Optimal Tariffs under Geopolitical Risk: A Theory of Strategic De-risking

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Abstract

We develop a strategic theory of optimal tariffs based on geopolitical risk. Our framework rationalizes tariffs as a policy instrument for reducing excessive dependence on a single, potentially adversarial foreign supplier. Private import-sourcing decisions fail to internalize that an adversarial country's export policy responds to its aggregate market share. This generates a sourcing externality: individual firms' sourcing decisions collectively determine aggregate exposure to policy-driven supply disruptions, such as export restrictions, imposing costs on other firms. We show that the optimal tariff comprises two components: a standard terms-of-trade term that is uniform across sectors, and a geopolitical risk premium that targets sectors with high import dependence. Calibrating the model to the U.S. and EU economies, we find that the geopolitical risk premium creates substantial cross-industry tariff variation. This variation explains the structure of the 2018 U.S. tariffs on China, which are difficult to explain using terms-of-trade considerations alone.

1 Introduction

Treasury Secretary Yellen warned in 2022 that *"we cannot allow countries to use their market position to disrupt our economy or exercise unwanted geopolitical leverage."* This remark

epitomizes what policymakers increasingly recognize: import dependence, though necessitated by technological and resource constraints, can create strategic vulnerability.

The issue of strategic vulnerability has become particularly apparent given the recent proliferation of export restrictions. Most notable examples are export restrictions on critical inputs, like rare earth minerals, semiconductors, and medical supplies, which have targeted sectors where importing countries are most import dependent. China imposed rare earth export quotas in 2010 after foreign manufacturers had concentrated production there, creating leverage over high-tech supply chains. During COVID-19, many countries imposed PPE export restrictions that proved disruptive precisely because production had concentrated among a handful of suppliers. When semiconductor shortages emerged in 2021, Taiwan's dominance of advanced chip manufacturing meant localized disruptions cascaded globally. The common thread in these examples is that import dependence creates strategic vulnerability to foreign export policies.

Despite this new reality, standard tariff theory treats foreign supply as a purely *technological* constraint, and attributes the gains from unilateral tariffs exclusively to terms-of-trade manipulation. This framing misses the above-noted aspect of the current policy landscape: foreign supply is not merely a technological object but a strategic one. When import dependence invites export restrictions, decentralized sourcing decisions generate a pecuniary externality, which leads to inefficient levels of exposure to individual suppliers. Tariffs can correct this externality by lowering aggregate exposure.

We develop a tractable model to formalize this point. The model has two basic ingredients: First, production is roundabout: firms use traded intermediates and domestic labor. Second, Foreign can impose export restrictions (modeled as an export tax) in an adversarial state. And from a purely welfare maximizing standpoint, the expected export restriction is increasing in Home's aggregate import dependence. Home firms are, however, atomistic and take the expected export restriction as given when choosing sourcing. Thus, atomistic sourcing decisions generate excessive aggregate exposure relative to the welfare-maximizing allocation.

Our main result is a closed-form decomposition of the optimal import tariff. Let $\Lambda \equiv \lambda_{FH}$ denote Home's aggregate expenditure share on Foreign goods. Let $\bar{\tau}(\Lambda)$ denote the expected Foreign export-tax factor on shipments to Home. Under mild regularity conditions, the optimal Home tariff satisfies

$$t^*_{FH} = \underbrace{\frac{1}{\varepsilon^S_{FH}}}_{\text{terms of trade}} + \underbrace{\frac{\epsilon\,\lambda_{HH}}{\varepsilon^D_{FH}} \cdot \frac{d\ln\bar{\tau}(\Lambda)}{d\ln\Lambda}}_{\text{geopolitical risk premium}}, \tag{1}$$

where ε_{FH}^{S} is the Foreign export-supply elasticity faced by Home, ε_{FH}^{D} is Home's import-demand elasticity for Foreign goods, and ϵ is the trade elasticity. The first term is the standard optimal-tariff component. The second term is new: it corrects the sourcing externality by reducing Λ when expected foreign restrictions rise with aggregate import dependence.

The multi-sector extension presents a clear rationale for targeting, which has proven elusive from the lens of quantitative trade models. Despite sector-specific trade elasticities ϵ_k, the terms-of-trade component of the optimal tariff is uniform across sectors. However, the corrective term varies with sectoral import dependence and with the sensitivity of expected export restrictions to that dependence. This prediction closely aligns with the 2018 US tariffs on China which are difficult to explain from then lens of standard terms of trade theory.[1]

2 Background: The 2018 China Tariffs

The 2018–2019 US tariff escalation against China was concentrated among sectors where the United States had become most dependent on Chinese supply. Figure (1) illustrates this pattern, showing that sectors with greater Chinese import dependence experienced the largest tariff hikes in 2018. The political rhetoric around these tariffs reinforces this statistical pattern: the administration framed the objective in terms of strategic vulnerability and national-security rather than import price manipulation.[2]

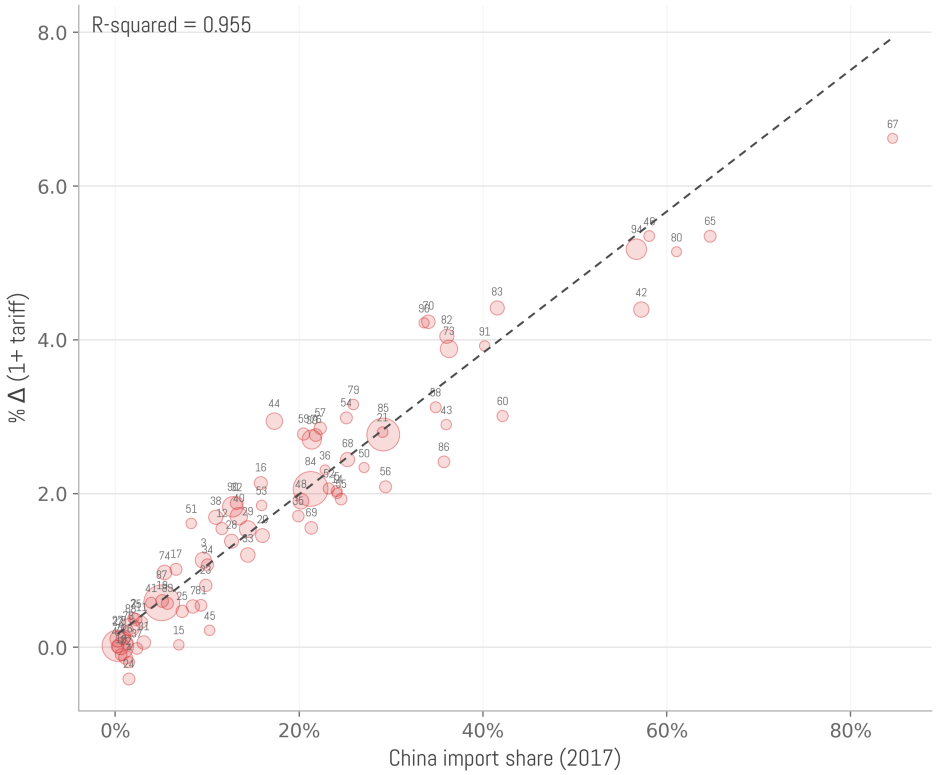
Classical optimal tariff theory offers no clear explanation for this cross-sectoral pattern. The canonical optimal-tariff formula sets the optimal tariff equal to the inverse of the foreign export-supply elasticity: $t^* = 1/\varepsilon^S$, where ε^S is the elasticity of foreign export supply. This elasticity reflects the home country's monopsony power, which bears little relation to the import share. Instead, it depends on what fraction of the foreign country's global sales go to the home market.

In fact, import dependence and monopsony power often pull in opposite directions. US import shares from China were highest in sectors where China commands a dom-

[1] Becko et al. [2025] model large countries that set tariffs when motivated by both economic welfare and geopolitical influence over smaller nations, finding that geopolitical objectives push optimal tariffs above the classic terms-of-trade level and that bipolar rivalry between great powers can substantially increase protectionism and drive a retreat from globalization. In contrast, we focus on large countries where tariffs correct an externality that operates independently of the terms-of-trade channel.

[2] Similarly, Clayton et al. [2025] use large language models to systematically classify and measure geoeconomic pressure, such as tariffs, sanctions, and export controls, from large textual corpora like earnings calls and analyst reports, find that U.S. firms in the highest-leverage industries are approximately 2.8 times more likely to face export controls than those at the median.

Figure 1: 2018 Tariffs on China correlate with import dependence



Notes: This figure plots HS2-level China import exposure against tariff changes over 2017–2018 for tariff-affected sectors. The unit of observation is an HS2 code. The horizontal axis shows the value of US imports from China divided by total US imports in the HS2 sector in 2017, displayed as a percentage. The vertical axis measures the percent change in $(1 + t)$ from 2017 to 2018, where t represents the sales-weighted average tariff rate in the HS2 sector. The sample includes all tariff lines subjected to the 2018 tariff hikes, excluding Section 232 tariffs that were uniformly applied to all trading partners, not just China. Marker size is scaled by HS2 import value in 2017. The dashed line represents the best weighted least-squares fit, with the corresponding weighted R^2 reported.

inant share of global production, e.g., rare earth minerals and electronic components. This higher market share reflects China's comparative advantage and its dominance of global production in these sectors. Because China dominates globally, other major importers also source from China in these same sectors. Consequently, the export supply elasticity faced by the United States is high in precisely these high-dependence sectors, implying a low optimal terms-of-trade tariff—the opposite of the pattern shown in Figure 1.[3]

[3]Broda et al. [2008] confirm empirically that countries do exploit market power through their tariff schedules: pre-WTO tariff levels were systematically higher in goods with less elastic foreign supply, consistent with the classic optimal tariff formula. Applying the same logic to US–China trade, standard theory predicts a negative cross-sectoral relationship between Chinese import dependence and optimal tariffs. The data exhibit a strongly positive one.

In light of this disconnect, we propose a different theory of optimal tariffs based on geopolitical risk. The key premise is that private sourcing decisions do not internalize the geopolitical risk of aggregate import concentration, leading to inefficiently high levels of import dependence that tariffs can correct. This consideration introduces a geopolitical risk premium to the optimal tariff formula, which increases with the aggregate import share—consistent with the pattern observed in 2018.

3 Model

The global economy consists of two countries: Home (H) and Foreign (F). Let $\mathcal{C} \equiv \{H, F\}$ denote the set of countries, with generic elements $i, n \in \mathcal{C}$. Each country is endowed with a fixed supply of labor, denoted L_i for country i, which is supplied inelastically. Let w_i denote the wage rate in country i.

3.1 Preferences

Consider a representative household in destination country $i \in \mathcal{C}$. The household derives utility from consuming differentiated varieties produced by firms located across both countries. Let Ω_n denote the set of firms located in origin country n, with $\bar{N}_n \equiv |\Omega_n|$ representing the measure of firms in country n. Each firm $\omega \in \Omega_n$ produces a unique differentiated variety.

