+T_{gUS})p^0_{gUS}}{P_g}\right)^{1-\sigma}\right] X_g} = \gamma_k \frac{\left(\frac{P_h}{P_k}\right)^{1-\eta}}{\left[1 - \left(\frac{(1+t^0_{hUS}+T_{hUS})p^0_{hUS}}{P_h}\right)^{1-\sigma}\right] X_h}. \tag{F.2}$$

The two expenditures in equation (F.2) are

$$\begin{aligned} X_g &= \frac{P_g^{1-\sigma} X_s}{P_s^{1-\sigma}}, \\ X_h &= \frac{P_h^{1-\sigma} X_k}{P_k^{1-\sigma}}, \end{aligned} \tag{F.3}$$

where $X_s = \gamma_s X / P_s$, $X_k = \gamma_k X / P_k$, and X is China's total expenditure on imported products.

The system of equations formed by equation (F.2) and the linear constraint in problem (20) has $G + 1$ equations and G unknowns, with G denoting the total number of imported products across sectors. As in the main text, define

$$T^{\triangle}_{gi} = \begin{cases} 1 + \frac{T^{+}_{gUS}}{1+t^0_{gUS}}, & \text{if } i = US, \\ 1, & \text{if } i \neq US, \end{cases}$$

Then the solutions to the system of equations can be written as

$$p^0_{gUS} T^{\triangle}_{gUS} = \frac{V}{X} \left[\sum_i \left((1 + t^0_{gi}) T^{\triangle}_{gi} p^0_{gi} \right)^{1-\sigma} \right], \tag{F.4}$$

for US product variety g. This is equation (23) in the main text.