Let $c_{ni}(\omega) \geq 0$ denote the quantity of the variety produced by firm $\omega \in \Omega_n$ that is consumed by the representative household in country i. The household aggregates varieties through a CES utility function

$$C_i = \left(\sum_{n \in \mathcal{C}} C_{ni}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}, \qquad with \quad C_{ni} = \left[\int_{\Omega_n} c_{ni}(\omega)^{\frac{1}{\mu}} d\omega \right]^{\mu} \tag{2}$$

where $\sigma > 1$ is the Armington elasticity of substitution across national-level varieties and $\mu \geq 1$ is the degree of firm-level market power, determined by the sub-national elasticity of substitution between firm varieties:

$$\gamma \equiv \frac{\mu}{\mu - 1}$$

Consumer Demand. Let $\tilde{p}_{ni}(\omega) > 0$ denote the *consumer price* in destination country i for one unit of the variety produced by firm $\omega \in \Omega_n$. This price is inclusive of all

trade costs and taxes, as specified below. Let Y_i denote the *net expendable income* of the representative household in country i, defined as wage income plus rebated trade-tax revenue. The household maximizes utility (2) subject to the budget constraint:

$$\sum_{n\in\mathcal{C}} \int_{\Omega_n} \tilde{p}_{ni}(\omega)\, c_{ni}(\omega)\, d\omega \leq Y_i.$$

The household's optimization yields the following CES demand function for each variety $\omega \in \Omega_n$:

$$c_{ni}(\omega) = \left(\frac{\tilde{p}_{ni}(\omega)}{\tilde{P}_{ni}}\right)^{-\gamma} \left(\frac{\tilde{P}_{ni}}{\tilde{P}_i}\right)^{-\sigma} \frac{Y_i}{\tilde{P}_i}, \tag{3}$$

where $\tilde{P}_{ni}$ and $\tilde{P}_i$ denote aggregate price indexed in country i:

$$\tilde{P}_{ni} \equiv \left(\int_{\Omega_n} \tilde{p}_{ni}(\omega)^{1-\gamma} d\omega\right)^{\frac{1}{1-\gamma}} \qquad \tilde{P}_i = \left[\sum_{n\in\mathcal{C}} \tilde{P}_{ni}^{1-\sigma}\right]^{\frac{1}{1-\sigma}}.$$

The *indirect utility* of the representative household equals real income, and pins down social welfare, denote by $W_i = Y_i/\tilde{P}_i$.

3.2 Production Technology

Each country $n \in \mathcal{C}$ hosts a fixed set Ω_n of differentiated firms that compete under monopolistic competition. Firms produce using labor and a composite intermediate input, with a constant-returns-to-scale Cobb-Douglas technology. Let $\ell_n(\omega)$ denote the labor input and $M_n(\omega)$ denote the composite intermediate input used by firm $\omega \in \Omega_n$. Each firm is characterized by a productivity parameter $\varphi_n(\omega) > 0$, which is fixed and heterogeneous across firms. The production function is:

$$q_n(\omega) = A_n \left(\frac{\ell_n(\omega)}{\beta}\right)^{\beta} \left(\frac{M_n(\omega)}{1-\beta}\right)^{1-\beta}, \qquad \beta \in (0,1], \tag{4}$$

where $q_n(\omega)$ denotes the output of firm ω and β represents the *value-added share* in production.

The composite intermediate input $M_n(\omega)$ aggregates over the same differentiated varieties that enter final consumption, with the identical CES aggregation structure:

$$M_n(\omega) = \left(\sum_{j\in\mathcal{C}} M_{jn}(\omega)^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}, \qquad with \quad M_{jn}(\omega) = \left[\int_{\Omega_j} m_{jn}(\omega,\omega')^{\rho} d\omega'\right]^{\frac{1}{\rho}} \tag{5}$$

where $m_{jn}(\omega, \omega')$ denotes the quantity of variety $\omega' \in \Omega_j$ used as an intermediate input by firm $\omega \in \Omega_n$.

Cost Minimization and Optimal Pricing. Given the Cobb-Douglas production technology (4) and the CES intermediate input aggregator (5), cost minimization yields the unit input cost:

$$\mathscr{C}_n(w_n, \tilde{P}_n) = w_n^{\beta}\, \tilde{P}_n^{1-\beta}, \tag{6}$$

where $\tilde{P}_n$ represent the intermediate input price index which the same as the consumer price index, since the intermediate composite uses the same aggregation structure as final consumption.

Under monopolistic competition, each firm charges a factory-gate price equal to a constant markup equal to μ over marginal cost:

$$p_n(\omega) \;=\; \frac{\mu}{A_n}\mathscr{C}_n(w_n, \tilde{P}_n) \;=\; \frac{\mu}{A_n} w_n^{\beta}\, \tilde{P}_n^{1-\beta}. \tag{7}$$

3.3 Trade Costs and Policy Instruments

International trade is subject to both natural trade frictions and policy-induced barriers. Let $d_{ni} \geq 1$ denote the *iceberg trade cost* for shipping goods from origin n to destination i: delivering one unit in country i requires producing d_{ni} units in country n. We normalize domestic trade costs to unity: $d_{ii} = 1$ for all $i \in \mathcal{C}$.

Countries may impose ad valorem trade taxes. Let $t_{ni} \geq 0$ denote the *import tariff* levied by destination country i on imports from origin $n \neq i$, with $t_{ii} = 0$. Let $x_{ni} \geq 0$ denote the *export tax* levied by origin country n on exports to destination $i \neq n$, with $x_{ii} = 0$. Define the corresponding gross tax factors:

$$\tau_{ni}^{M} \equiv 1 + t_{ni}, \qquad \tau_{ni}^{X} \equiv 1 + x_{ni}. \tag{8}$$

3.4 Policy-Implied Buyer Prices

The consumer price in destination i for variety $\omega \in \Omega_n$ incorporates the factory-gate price, iceberg trade costs, export taxes, and import tariffs. We assume that the export tax applies to the after-iceberg price $d_{ni} p_n(\omega)$, and the import tariff applies on top of the export-tax-inclusive price. This yields:

$$\tilde{p}_{ni}(\omega) = \tau_{ni}^{M}\, \tau_{ni}^{X}\, d_{ni}\, p_n(\omega). \tag{9}$$

For domestic varieties, this simplifies to $\tilde{p}_{ii}(\omega) = p_i(\omega)$ since $\tau_{ii}^X = \tau_{ii}^M = d_{ii} = 1$.

3.5 Total Demand and Gross Expenditure

Cost minimization by firms implies that the demand for intermediate input varieties follows the same structure as final demand. Specifically, the demand for variety $\omega' \in \Omega_j$ as an intermediate input by firm $\omega \in \Omega_n$ is:

$$m_{jn}(\omega, \omega') = \left(\frac{\tilde{p}_{jn}(\omega')}{\tilde{P}_n}\right)^{-\gamma} \left(\frac{\tilde{P}_{ni}}{\tilde{P}_i}\right)^{-\sigma} M_n(\omega), \tag{10}$$

where $\tilde{P}_n M_n(\omega)$ denotes total intermediate input expenditure by firm ω. Aggregating across all firms in country n, total intermediate input expenditure equals:

$$\tilde{P}_n M_n = \frac{1-\beta}{\beta} w_n L_n, \tag{11}$$

Total demand facing firm $\omega \in \Omega_n$ in destination market i consists of *(i)* final consumption demand $c_{ni}(\omega)$ and *(ii)* intermediate input demand from all firms located in i. Define total demand as:

$$q_{ni}(\omega) \equiv c_{ni}(\omega) + \int_{\Omega_i} m_{ni}(\omega', \omega) d\omega'. \tag{12}$$

Given the common CES structure, total demand simplifies to:

$$q_{ni}(\omega) = \left(\frac{\tilde{p}_{ni}(\omega)}{\tilde{P}_{ni}}\right)^{-\gamma} \left(\frac{\tilde{P}_{ni}}{\tilde{P}_i}\right)^{-\sigma} \frac{E_i}{\tilde{P}_i}, \tag{13}$$

where E_i denotes *gross expenditure* in country i, defined as the sum of final consumption expenditure and intermediate input expenditure:

$$E_i \equiv \tilde{P}_i C_i + \tilde{P}_i M_i = Y_i + \frac{1-\beta}{\beta} w_i L_i. \tag{14}$$

The second lines imposes that final consumption expenditure equals net income Y_i which is the sum of wage income and profits rebates, which will be characterized shortly.

4 General Equilibrium

Aggregate Trade Shares. Define the *aggregate expenditure share* on goods sourced from origin n in destination i as $\lambda_{ni} \equiv \int_{\Omega_n} (\tilde{p}_{ni}(\omega) q_{ni}(\omega) d\omega) / E_i$. Substituting the demand function (13) and the pricing equation (7), and using the consumer price relationship (9), the aggregate trade share becomes:

$$\lambda_{ni} = \frac{\left(\frac{1}{\bar{\varphi}_n} \tau_{ni}^M \tau_{ni}^X d_{ni} w_n^\beta \tilde{P}_n^{1-\beta}\right)^{-\epsilon}}{\sum_{\ell \in \mathcal{C}} \left(\frac{1}{\bar{\varphi}_\ell} \tau_{\ell i}^M \tau_{\ell i}^X d_{\ell i} w_\ell^\beta \tilde{P}_\ell^{1-\beta}\right)^{-\epsilon}}, \tag{15}$$

where $\epsilon \equiv \sigma - 1$ is the trade elasticity and $\bar{\chi}_n$ is a constant measure of aggregate TFP: $\bar{\varphi}_n \equiv \bar{N}_n^{\frac{1}{\epsilon}} A_n$. These shares satisfy the adding up constraint $\sum_{n \in \mathcal{C}} \lambda_{ni} = 1$ for all $i \in \mathcal{C}$.

Aggregate Price Index. The consumer price index in country i can be expressed in terms of aggregate trade costs and unit costs:

$$\tilde{P}_i = \left[\sum_{n \in \mathcal{C}} \bar{\chi}_n \left(\tau_{ni}^M \tau_{ni}^X d_{ni} w_n^\beta \tilde{P}_n^{1-\beta}\right)^{-\epsilon}\right]^{-\frac{1}{\epsilon}}. \tag{16}$$

This equation, together with its counterpart for the other country, forms a system that determines the equilibrium price indexes as functions of wages and policy variables.

We also denote

$$p_n = \frac{1}{A_n} w_n^\beta \tilde{P}_n^{1-\beta} \qquad\qquad \tilde{p}_{ni} = \tau_{ni}^M \tau_{ni}^X d_{ni} p_n$$

Factor Market Clearing. Labor market clearing requires that total wage payments in country n equal the labor share of producer revenue across all destinations. The delivered producer-value revenue from origin n to destination i (net of both taxes) is $\lambda_{ni} E_i / \tau_{ni}^M \tau_{ni}^X$. Summing across destinations and using the labor share β yields:

$$w_n L_n = \frac{\beta}{\mu} \sum_{i \in \mathcal{C}} \frac{1}{\tau_{ni}^M \tau_{ni}^X} \lambda_{ni} E_i, \qquad \forall n \in \mathcal{C}. \tag{17}$$

Profits are given by $\Pi_n = (\mu - 1)\frac{1}{\beta} w_n L_n$. Net income is $Y_n = w_n L_n + \Pi_n$.

Tax Revenue and Net Income. Import tariff revenue collected by destination country i equals the tariff fraction of buyer spending on imports:

$$T_i^M = \sum_{n \neq i} \frac{\tau_{ni}^M - 1}{\tau_{ni}^M} \lambda_{ni} E_i. \tag{18}$$

Export tax revenue collected by origin country n equals the export-tax fraction of the net-of-import-tariff value of exports:

$$T_n^X = \sum_{i \neq n} \frac{\tau_{ni}^X - 1}{\tau_{ni}^X} \cdot \frac{1}{\tau_{ni}^M} \lambda_{ni} E_i. \tag{19}$$

Net income in country i is wage income plus profits plus rebated trade-tax revenue:

$$Y_i = (1 + \frac{\mu - 1}{\beta}) w_i L_i + T_i^M + T_i^X. \tag{20}$$

Combining (14) and (20) yields an alternative expression for gross expenditure:

$$E_i = \frac{\mu}{\beta} w_i L_i + T_i^M + T_i^X. \tag{21}$$

Definition 1. *[General Equilibrium]* For a given set of trade taxes $\{t_{ni}, x_{ni}\}$, a general equilibrium is a collection of prices $\{w_i, \tilde{P}_i\}_{i \in \mathcal{C}}$, trade shares $\{\lambda_{ni}\}_{n,i \in \mathcal{C}}$, tax revenues $\{T_i^M, T_i^X\}_{i \in \mathcal{C}}$, and expenditures $\{Y_i, E_i\}_{i \in \mathcal{C}}$ such that: (i) *trade shares satisfy* (15); (ii) *price indexes satisfy* (16); (iii) *labor markets clear according to* (17); (iv) *tax revenues satisfy* (18)–(19); (v) *income and expenditure satisfy* (20)–(21); *and* (vi) *trade is balanced according to* (22).

Balanced Trade. There is no international lending or borrowing. The national-level budget constraint, therefore, implies that trade is balanced. That is, the net-of-import-tariff value of Home's imports from Foreign equals the net-of-import-tariff value of Foreign's imports from Home. The balanced trade condition can be formally written as:

$$\frac{1}{\tau_{FH}^M} \lambda_{FH} E_H = \frac{1}{\tau_{HF}^M} \lambda_{HF} E_F. \tag{22}$$

5 Optimal Import Tariff if Foreign is Passive

This section characterizes Home's optimal unilateral trade policy under the assumption that Foreign remains passive. Our goal here is to highlight the rationale for trade

policy intervention. To this end, we purposely abstract away from policies intended at correcting purely domestic market failures, as formalized by the following assumption.

Assumption 1. *Firms posses no market power ($\mu = 1$) or equivalently domestic policies are in place to counteract firm-level market power ensuring the allocation is efficient absent trade taxes.*

As an intermediate step toward deriving the optimal tariff, we characterize the export supply and import demand elasticity in our general equilibrium framework.

Export Supply and Import Demand Elasticity. Set $p_H \equiv 1$ by choice of numeriare. Leveraging the balanced trade condition, we can write he foreign export supply function in term of $p_F \sim p_F/p_H$

$$q_{FH} = \bar{\varphi}_F \, \lambda_{FF}(p_F)^{\frac{1-\beta}{\beta\epsilon}} \, \lambda_{HF}(p_F) \, L_F \tag{23}$$

where the trade shares functions are defines as

$$\lambda_{FF}(p_F) \coloneqq \frac{p_F^{-\epsilon}}{p_F^{-\epsilon} + d_{HF}^{-\epsilon}}, \qquad \lambda_{HF}(p_F) = 1 - \lambda_{FF}(p_F)$$

Equation 23 implicitly solves p_F in terms of the export supply q_{HF}. Define the export supply elasticity as

$$\frac{1}{\varepsilon_{FH}^S} \equiv \frac{\mathrm{d} \ln p_F}{\mathrm{d} \ln q_{FH}} \qquad \text{[export supply elasticity]}$$

We can apply the Implicit function Theorem to Equation 23 yields the following expression for the export supply elasticity:

$$\varepsilon_{FH}^S = \epsilon \lambda_{FF} + \frac{1-\beta}{\beta} \lambda_{HF}$$

The import demand elasticity could be characterize by noting that import demand function for foreign varieties is

$$q_{FH} = \frac{1}{\tilde{p}_{FH}} \lambda_{FH}(\tilde{p}_{FH}) E_H(\tilde{p}_{FH}).$$

Define the import demand elasticity as

$$\varepsilon_{FH}^D \equiv -\frac{\mathrm{d} \ln q_{FH}}{\mathrm{d} \ln \tilde{p}_{FH}} \qquad \text{[import demand elasticity]}$$

The import demand function can be characterized as

$$\varepsilon_{FH}^{D} = 1 + \frac{\epsilon \lambda_{HH}}{1 - \frac{\tau_{FH}-1}{\tau_{FH}} \lambda_{FH}} + \frac{1-\beta}{\beta} \lambda_{FH} \tag{24}$$

Optimal Tariff Problem. Consider a scenario in which the Foreign government is passive and does not impose any trade taxes ($\tau_{HF} = 1$). Home, in contrast, optimally sets its import tariff $\tau_{FH}^{M} \geq 1$ to maximize domestic welfare. Given the Lerner symmetry, we abstract from export taxes without loss of generality ($\tau_{ni}^{X} = 1$ for all n, i). Home's unilaterally-optimal import tariff solves

$$\max_{\tau_{FH}^{M}} \; W_H = \frac{Y_H}{\tilde{P}_H} \quad s.t. \quad \text{equilibrium constraints.} \tag{25}$$

The optimal tariff balances the unilateral gains from improved terms of trade against the efficiency loss from reduced trade.

Optimal Tariff Formula. Following the traditional optimal tariff logic, the home country can improve its terms of trade, *i.e.*, lower p_F/p_H, by restricting export supply. And the optimal tariff equals the inverse of the Foreign export-supply elasticity, as formalized below.

Proposition 1. *[Optimal Import Tariff with Passive Foreign]* Suppose Foreign is passive ($\tau_{HF}^{M} = \tau_{FH}^{X} = 1$). The welfare-maximizing Home import tariff satisfies

$$t_{FH}^{*} = \frac{1}{\varepsilon_{FH}^{S}} = \frac{1}{\epsilon \lambda_{FF} + \frac{1-\beta}{\beta} \lambda_{HF}}, \tag{26}$$

where $\epsilon \equiv \sigma - 1$ is the trade elasticity, λ_{FF} is Foreign's domestic expenditure share, $\lambda_{HF} = 1 - \lambda_{FF}$ is Foreign's import share from Home, and β is the value-added share in production.

Two limiting cases are instructive. First, when $\beta = 1$ (no intermediate inputs), the optimal tariff reduces to $t_{FH}^{*} = 1/(\epsilon \lambda_{FF})$, which is the standard Gross formula. Second, As $\beta \to 0$ (production becomes fully round-about), the optimal tariff approaches zero because Foreign prices become infinitely elastic with respect to Home's import demand.

6 Optimal Tariff if Foreign is Strategic

This section characterizes Home's optimal unilateral import tariff when Foreign is *active* and sets an export tax. The key new force relative to the passive-Foreign benchmark is an *sourcing externality*: the Foreign export tax depends on an aggregate exposure, determined by private sourcing decisions. Individual firms are infinitesimal and take aggregate exposure as given when making sourcing decisions, thereby increasing the vulnerability of other firms to foreign's export policy.

Policy Environment. Without loss of generality, we restrict foreign policy to export taxes and Home's policy to import taxes ($\tau^X_{HF} = \tau^M_{HF} = 1$). We also note that domestic varieties are not subjected to taxes by design ($\tau^X_{ii} = \tau^M_{ii} = 1$). Buyer prices are given by (9):

$$\tilde{p}_{ni}(\omega) = \tau^M_{ni}\, \tau^X_{ni}\, d_{ni}\, p_n(\omega).$$

We continue to normalize the Home aggregate producer price to unity, $p_H \equiv 1$ by choice of numeraire.

Foreign export-tax schedule. Foreign is reliable with probability $\pi \in [0,1]$. Let $g \equiv 1-\pi$ denote *geopolitical risk*, i.e., the probability that the foreign supplier enters an adversarial state and imposes export restrictions. In the aligned state (probability π), Foreign sets no export restrictions, i.e.,$\tau^X_{FH} = 1$. In the adversarial state (probability g), Foreign imposes an export restriction that depends on its export market power. Specifically, denoted Home's aggregate import share from Foreign by

$$\Lambda \equiv \lambda_{FH}$$

Foreign's export tax in the non-aligned state is $\tau^X_{FH} = 1 + \mathrm{x}(\Lambda)$, where $\mathrm{x}_F : [0,1] \to \mathbb{R}_+$ is a univariate and strictly increasing function: $\mathrm{x}'(.) > 0$. One possible specification is that Foreign's export tax is set to its unilaterally optimal rate. Relatedly, we let geopolitical risk be a function of Foreign's export market power: $g(\Lambda) \equiv a\,\Lambda^{\zeta}$, motivated by the fact that the gains from export restrictions are proportional to Λ, as elaborated shortly.

Sourcing decisions in Home depend on the *expected* export-tax:

$$\bar{\tau}(\Lambda) \equiv \mathbb{E}[\tau^X_{FH} \mid \Lambda] = \pi(\Lambda)\cdot 1 + g(\Lambda)\cdot\big(1+\mathrm{x}(\Lambda)\big) = 1 + g(\Lambda)\,\mathrm{x}(\Lambda). \tag{27}$$

In equilibrium, the effective tax wedge on composite good FH is $\tau^M_{FH}\bar{\tau}^X_F(\Lambda)$, where the

export tax wedge is increasing in aggregate exposure as noted next.

6.1 $\bar{\tau}(\Lambda)$ is Increasing in Aggregate Exposure

In this section we argue that both components of the expected export wedge, $x(\Lambda)$, and $g(\Lambda)$, are organically increasing in the aggregate exposure or import dependence measure. As a result, expected export wedge, $\bar{\tau}(\Lambda) = 1 + g(\Lambda)\, x(\Lambda)$, is also increasing in Λ, implying that $\frac{\partial \ln \bar{\tau}(\Lambda)}{\partial \ln \Lambda} > 0$. Our goal here is to show that this feature is not baked in by assumption, but arises instead as a direct consequence of the Foreign government's welfare-maximizing behavior.

We first establish this property for the export tax $\mathrm{x}(\Lambda)$. The unilaterally-optimal export tax rate in the adversarial state is $x(\Lambda) = 1/\varepsilon(\Lambda)$, equal to the inverse of the import demand elasticity facing Foreign exports. Since $\varepsilon(\Lambda) \equiv \epsilon(1-\Lambda) + \frac{1-\beta}{\beta}\Lambda$, greater import dependence compresses the import demand elasticity and thereby raises the optimal export tax rate. Formally, if $\epsilon > \frac{1-\beta}{\beta}$, then

$$\frac{d\mathrm{x}(\Lambda)}{d\Lambda} = \frac{\epsilon - \frac{1-\beta}{\beta}}{\left[\epsilon(1-\Lambda) + \frac{1-\beta}{\beta}\Lambda\right]^2} > 0. \tag{28}$$

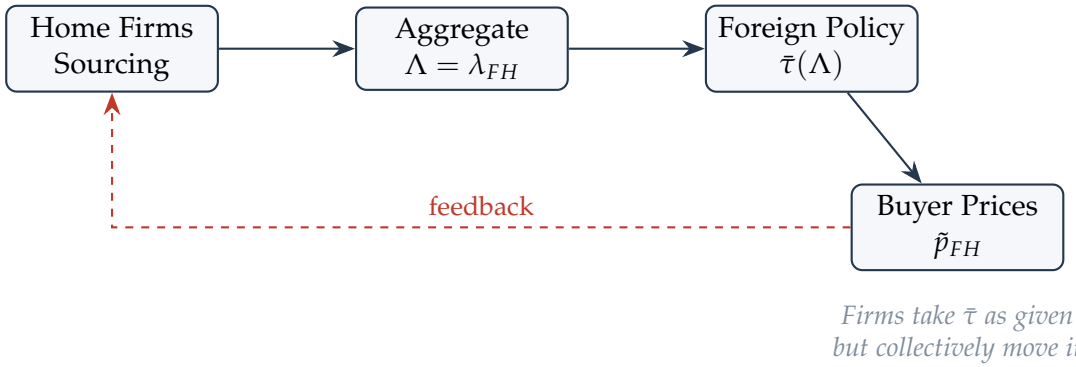
Greater import dependence thus confers additional export market power on Foreign, enabling it to extract a higher revenue-maximizing markup on its exports.

An analogous logic applies to the geopolitical hazard $g(\Lambda)$. The basic idea is that greater import dependence amplifies the welfare gains that Foreign can secure through optimal export restriction. To a first-order approximation, Foreign's welfare gain from imposing the optimal export restriction is $\Delta_x \ln W_F \;\approx\; \mathrm{x}(\Lambda)\,\Lambda\,\frac{E_H}{Y_F}$, which is increasing in Λ given that $\frac{d\mathrm{x}(\Lambda)}{d\Lambda} > 0$. If the probability that Foreign assumes an adversarial stance, $g(\Lambda)$, reflects the trade-off between these welfare gains and a non-pecuniary reputational cost, then the geopolitical hazard will also be increasing in Λ. Formally,

$$\frac{\partial(\Delta_x \ln W_F)}{\partial \Lambda} > 0 \quad \Longrightarrow \quad \frac{dg(\Lambda)}{d\Lambda} > 0$$

For tractability, we model the geopolitical hazard as a power function $g(\Lambda) = a\Lambda^{\zeta}$, which is increasing in aggregate exposure Λ. This specification provides a parsimonious representation of the idea that Foreign's incentive to impose export restrictions rises with Λ. The geopolitical risk elasticity parameter, ζ, estimated in a later section, governs the sensitivity of this relationship.

Figure 2: Sourcing externality leads to over-exposure in the decentralized equilibrium



Notes: The diagram traces the causal chain linking individual sourcing decisions to the expected foreign export-tax wedge. Home firms make decentralized sourcing choices (left node), which aggregate into the economy-wide import share $\Lambda \equiv \lambda_{FH}$ (second node). Foreign observes Λ and sets its expected export-tax wedge $\bar{\tau}(\Lambda)$ accordingly (third node), which determines the buyer prices$\tilde{p}_{FH}$ that Home firms face (right node). The dashed arrow shows the feedback loop: buyer prices shape sourcing decisions, which collectively determine the aggregate exposure that drives Foreign policy. The externality arises because each firm is infinitesimal and takes $\bar{\tau}$ as given when making sourcing decisions, ignoring its own marginal contribution to Λ and hence to Foreign's export incentives. Decentralized sourcing therefore generates excessive import concentration relative to the social optimum. The government's optimal tariff corrects this over-exposure by internalizing the effect of aggregate sourcing on $\bar{\tau}(\Lambda)$.

***Market Failure*: Firms Do Not Internalize the Tax Response.** Firms' decentralized sourcing decisions leads to market failure because $\bar{\tau}(\Lambda)$ depends on the *aggregate* exposure statistic $\Lambda = \lambda_{HF}$. To see this, consider any individual firm $\omega \in \Omega_H$. Its intermediate input purchases and final sales are governed by the CES demand system (3)–(13). When choosing input demands and pricing, the firm treats buyer prices $\tilde{p}_{ni}(\cdot)$ as given. In particular, it treats the Foreign export-tax factor τ^X_{FH} (and hence $\bar{\tau}(\Lambda)$) as fixed. However, $\Lambda = \lambda_{HF}$ is an equilibrium object determined by the *joint* sourcing choices of all firms and households. Through balanced trade (22) and the expenditure identities (21), a shift in Home's import demand changes equilibrium trade flows and therefore changes Λ. Since $\bar{\tau}'(\Lambda) \neq 0$, this change feeds back into the wedge faced by *all* Home firms. Because any single firm is infinitesimal, it ignores its own effect on the aggregate Λ and on $\bar{\tau}(\Lambda)$. This is the aggregation externality: decentralized sourcing decisions generate excessive exposure relative to the welfare-maximizing allocation.

Optimal Tariff. Home chooses the import tariff τ_{FH} to maximize domestic welfare:

$$\max_{\tau^M_{FH}} \; W_H = \frac{Y_H}{\tilde{P}_H} \quad s.t. \begin{cases} \text{equilibrium constraints} \\ \tau^X_{FH} = \bar{\tau}(\Lambda) \end{cases} \tag{29}$$

Under the updated optimal tariff problem, the policy also corrects for the fact that private sourcing decisions do not internalize the sourcing externality, leading to overexposure. As a result, the optimal tariff exhibits a new term reflecting the Home governments desire to correct overexposure when foreign's export barrier is increasing in its export market power. In particular,For analytical tractability, we assume that Foreign export-tax revenue is a negligible fraction of Foreign income, $T_F^X / E_F \approx 0$. Under this added assumption, The following proposition characterizes the optimal Home tariff when Foreign is active.

Proposition 2. *[Optimal Import Tariff with Unreliable Foreign] Suppose Foreign sets a non-cooperative export tax with probability* $1 - \pi$*. Then Home's unilaterally import tariff is*

$$t_{FH}^* = \frac{1}{\varepsilon_{FH}^S} + \underbrace{\frac{\epsilon \lambda_{HH}}{\varepsilon_{FH}^D} \frac{\mathrm{d} \ln \bar{\tau}(\lambda_{FH})}{\mathrm{d} \ln \lambda_{FH}}}_{\text{geopolitical risk premium}}$$

where $\frac{\partial \ln \bar{\tau}(\Lambda)}{\partial \ln \Lambda} > 0$ is the elasticity of the foreign's expected export restriction w.r.t. import dependence, $\Lambda \equiv \lambda_{FH}$ and the export supply elasticity $\varepsilon_{FH}^S = \epsilon \lambda_{FF} + \frac{1-\beta}{\beta} \lambda_{HF}$ and the import demand elasticity is given by Equation 24.

Multiple Sectors

Suppose there are multiple sectors, denoted by $k = 1, ..., K$. Suppose that the final good and intermediate input aggregator has a common Cobb-Douglas Aggregator across sectors: $\tilde{P}_i = \prod_k \tilde{P}_{i,k}^{e_k}$ where e_k is the share of expenditure on sector k goods. The sector-level price index is

$$\tilde{P}_{i,k} = \left[\sum_{n \in \mathcal{C}} \frac{1}{\bar{\varphi}_{n,k}} \left(\tau_{ni,k}^M \tau_{ni,k}^X d_{ni,k} w_n^\beta \tilde{P}_n^{1-\beta} \right)^{-\epsilon_k} \right]^{-\frac{1}{\epsilon_k}}$$

where ϵ_k is the sector-level trade elasticity, with the corresponding trade share given by

$$\lambda_{ni,k} = \frac{\left(\frac{1}{\bar{\varphi}_{n,k}} \tau_{ni,k}^M \tau_{ni,k}^X d_{ni,k} w_n^\beta \tilde{P}_n^{1-\beta} \right)^{-\epsilon_k}}{\sum_{\ell \in \mathcal{C}} \left(\frac{1}{\bar{\varphi}_{\ell,k}} \tau_{\ell i,k}^M \tau_{\ell i,k}^X d_{\ell i,k} w_\ell^\beta \tilde{P}_\ell^{1-\beta} \right)^{-\epsilon_k}}.$$

The foreign export tax is applied with probability π_k on a sector-by-sector basis. In expected export restriction in sector k is, $\tau_{FH,k} = \bar{\tau}_k(\Lambda_k)$, where

$$\bar{\tau}_k(\Lambda_k) \equiv \mathbb{E}[\tau^X_{FH,k} \mid \Lambda_k] = 1 + g_k(\Lambda_k)\mathrm{x}_k(\Lambda_k).$$

Here, $\Lambda_k \equiv \lambda_{FH,k}$ is Foreign's export market power in sector k with $d\bar{\tau}_k(\Lambda_k)/d\Lambda_k > 0$. Home's optimal tariff schedule is a vector $\{\tau_{FH,k}\}_k$ that maximizes Home's welfare $W_H = Y_H/\tilde{P}_H$ subject to equilibrium constraints and expectations over Foreign policy. The next proposition characterize the optimal sector-level tariff.

Proposition 3. [Optimal Import Tariff with Unreliable Foreign] *Suppose there is a positive probability that Foreign would restricted exports. Then Home's unilaterally import tariff is*

$$t^*_{FH,k} = \underbrace{\frac{1}{\varepsilon^S_{FH}}}_{ToT} + \underbrace{\frac{\epsilon_k \lambda_{HH,k}}{\varepsilon^D_{FH,k}} \frac{d \ln \bar{\tau}_k(\lambda_{FH,k})}{d \ln \lambda_{FH,k}}}_{\text{geopolitical risk premium}}$$

where $\varepsilon^D_{FH,k}$ is the sector-level import demand elasticity, and terms of trade (ToT) component of the tariff is uniform and determined by the aggregate export supply elasticity:

$$\varepsilon^S_{FH} = \sum_k \left[\frac{\lambda_{HF,k} e_k}{\lambda_{HF}} \epsilon_k \lambda_{FF,k} \right] + \frac{1-\beta}{\beta} \lambda_{HF}.$$

7 Data and Calibration

This section describes the data sources and calibration used in the quantitative analysis. We calibrate the model to the United States and the European Union as alternative home economies, treating the rest of the world as the foreign trading partner. The calibration combines baseline macroeconomic aggregates and trade shares, standard structural parameters, and an estimate of the elasticity ζ in the geopolitical-risk function that links import dependence to the hazard of export restrictions.

7.1 Baseline Macroeconomic Data

We construct the baseline equilibrium using 2018 data from the World Bank World Development Indicators[World Bank, 2018]. For each home economy $H \in \{\text{US}, \text{EU}\}$, we obtain data on GDP, total imports as a share of GDP, and services value added as a share of GDP. The baseline trade shares are constructed as follows. Under balanced trade, the

value of bilateral trade flows equals: $X = (\text{imports/GDP}) \times Y_H$. In the baseline calibration, we use a two-sector representation with a non-traded services sector ($k = 1$) and a traded composite sector ($k = 2$). Given the value-added share β, gross expenditure on traded sector in in each country is $E_i = Y_i/\beta$. The baseline import shares are then:

$$\lambda_{FH} = \frac{X}{E_H} = \frac{X \cdot \beta}{Y_H}, \qquad \lambda_{HF} = \frac{X}{E_F} = \frac{X \cdot \beta}{Y_F}. \tag{30}$$

where $Y_F = Y^{(world)} - Y_H$. Table 1 reports the baseline values for both home economies. The European Union exhibits substantially higher import exposure than the United States (24.9% versus 8.5%). In the multi-sector case we treat services as non-traded and use the services share in GDP to construct sectoral weights.

Table 1: Baseline Macroeconomic Data and Parameters (2018)

	United States	European Union	Source
Panel A. Macroeconomic Aggregates			
GDP (Trillions USD)	20.5	16.1	
Imports / GDP (%)	15.2	44.5	
Services / GDP (%)	76.7	65.2	World Bank WDI
Home Import Share λ_{FH} (%)	8.5	24.9	
Foreign Import Share λ_{HF} (%)	2.6	5.7	
Panel B. Structural Parameters			
Trade Elasticity ϵ	4.00		Simonovska-Waugh
Value-added Share β	0.56		BEA Input-Output

Notes: In each column, "home" denotes the reported economy and "foreign" denotes the rest of the world. Trade shares are computed consistent with $\beta = 0.56$.

Structural Parameters. We set the trade elasticity to $\epsilon = 4$, a value in the range commonly used in the quantitative trade literature [Simonovska and Waugh, 2014]. The value-added share $\beta = 0.56$ is calibrated from the U.S. Bureau of Economic Analysis input-output accounts, representing the share of value added in gross output.

7.2 Estimating the Geopolitical Risk Elasticity ζ

A key input into the quantitative exercise is the structural parameter ζ, which governs how geopolitical risk responds to sectoral import exposure. Let $g_s = 1 - \pi_s$ denote the probability that sector s is subject to an export restriction, where π_s is the probability of

no restriction. We parameterize this margin as:

$$g_s(\Lambda) = a_s \Lambda_s^{\zeta}, \tag{31}$$

where Λ_s denotes the foreign market share in sector s. Higher values of ζ imply a steeper increase in disruption risk as the home economy becomes more dependent on foreign supply.

Data Sources. To estimate ζ we compiling a comprehensive data set on export restrictions. We match this data to bilateral import flows from BACI at the HS6-year level over 2017-2023.

Our primary source for export restrictions is the Global Trade Alert (GTA) database[Evenett and Fritz, 2024], a public record of state interventions affecting trade and investment. We use its export-restriction subset, retaining eight restrictive policy types: export taxes, bans, quotas, licensing requirements, price benchmarks, tariff quotas, local-supply requirements, and related non-tariff measures. We restrict attention to interventions classified by GTA as Red or Amber. The raw extract covers 4,157 export-related interventions across 146 economies; limiting the sample to measures active during 2017–2024 yields 1,866 policy lines. Of these, 1,784 include explicit product identifiers, and a further 21 can be linked to HS6 products via UN CPC 2.1-to-HS 2017 concordances. After collapsing to exporter–HS6–year observations and matching to BACI, GTA contributes 274,817 flow observations and 517,868 stock observations — where flow observations record new restrictive actions and stock observations record measures active in a given year — spanning 126 exporters and 5,692 HS6 products in the flow panel and 138 exporters and 5,709 products in the stock panel.

We complement GTA with two OECD sources: the Inventory of Export Restrictions on Industrial Raw Materials and the Database on Export Restrictions on Staple Crops. The industrial inventory tracks restrictions on 65 industrial commodities at the HS6 level and has been collected since 2009. The staple-crops database — an OECD contribution to the Agricultural Market Information System — records six restrictive instruments applied to wheat, maize, rice, and soybeans since 2007. In our harmonized 2017–2024 sample, the industrial inventory covers 39 exporters and 260 HS6 products in the flow panel and 60 exporters and 485 products in the stock panel. The staple-crops database adds 10 exporters and 32 HS6 products in flow terms and 10 exporters and 34 products in stock terms. Together, the two OECD sources span 1,979 flow observations and 22,059 stock observations, covering 39 exporters and 292 HS6 products in the flow panel and

60 exporters and 519 products in the stock panel.

We construct two harmonized policy panels. The flow panel records restrictive actions in the year of the policy change. The stock panel — our baseline — records whether a restriction is active in year t, using OECD start and end dates and applying a three-year carry-forward rule when no end date is reported. In the staple-crops file, measures listed with a change type of n.a. are retained in both panels: treated as restrictive events in the flow panel and as active restrictions in the stock panel. After harmonization, we take the union of industrial and staple restrictions at the exporter–HS6–year level. Relative to the industrial inventory alone, the combined file adds 32 HS6 products in the flow construction and 34 in the stock construction.

Construction of the Hazard Measure. For each home economy i, HS6 product s, and year t, we define the geopolitical hazard as the share of imports in that cell sourced from exporters that register a restrictive measure under the relevant encoding:

$$g_{i,st} = \sum_n \omega_{ni,st} \cdot \mathbf{1}\{\text{exporter } n \text{ restricts product } s \text{ in year } t\}, \tag{32}$$

where $\omega_{ni,st}$ is exporter n's share of home country i's total imports in product s in year t:

$$\omega_{nHst} = \frac{M_{ni,st}}{M_{i,st}}, \qquad M_{i,st} = \sum_n M_{ni,st}.$$

This object maps the underlying policy data into the model's notion of exposure to supply disruptions.

The sectoral import dependence measure $\Lambda_{i,st}$ is constructed by noting that

$$\Lambda_{i,st} = \frac{X_{-ii,st}}{X_{-ii,t}} \frac{X_{-ii,t}}{E_{i,t}} \frac{E_{i,t}}{E_{i,st}} \tag{33}$$

where $X_{-ii,st} = \sum_{n \neq i} X_{ni,st}$ denotes home i's total imports in product s in year t, sourced from BACI, and $X_{-ii,t} = \sum_{s'} X_{-ii,s't}$ represents aggregate imports. $E_{i,st}$ is the gross expenditure on good s and $E_{i,t} = \sum_{s'} E_{i,s't}$ is aggregate expenditure, which is equal to Y_i/β. Thus, $X_{-ii,t}/E_{i,t}$ is equal to $\beta \times (\frac{import}{GDP})$, which can be constructed using import-to-GDP data from the World Bank. Since we do not observe $E_{i,st}$ at the HS6 level of aggregation, we take this data from the ICIO database[OECD, 2021] which is recorded at the sector level. To handle the added layer of aggregation, we assume that $E_{i,st}/E_{i,t}$ is common across HS6 codes within a sector.

Estimation Procedure. We estimate ζ with both the flow and stock encodings. The stock hazard is our baseline because the model is disciplined by the probability that export restrictions are active when imports are realized, not merely by the arrival of new policy actions. The flow hazard provides an event-style robustness check. For each encoding, we estimate:

$$\ln g_{i,st} = \zeta \cdot \ln \Lambda_{i,st} + \delta_S + \delta_t + \varepsilon_{i,st}, \tag{34}$$

where δ_S denotes sector fixed effects, with $s \in S$, and δ_t denotes year fixed effects. We report OLS estimates of equation (34) and 2SLS estimates that instrument $\ln \Lambda_{i,st}$ with $\ln \Lambda_{i,st-1}$, including year fixed effects in both stages. This procedure uses variation across sectors and over time in the share of aggregate imports accounted for by each HS6 product. We use data for years 2017-2023.[4]

Results. Table 2 reports the updated estimates based on the combined OECD calibration. The additional staple-crops data broaden coverage from 260 to 292 HS6 sectors in the flow panel and from 485 to 519 HS6 sectors in the stock panel, and they raise the pooled stock sample to 7,124 home-sector-year observations.

Panel A reports the baseline stock hazard. The pooled OLS estimate is $\hat{\zeta} = 0.382$ (s.e. 0.025), while the pooled IV estimate is 0.392 (s.e. 0.027). The home-specific IV elasticities, which we use in the quantitative simulations, are 0.381 for the United States and 0.361 for the European Union. Relative to the industrial-only calibration, the combined sample therefore modestly raises the baseline elasticities that discipline the policy counterfactuals.

Panel B turns to the flow hazard. The pooled elasticities remain positive at 0.234 in OLS and 0.263 in IV, with country-specific IV estimates of 0.266 for the United States and 0.269 for the European Union. Across encodings, the central message is unchanged: sectors that absorb a larger share of total imports are systematically more exposed to foreign export controls.

The quantitative baseline in the numerical simulations uses the Panel A IV estimates.

8 Numerical Simulation

We outline a quantitative exercise that uses exact hat algebra to compute counterfactual equilibria under alternative tariff schedules. We take a factual baseline equilibrium char-

[4]For the European Union, we aggregate imports across all 27 EU member states.

Table 2: Estimates of the Geopolitical Risk Elasticity

	OLS			IV		
	US (1)	EU (2)	Pooled (3)	US (4)	EU (5)	Pooled (6)
Panel A. Stock hazard						
ζ	0.366	0.356	0.382	0.381	0.361	0.392
	(0.041)	(0.023)	(0.025)	(0.046)	(0.023)	(0.027)
N	37,087	37,371	74,458	37,087	37,371	74,458
Panel B. Flow hazard						
ζ	0.232	0.246	0.234	0.266	0.269	0.263
	(0.030)	(0.030)	(0.018)	(0.039)	(0.034)	(0.023)
N	37,066	37,350	74,416	31,730	32,011	63,741

Notes: OLS estimates are from equation (34). Data span 2017-2023. Panel A reports the stock-based hazard encoding (baseline), and Panel B reports the flow-based hazard encoding (robustness). In OLS, sector and year fixed effects are included. In IV, $\ln(\Lambda_{i,st-1})$ instruments for $\ln(\Lambda_{i,st})$ with year fixed effects. Standard errors are reported for all estimates. The quantitative baseline uses the Panel A IV estimates.

acterized by free trade ($\tau^M_{ni} = \tau^X_{ni} = 1$) and interpret Home as the United States and Foreign as the rest of the world. We discipline $(\lambda_{ni,k})$ using baseline trade shares by sector, set trade elasticities ϵ_k from the literature, and calibrate value-added shares β_k from input–output accounts.

Foreign Policy. Given a candidate Home tariff τ^M_{FH}, we specify Foreign's export restriction in the adversarial state as the unilaterally optimal export tax:

$$\tau^X_{FH} = 1 + x(\lambda_{FH}), \qquad x(\lambda_{FH}) = \frac{1}{\epsilon_k \, \lambda_{HH} + \frac{1-\beta}{\beta}\lambda_{FH}}. \tag{35}$$

We explore two specifications for the cooperation probability, π: One where π is fixed, and another where it decreases at a constant elasticity with Foreign's export market power:

$$g(\lambda_{HF}) = a\lambda^{\zeta}_{HF}$$

We compute the expected wedge $\bar{\tau}_k(\lambda_{FH,k})$ by plugging these values in (27).

Exact hat system. In a one-sector version of the model, we search over τ^M_{FH} to maximize welfare Home's changes $\hat{W}_H = \hat{Y}_H / \hat{\hat{P}}_H$ subject to equilibrium constraints specified in hat

notation. The key constraints are

$$\hat{p}_n = \hat{w}_n^{\beta} \hat{\hat{P}}_n^{1-\beta}, \tag{36}$$

$$\hat{\hat{P}}_i = \left[\sum_{n \in \mathcal{C}} \lambda_{ni} \left(\tau_{ni}^M \tau_{ni}^X \hat{p}_n \right)^{-\epsilon} \right]^{-1/\epsilon} \tag{37}$$

$$\tau_{FH}^X = 1 + \frac{g(\hat{\lambda}_{HF} \lambda_{HF})}{\epsilon \hat{\lambda}_{HH} \lambda_{HH} + \frac{1-\beta}{\beta} \hat{\lambda}_{FH} \lambda_{FH}} \tag{38}$$

$$\hat{\lambda}_{ni} = \frac{\lambda_{ni,k} \left(\tau_{ni}^M \tau_{ni}^X \hat{p}_n \right)^{-\epsilon}}{\sum_{\ell \in \mathcal{C}} \lambda_{\ell i} \left(\tau_{\ell i}^M \tau_{\ell i}^X \hat{p}_\ell \right)^{-\epsilon}}, \tag{39}$$

which together with hat versions of Equations (17), (18)–(19), and (14) characterize the full set of equilibrium constraints. The multi-sector analysis is conducted as a basic extension of this approach.

9 Results

This section presents quantitative results from our calibrated model. We first characterize optimal macro tariffs, applied uniformly to all traded goods, comparing the rates under geopolitical risk with a benchmark case where tariffs are driven solely to terms-of-trade motives. We then examine sector-specific tariffs. While terms-of-trade considerations generate uniform tariffs across sectors, the geopolitical risk premium varies substantially with sectoral import dependence, creating heterogeneous optimal tariffs.

9.1 Optimal Macro Tariffs

Table 3 summarizes the optimal macro tariffs for the US and EU. Column (1) reports the terms-of-trade benchmark without geopolitical risk ($g = 0$). The remaining columns present results under geopolitical risk, where the risk $g(\Lambda) = a\,\Lambda^{\zeta}$ is determined by import dependence Λ , with logic being that export restrictions are more beneficial to an adversarial partner if Λ is higher.

The terms-of-trade benchmark generates tariffs of 27–28 percent for both economies, reflecting that the parameters governing the optimal tariffs (ϵ and β) are common across economies. The slightly higher EU tariff (28.0% vs. 26.9%) reflects the EU's larger foreign market share, which increases its market power.

Geopolitical risk raises optimal tariffs for both economies, but the magnitude differs

Table 3: Optimal Macro Tariffs under Geopolitical Risk

	Benchmark: $g = 0$	Geopolitical risk: $g(\Lambda)$		
	Tariff Rate (%)	Tariff Rate (%)	ToT Share	Risk Share
United States	26.9	34.7	77.5	22.5
European Union	28.0	40.4	69.4	30.6

The Benchmark column reports the optimal tariff under perfect cooperation ($\pi = 1$). The Endogenous Cooperation panel reports results where cooperation varies with import shares, $\pi(\Lambda) = 1 - a\Lambda^{\zeta}$. The Decomposition columns report the share of the endogenous tariff attributable to terms-of-trade manipulation versus the risk premium; these shares sum to 100 percent.

substantially. The US optimal tariff rises to 34.7%, while the EU tariff reaches 40.4%. The difference is driven primarily by the EU's greater degree of import dependence, marked by a higher foreign market share in the EU market.

The model delivers a clean decomposition of the optimal tariff into terms-of-trade and geopolitical-risk premium components. For the United States, the terms-of-trade motive accounts for 77.5 percent of the optimal tariff, with the geopolitical-risk channel contributing the remaining 22.5 percent. This relatively modest geopolitical-risk premium component reflects the smaller baseline import dependence of the United States.

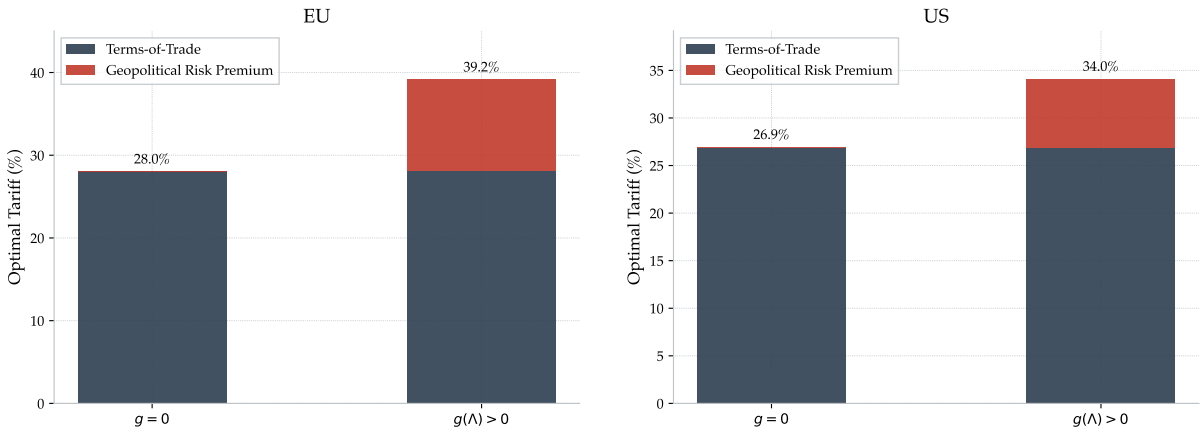
The European Union presents a fundamentally different picture. Here, the geopolitical risk premium accounts for 30.6 percent of the optimal macro tariff (see Figure 3). This magnitude is striking because it applies to a uniform macro tariff, not a targeted sectoral measure. While skepticism often surrounds the political feasibility of high sectoral tariffs, our results suggest that even under the constraint of a uniform policy, the structural incentives to hedge against geopolitical risk remain powerful enough to justify a near-30% tariff increase.

9.2 Optimal Sectoral Tariffs

We extend the analysis to a ten-sector framework to study how geopolitical risk shapes the cross-sectoral distribution of optimal tariffs. The representative-sector model delivers nearly uniform tariffs because the terms-of-trade component depends on aggregate import market power rather than on sectoral import concentration. Introducing sectoral heterogeneity in import shares, while holding trade elasticities and input-output structure fixed—activates the sector-specific risk premium and generates a steeply upward-sloping tariff schedule.

We construct ten traded sectors by ranking HS6 products by import share and grouping them into deciles. The lowest-concentration sector has $\Lambda_s \approx 0.01$; the highest has

Figure 3: Optimal Tariff Decomposition: European Union



Notes: The figure decomposes the optimal tariff into terms-of-trade (ToT) and geopolitical-risk premium components across cooperation scenarios. The variable geopolitical risk g scenario uses $g(\Lambda) = a\,\Lambda^{\zeta}$.

$\Lambda_s \approx 0.40$. We maintain a common trade elasticity ($\epsilon = 4$) and value-added share ($\beta = 0.56$) across all sectors to isolate the role of import concentration.

Absent geopolitical risk ($g = 0$), the terms-of-trade motive generates nearly uniform tariffs across sectors: 27.8% for the United States and 29.7% for the European Union. Uniformity follows directly from the structure of the terms-of-trade component, $1/\varepsilon^{S}_{FH}$: when trade elasticities are common across sectors, the aggregate export supply elasticity is insensitive to the distribution of sectoral import shares, and so is the optimal tariff.

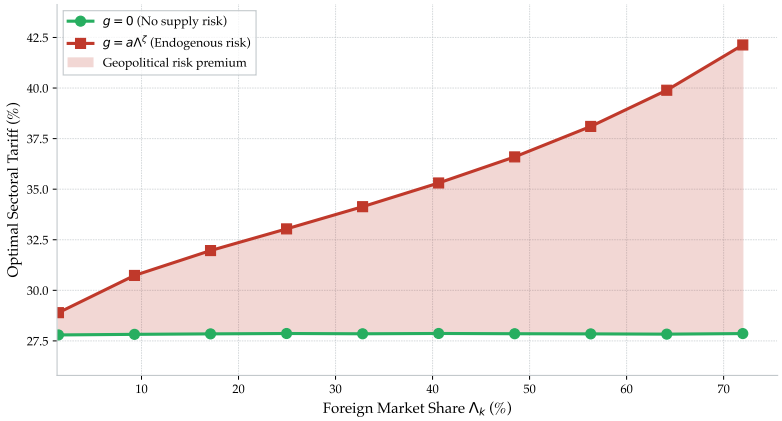
Under geopolitical risk ($g > 0$), optimal tariffs are strongly increasing in sectoral import concentration. For the United States, tariffs range from 28.9% in the lowest-concentration sector to 42.1% in the highest, a spread of roughly 13 percentage points. For the European Union, the spread is far larger: tariffs range from 35.0% to 64.7%, a dispersion of nearly 30 percentage points that reflects the EU's higher estimated hazard elasticity ζ.

Figure 4 plots optimal sectoral tariffs against the sectoral import share for both economies under both scenarios. Under the terms-of-trade benchmark ($g = 0$), the tariff schedule is essentially flat across the import-share distribution. Under geopolitical risk ($g > 0$), it slopes sharply upward, with the European Union exhibiting a steeper gradient due to its higher hazard elasticity.

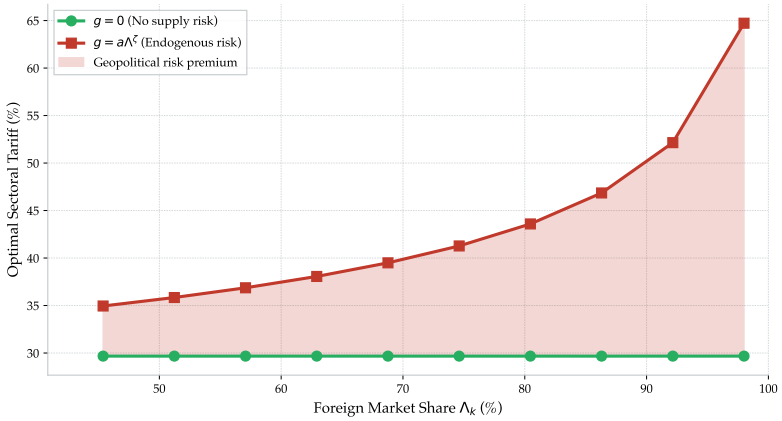
Geopolitical risk generates *targeted* protection. Unlike the terms-of-trade motive, which produces nearly uniform tariffs under a common trade elasticity, the risk premium is largest precisely where import dependence is greatest. These are also the sectors where comparative advantage is most pronounced and the gains from trade are largest,

Figure 4: Optimal Sectoral Tariffs vs. Import Share: United States

(a) United States



(b) European Union



Notes: Each point represents one of ten traded sectors ranked by foreign import share. Solid line: geopolitical risk ($g(\lambda_s) = a\lambda_s^{\zeta}$). Dashed line: terms-of-trade benchmark ($g = 0$).

so the efficiency cost of geopolitical de-risking falls disproportionately on the economy's most productive import relationships.

9.3 Model Validation

Table 4 reports the baseline estimates for the cross-sectional relationship between pre-trade-war China exposure and subsequent U.S. tariff protection. The regressor is the sector's share of imports sourced from China in 2017, measured before the main tariff escalation. The outcomes are the logarithm of one plus the 2018 applied tariff and a chained annual tariff-change index that cumulates monthly changes in the log of one plus the applied tariff over 2018. We report the results under both a trade aggregation

and an industry aggregation, restricting the sample to products that experienced a positive tariff increase in 2018 and excluding steel and aluminum products covered by the Section 232 actions.

Table 4: China Exposure and 2018 Tariff Protection

	HS6 flows		NAICS flows	
	Tariff Level (1)	Tariff Change (2)	Tariff Level (3)	Tariff Change (4)
Panel A. Baseline				
China's Market Share (2017)	0.047***	7.230***	0.050***	8.693***
	(0.002)	(0.211)	(0.006)	(0.350)
Observations	3,591	3,591	373	373
R-squared	0.130	0.379	0.300	0.690
Panel B. Scaled Market Share				
China's Market Share (2017)	0.051***	11.119***	0.063***	12.913***
	(0.004)	(0.385)	(0.009)	(0.676)
Observations	3,173	3,173	341	341
R-squared	0.063	0.359	0.201	0.641
Panel C. Weighted OLS				
China's Market Share (2017)	0.037***	7.541***	0.039***	7.755***
	(0.009)	(0.965)	(0.013)	(1.134)
Observations	3,591	3,591	373	373
R-squared	0.202	0.633	0.233	0.713

Notes: This table reports estimates of $y = \alpha + \beta x + \varepsilon$ on the treated sample of tariff lines with positive tariff increases in 2018, excluding steel and aluminum products covered by the Section 232 actions. "Tariff Level" is $\ln(1 + t^{app})$ in 2018. "Tariff Change" is $100 \sum_{m \in 2018} \Delta \ln(1 + t_m^{app})$. In Panels A and C, x is the sector's 2017 import share sourced from China. In Panel B, x is the corresponding expenditure share, which scales Chinese imports by total imports plus domestic sales. Panels A and B are unweighted; Panel C uses import-value weights. HC3 robust standard errors are in parentheses.
*** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level (based on two-sided HC3 asymptotic p-values).

The baseline estimates support the model's core prediction. In every column, sectors that were more exposed to Chinese imports before the trade war received more protection in 2018. The result appears in both tariff levels and tariff changes, and it survives the two alternative aggregation schemes. In the unweighted specification, the coefficient on China exposure is 0.047 for tariff levels at the trade aggregation and 0.050 at the industry aggregation; for tariff changes, the corresponding coefficients are 7.2 and 8.7. The

weighted estimates are somewhat smaller, especially for tariff levels, but they remain positive and precisely estimated.

Panel B shows that the same pattern holds under a stricter exposure concept that scales Chinese imports by total imports plus domestic sales. Under that measure, the slope becomes steeper, particularly for tariff changes: the change coefficient rises to 11.1 at the trade aggregation and 12.9 at the industry aggregation. The interpretation is straightforward. The sectors most exposed to Chinese competition in final expenditure terms were also among the sectors that received the strongest subsequent protection.

The appendix shows that this conclusion does not hinge on the precise tariff construction. The sensitivity analysis reports coefficient plots for both tariff changes and tariff levels under chained statutory tariffs, simple annual applied tariffs, and simple annual statutory tariffs, alongside the baseline chained applied specification. Across all four constructions, the estimated relationship between pre-trade-war China exposure and subsequent tariff protection remains positive, economically meaningful, and statistically precise.

10 Conclusion

This paper develops a theory of optimal tariffs under geopolitical supply risk. We develop a model where a foreign supplier is more likely to impose export restrictions as import dependence grows. Under these circumstances, private sourcing decisions generate a negative externality: atomistic firms ignore how their collective import choices raise aggregate exposure to foreign export restrictions, amplify aggregate risk. The optimal tariff, as a result, includes two components: a standard terms-of-trade component and a geopolitical risk premium that internalizes the noted market failure. The premium is absent when foreign is fully cooperative and rises with the elasticity of geopolitical risk with respect to import dependence.

The targeting implication is sharp. In the representative-sector model, the terms-of-trade motive generates nearly uniform tariffs. Sectoral heterogeneity in import concentration activates the sector-specific risk premium and breaks this uniformity: the model predicts that optimal tariffs should be highest precisely in sectors where import dependence is greatest. These are also the sectors where comparative advantage is most pronounced. Thus, hedging against geopolitical risk calls for restricting trade in precisely the sectors that deliver the largest gains from trade.

We discipline the model using panel data on OECD export restrictions and an IV

strategy that exploits lagged import shares. The elasticity of geopolitical hazard with respect to import exposure is positive, precisely estimated, and robust across specifications and hazard encodings. In the calibrated model, the geopolitical risk premium accounts for 22.5 percent of the optimal US tariff and 30.6 percent for the EU, with the EU's larger share reflecting its greater import dependence. The multi-sector model's predicted tariff schedule, whereby tariffs rise steeply in sectoral import concentration, closely matches the 2018 US tariff hikes on China.

Appendix

A Data Construction for Hazard Measures

This appendix documents the construction of the geopolitical-risk hazard from first principles using the OECD Inventory of Export Restrictions on Industrial Raw Materials and BACI bilateral trade flows. The sample period is 2017-2023. We define Home as either the United States or the aggregate of the 27 European Union member states, and we work at the HS6 product level.

For each exporter n, home H, product s, and year t, we observe bilateral import values M_{nHst} from BACI and define import-share weights

$$\omega_{nHst} \equiv \frac{M_{nHst}}{\sum_{n'} M_{n'Hst}}.$$

Given a binary exporter-product-year restriction indicator R_{nst}, the hazard is the weighted average

$$\text{hazard}_{Hst} \equiv \sum_{n} \omega_{nHst} R_{nst}.$$

The model-consistent sectoral exposure variable is constructed as

$$\lambda_{Hst} \equiv \lambda_H^{\text{agg}} \times \frac{M_{Hst}}{\sum_{s'} M_{Hs't}}, \qquad \lambda_H^{\text{agg}} \equiv \beta \times \frac{\text{imports}_H}{\text{GDP}_H},$$

where $\beta = 0.56$ and $\text{imports}_H/\text{GDP}_H$ is measured at the 2018 baseline used in the quantitative calibration.

The flow encoding defines $R_{nst}^{\text{flow}} = 1$ when the OECD file records at least one restrictive event in year t for exporter n and HS6 product s, restricting the measure type to the same set used throughout the paper and restricting the direction of change to

introductions, increases, extensions, and reintroductions. In all other cases $R^{\text{flow}}_{nst} = 0$.

The stock encoding tracks whether a measure is in force in year t. Let m index OECD policy lines identified by the measure key used in the data. For each (n, s, m), the stock state is activated in years with directions introduction, increase, extension, reintroduction, left unchanged, decrease, or revision, and it is deactivated in years with elimination or partial elimination. When no deactivation is observed, the measure remains active up to the reported end date if available; if the end date is missing, activity is carried forward for three years after the last active observation. The exporter-product stock indicator is then

$$R^{\text{stock}}_{nst} \equiv \max_{m} \mathbf{1}\{m \text{ active for } (n, s) \text{ in } t\}.$$

The stock hazard replaces R^{flow}_{nst} with R^{stock}_{nst} in the same weighted-hazard formula.

B Optimal Tariff with Passive Foreign

This appendix derives the optimal tariff formula presented under Proposition 1.

Setup and Notation. Home chooses $\tau^M_{FH} \geq 1$ with $\tau^M_{HF} = 1$ and $\tau^X_{ni} = 1$ for all (n, i). Define aggregate demand from Home for Foreign goods as $q_{FH} \equiv \lambda_{FH} E_H / \tilde{p}_{FH}$, where $\tilde{p}_{FH} = \tau^M_{FH} d_{FH} p_F$. Home income can be written as:

$$Y_H = (1 + \frac{1}{\sigma\beta}) w_H L_H + (\tilde{p}_{FH} - d_{FH} p_F) q_{FH}, \tag{40}$$

where the second term represents tariff revenue. Balanced trade implies $d_{FH} p_F q_{FH} = \lambda_{HF} w_F L_F$, yielding:

$$w_F = \frac{d_{FH} p_F q_{FH}}{\lambda_{HF} L_F}. \tag{41}$$

Foreign Prices and Trade Shares. The Foreign unit cost is $p_F = \frac{1}{\bar{\varphi}_F} w_F^{\beta} \tilde{P}_F^{1-\beta}$. With $d_{FF} = \tau^M_{FF} = \tau^X_{FF} = 1$ and $p_H \equiv 1$, the CES price index in Foreign is $\tilde{P}_F = p_F \lambda_{FF}^{1/\epsilon}$ where:

$$\lambda_{FF}(p_F) = \frac{p_F^{-\epsilon}}{p_F^{-\epsilon} + d_{HF}^{-\epsilon}}, \qquad \lambda_{HF}(p_F) = 1 - \lambda_{FF}(p_F).$$

This equation implies that

$$p_F = \frac{1}{\bar{\varphi}_F} w_F^{\beta} p_F^{1-\beta} \lambda_{FF}^{\frac{1}{\epsilon}(1-\beta)} = \bar{\varphi}_F^{-1/\beta} w_F \lambda_{FF}^{\frac{1-\beta}{\beta\epsilon}}$$

Substituting the above expression back into (41) and rearranging yields:

$$q_{FH} = \bar{\varphi}_F^{\frac{1}{\beta}} \lambda_{FF}(p_F)^{-\frac{1-\beta}{\beta\epsilon}} \lambda_{HF}(p_F) L_F. \tag{42}$$

This equation implicitly defines p_F as a function of q_{FH}.

Inverse Export Supply Elasticity. Differentiating (42) logarithmically obtains,

$$\mathrm{d}\ln q_{FH} = -\frac{1-\beta}{\beta\epsilon}\mathrm{d}\ln\lambda_{FF} + \mathrm{d}\ln\lambda_{HF}, \tag{43}$$

where the right-hand side can be evaluated using

$$\frac{\mathrm{d}\ln\lambda_{FF}}{\mathrm{d}\ln p_F} = -\epsilon\lambda_{HF}, \qquad \frac{\mathrm{d}\ln\lambda_{HF}}{\mathrm{d}\ln p_F} = \epsilon\lambda_{FF}.$$

Substituting $\mathrm{d}\ln\lambda_{FF} = -\epsilon\lambda_{HF}\mathrm{d}\ln p_F$ and $\mathrm{d}\ln\lambda_{HF} = \epsilon\lambda_{FF}\mathrm{d}\ln p_F$ into 43 and rearranging delivers:

$$\frac{1}{\varepsilon_{FH}^S} \equiv \frac{\mathrm{d}\ln p_F}{\mathrm{d}\ln q_{FH}} = \frac{1}{-\frac{1-\beta}{\beta\epsilon}\cdot(-\epsilon\lambda_{HF}) + \epsilon\lambda_{FF}} = \frac{1}{\epsilon\lambda_{FF} + \frac{1-\beta}{\beta}\lambda_{HF}}. \tag{44}$$

Income Derivative. Differentiating Home income (40) with respect to $\ln\tau_{FH}$:

$$\begin{aligned}\frac{\mathrm{d}\ln Y_H}{\mathrm{d}\ln\tau_{FH}^M} = \frac{1}{Y_H}\Bigg[&(1+\frac{1}{\sigma\beta})w_H L_H \frac{\mathrm{d}\ln w_H}{\mathrm{d}\ln\tau_{FH}^M} + \tilde{p}_{FH}q_{FH} \\ &+ \left(\tilde{p}_{FH} - \left(1+\frac{\mathrm{d}\ln p_F}{\mathrm{d}\ln q_{FH}}\right) d_{FH}p_F\right) q_{FH}\frac{\mathrm{d}\ln q_{FH}}{\mathrm{d}\ln\tau_{FH}^M}\Bigg].\end{aligned} \tag{45}$$

Using $\tilde{p}_{FH} = \tau_{FH}^M d_{FH} p_F$, this simplifies to:

$$\frac{\mathrm{d}\ln Y_H}{\mathrm{d}\ln\tau_{FH}^M} = \left[\frac{w_H L_H}{E_H}\frac{\mathrm{d}\ln w_H}{\mathrm{d}\ln\tau_{FH}^M} + \lambda_{FH} + \left(1 - \frac{1}{\tau_{FH}}\left(1+\frac{\mathrm{d}\ln p_F}{\mathrm{d}\ln q_{FH}}\right)\right)\lambda_{FH}\frac{\mathrm{d}\ln q_{FH}}{\mathrm{d}\ln\tau_{FH}^M}\right]\frac{E_H}{Y_H}. \tag{46}$$

Price Index Derivative. The CES price index in Home implies:

$$\frac{\mathrm{d}\ln\tilde{P}_H}{\mathrm{d}\ln\tau_{FH}^M} = \lambda_{FH}. \tag{47}$$

The numeraire condition $p_H \equiv 1 = \frac{1}{\bar{\varphi}_H} w_H^{\beta} \tilde{P}_H^{1-\beta}$ implies:

$$\beta \frac{\mathrm{d} \ln w_H}{\mathrm{d} \ln \tau_{FH}^M} + (1-\beta) \frac{\mathrm{d} \ln \tilde{P}_H}{\mathrm{d} \ln \tau_{FH}^M} = 0 \quad \Rightarrow \quad \frac{\mathrm{d} \ln w_H}{\mathrm{d} \ln \tau_{FH}^M} = -\frac{1-\beta}{\beta} \lambda_{FH}. \tag{48}$$

First-Order Condition. Combining the expressions above yields the necessary first-order condition for optimality:

$$\begin{aligned}
\frac{\mathrm{d} \ln W_H}{\mathrm{d} \ln \tau_{FH}^M} =& \frac{\mathrm{d} \ln Y_H}{\mathrm{d} \ln \tau_{FH}} - \frac{\mathrm{d} \ln \tilde{P}_H}{\mathrm{d} \ln \tau_{FH}^M} \\
=& \left[\frac{w_H L_H}{E_H} \frac{\mathrm{d} \ln w_H}{\mathrm{d} \ln \tau_{FH}^M} + \lambda_{FH} + \left(1 - \frac{1}{\tau_{FH}} \left(1 + \frac{\mathrm{d} \ln p_F}{\mathrm{d} \ln q_{FH}}\right)\right) \lambda_{FH} \frac{\mathrm{d} \ln q_{FH}}{\mathrm{d} \ln \tau_{FH}^M} \right] \frac{E_H}{Y_H} - \lambda_{FH} \\
=& \left[\frac{w_H L_H}{E_H} \left(\frac{\mathrm{d} \ln w_H}{\mathrm{d} \ln \tau_{FH}^M} + \frac{1-\beta}{\beta} \lambda_{FH} \right) + \left(1 - \frac{1}{\tau_{FH}^M} \left(1 + \frac{1}{\varepsilon_{FH}^S}\right)\right) \lambda_{FH} \frac{\mathrm{d} \ln q_{FH}}{\mathrm{d} \ln \tau_{FH}^M} \right] \frac{E_H}{Y_H} = 0
\end{aligned} \tag{49}$$

where the last lines uses $\lambda_{FH} \frac{E_H}{Y_H} - \lambda_{FH} = \frac{w_H L_H}{Y_H} \frac{1-\beta}{\beta} \lambda_{FH}$. Using (48), the first bracketed term vanishes. Thus, (49) reduces to

$$1 - \frac{1}{\tau_{FH}^M} \left(1 + \frac{1}{\varepsilon_{FH}^S}\right) = 0. \tag{50}$$

Rearranging:

$$t_{FH}^* = \tau_{FH}^{M*} - 1 = \frac{1}{\varepsilon_{FH}^S}. \tag{51}$$

Substituting(44) into (51) delivers the optimal tariff formula:

$$t_{FH}^* = \frac{1}{\epsilon \lambda_{FF} + \frac{1-\beta}{\beta} \lambda_{HF}}.$$

This completes the proof of Proposition 1.□

C Optimal Tariff with Active Foreign

The only difference in this case with the baseline derivation is that the foreign price includes an additional wedge $p_{FH} = \bar{\tau}(\lambda_{FH}) d_{FH} p_F$. Thus, the expression for net income

at home must be updated as

$$Y_H = w_H L_H + (\tilde{p}_{FH} - \bar{\tau}(\lambda_{FH}) d_{FH} p_F) q_{FH}$$

To better handle this additional policy wedge, we formulate the optimal tariff problem as one where the government directly selects price $\tilde{p}_{FH}$ rather that τ_{FH}^M. Extrapolating from our baseline derivation:

$$\begin{aligned}\frac{\mathrm{d}\ln Y_H}{\mathrm{d}\ln \tilde{p}_{FH}} = \frac{1}{Y_H}\Bigg[& w_H L_H \frac{\mathrm{d}\ln w_H}{\mathrm{d}\ln \tilde{p}_{FH}} + \tilde{p}_{FH} q_{FH} \\ & + \left(\tilde{p}_{FH} - \left(1 + \frac{\mathrm{d}\ln p_F}{\mathrm{d}\ln q_{FH}}\right) p_{FH}\right) q_{FH} \frac{\mathrm{d}\ln q_{FH}}{\mathrm{d}\ln \tilde{p}_{FH}} - p_{FH} q_{FH} \frac{\partial \ln \bar{\tau}(\lambda_{FH})}{\partial \ln \lambda_{FH}} \frac{\mathrm{d}\ln \lambda_{FH}}{\mathrm{d}\ln \tilde{p}_{FH}}\Bigg].\end{aligned}$$

Henceforth we apply our compact notation for the export supply and import demand elasticities:

$$\varepsilon_{FH}^D \equiv -\frac{\mathrm{d}\ln q_{FH}}{\mathrm{d}\ln \tilde{p}_{FH}} \qquad\qquad \frac{1}{\varepsilon_{FH}^S} \equiv \frac{\mathrm{d}\ln p_F}{\mathrm{d}\ln q_{FH}}$$

Following the same logic we can show that

$$\frac{\mathrm{d}\ln \tilde{P}_H}{\mathrm{d}\ln \tilde{p}_{FH}} = \lambda_{FH}, \qquad\qquad \frac{\mathrm{d}\ln w_H}{\mathrm{d}\ln \tilde{p}_{FH}} = -\frac{1-\beta}{\beta}\lambda_{FH}$$

Noting that $\tau_{FH} = \tilde{p}_{FH}/p_{FH}$ and $\lambda_{FH} = \tilde{p}_{FH} q_{FH}/E_H$, we can write the first-order condition by extrapolating from the baseline derivation:

$$\begin{aligned}\frac{\mathrm{d}\ln W_H}{\mathrm{d}\ln \tilde{p}_{FH}} &= \frac{\mathrm{d}\ln Y_H}{\mathrm{d}\ln \tilde{p}_{FH}} - \frac{\mathrm{d}\ln \tilde{P}_H}{\mathrm{d}\ln \tilde{p}_{FH}} \\ &= -\left[\left(1 - \frac{1}{\tau_{FH}}\left(1 + \frac{1}{\varepsilon_{FH}^S} - \frac{\frac{\mathrm{d}\ln \lambda_{FH}}{\mathrm{d}\ln \tilde{p}_{FH}}}{\varepsilon_{FH}^D} \frac{\partial \ln \bar{\tau}}{\partial \ln \lambda_{FH}}\right)\right) \lambda_{FH} \varepsilon_{FH}^D\right] \frac{E_H}{Y_H} = 0,\end{aligned}$$

The trade share derivative can be obtained by noting that $\lambda_{FH} = \frac{\tilde{p}_{FH}^{-\epsilon}}{\tilde{p}_{FH}^{-\epsilon} + P_H^{-\epsilon}}$, where $p_H = 1$ by choice of numeriare. More specifically,

$$\frac{\mathrm{d}\ln \lambda_{FH}}{\mathrm{d}\ln \tilde{p}_{FH}} = -\epsilon(1 - \lambda_{FH}) = -\epsilon \lambda_{HH}$$

The import demand elasticity is

$$\varepsilon_{FH}^D \equiv -\frac{d\ln q_{FH}}{d\ln \tilde{p}_{FH}} = -\frac{\partial \ln(\lambda_{FH} E_H/\tilde{p}_{FH})}{\partial \ln \tilde{p}_{FH}} = -\frac{d\ln \lambda_{FH}}{d\ln \tilde{p}_{FH}} - \frac{d\ln E_H}{d\ln \tilde{p}_{FH}} + 1 \approx 1 + \epsilon\lambda_{HH} + \frac{1-\beta}{\beta}\lambda_{FH}$$

where the last line follows from the simplifying assumption, $T_H^M / E_H \approx 0$, whereby

$$\frac{\mathrm{d} \ln E_H}{\mathrm{d} \ln \tilde{p}_{FH}} \approx \frac{\mathrm{d} \ln w_H}{\mathrm{d} \ln \tilde{p}_{FH}} = -\frac{1-\beta}{\beta} \lambda_{FH}.$$

Below, we relax this assumption and derive ε_{FH}^D without the noted restriction. Plugging the expression $\frac{\mathrm{d} \ln \lambda_{FH}}{\mathrm{d} \ln \tilde{p}_{FH}}$ into the first-order condition, the optimal tariff solves

$$\frac{1}{\tau_{FH}^M} \left(1 + \frac{1}{\varepsilon_{FH}^S} + \frac{\epsilon \lambda_{HH}}{\varepsilon_{FH}^D} \frac{\partial \ln \bar{\tau}}{\partial \ln \lambda_{FH}} \right) = 0$$

which delivers:

$$t_{FH}^* = \frac{1}{\varepsilon_{FH}^S} + \frac{\epsilon \lambda_{HH}}{\varepsilon_{FH}^D} \frac{\partial \ln \bar{\tau}}{\partial \ln \lambda_{FH}}$$

Following the assumption that $T_i / E_i \approx 0$,the export supply and import demand elasticities are

$$\varepsilon_{FH}^S = \epsilon \lambda_{FF} + \frac{1-\beta}{\beta} \lambda_{HF}, \qquad \varepsilon_{FH}^D = 1 + \epsilon \lambda_{HH} + \frac{1-\beta}{\beta} \lambda_{FH}$$

Import Demand Elasticity with Large Trade Tax Revenues. Previously, we assumed that $T_H / E_H \approx 0$, which implied that $d \ln E_H = d \ln w_H$. Now we relax this assumption, without which gross expenditure is precisely given by

$$E_H = \frac{w_H L_H}{\beta} + \frac{\tau_{FH} - 1}{\tau_{FH}} \lambda_{FH} E_H = \frac{w_H L_H / \beta}{1 - \frac{\tau_{FH}-1}{\tau_{FH}} \lambda_{FH}}$$

Taking log derivatives from the above equation, yields

$$\frac{d \ln E_H}{d \ln \tilde{p}_{FH}} = \frac{d \ln w_H}{d \ln \tilde{p}_{FH}} - \frac{d \ln (1 - \frac{\tau_{FH}-1}{\tau_{FH}} \lambda_{FH})}{d \ln \tilde{p}_{FH}} = \frac{d \ln w_H}{d \ln \tilde{p}_{FH}} + \frac{\frac{\tau_{FH}-1}{\tau_{FH}} \lambda_{FH}}{1 - \frac{\tau_{FH}-1}{\tau_{FH}} \lambda_{FH}} d \ln \lambda_{FH}$$

Plugging the last line back into the previously-derived expression

$$\varepsilon_{FH}^D = 1 - \frac{d \ln \lambda_{FH}}{d \ln \tilde{p}_{FH}} - \frac{d \ln E_H}{d \ln \tilde{p}_{FH}}$$

and noting that wage derivative is

$$\frac{d \ln w_H}{d \ln \tilde{p}_{FH}} = -\frac{1-\beta}{\beta} \lambda_{FH}$$

delivers the precise expression for the import demand elasticity:

$$\varepsilon_{FH}^{D} = 1 + \frac{\epsilon \lambda_{HH}}{1 - \frac{\tau_{FH}-1}{\tau_{FH}}\lambda_{FH}} + \frac{1-\beta}{\beta}\lambda_{FH}$$

The previous formulation results from the approximation, $(\tau_{FH} - 1)\lambda_{FH} \approx 0$.

D Optimal Tariff Multiple Sectors

(i) Multi-Sector Export Supply Elasticity

In the multi-sector framework, the sector-level price is

$$p_{ni,k} = \tilde{d}_{ni,k} p_n, \qquad p_n = \frac{1}{A_n} w_n^{\beta} \tilde{P}_n^{1-\beta}$$

where $\tilde{d}$ collects iceberg costs and sector-specific productivity shifter, and $\tilde{P}_n = \prod_k \tilde{P}_{n,k}^{e_k}$, with e_k representing the constant sector-level expenditure share. With multiple sectors, we can use the fact that the sector-level CES demand system implies, $\tilde{P}_{F,k} = \tilde{\psi}_{FF,k} p_F \lambda_{FF,k}^{1/\epsilon_k}$, yielding

$$\tilde{P}_F = \prod_k \tilde{P}_{F,k}^{e_k} = \psi_F p_F \prod_k \lambda_{FF,k}^{\frac{e_k}{\epsilon_k}}$$

where $\psi_F \equiv \sum_k \tilde{d}_{FF,k}$, The balance trade condition is given by

$$\tilde{d}_{FH,k} p_F q_{FH} = \lambda_{HF} w_F (1 + \delta_F) w_F L_F$$

where $q_{ni} \equiv \sum_k \tilde{d}_{ni,k} q_{ni,k}$ is aggregate trade quantity and $\delta_i \equiv T_i / w_i L_i$. Noting that $\delta_F \approx 0$, we cab plug $p_F = \frac{1}{A_F} w_F^{\beta} \tilde{P}_F^{1-\beta}$ and $\tilde{P}_{F,k} = \psi_F p_F \prod_k \lambda_{FF,k}^{\frac{e_k}{\epsilon_k}}$ into the balanced trade condition to obtain

$$q_{FH} = \bar{\varphi}_F^{\frac{1}{\beta}} \prod_k \left(\lambda_{FF,k} (p_F)^{\frac{e_k}{\epsilon_k}} \right)^{-\frac{1-\beta}{\beta}} \lambda_{HF}(p_F)\, L_F \tag{52}$$

where $\varphi_F \equiv A_F / \psi_F^{1-\beta}$ and the aggregate shares are now a weighted sum of sector-level shares:

$$\lambda_{FF}(p_F) = \sum_k \lambda_{FF,k}(p_F) e_k, \qquad \lambda_{HF}(p_F) = 1 - \lambda_{FF}(p_F).$$

Taking log derivatives from Equation 52, derives the following expression for the inverse export supply elasticity:

$$\frac{1}{\varepsilon_{FH}^{S}} \equiv \frac{\mathrm{d}\ln p_F}{\mathrm{d}\ln q_{FH}} = \frac{1}{-\frac{1-\beta}{\beta}\sum_k \frac{e_k}{\epsilon_k}\frac{\mathrm{d}\ln \lambda_{FF,k}}{\mathrm{d}\ln p_F} + \frac{\mathrm{d}\ln \lambda_{HF}}{\mathrm{d}\ln p_F}}. \tag{53}$$

The first term in the denominator can be simplified as

$$\sum_k \frac{e_k}{\epsilon_k}\frac{\mathrm{d}\ln \lambda_{FF,k}}{\mathrm{d}\ln p_F} = \sum_k \frac{\lambda_{FF,k}e_k}{\lambda_{FF}}\frac{\mathrm{d}\ln \lambda_{FF,k}}{\mathrm{d}\ln p_F} = -\sum_k \frac{e_k}{\epsilon_k}\epsilon_k\lambda_{HF,k} = \lambda_{HF}$$

The second term is obtained by taking the derivatives of the above-listed equation for the aggregate shares:

$$\frac{\mathrm{d}\ln \lambda_{HF}}{\mathrm{d}\ln p_F} = \sum_k \frac{\lambda_{HF,k}e_k}{\lambda_{HF}}\frac{\mathrm{d}\ln \lambda_{HF,k}}{\mathrm{d}\ln p_F} = \sum_k \frac{\lambda_{HF,k}e_k}{\lambda_{HF}}\epsilon_k\lambda_{FF,k}.$$

Plugging the above two expressions back into Equation 53, yields

$$\frac{\mathrm{d}\ln p_F}{\mathrm{d}\ln q_{FH}} = \frac{1}{\sum_k\left[\frac{\lambda_{HF,k}e_k}{\lambda_{HF}}\epsilon_k\lambda_{FF,k}\right] + \frac{1-\beta}{\beta}\lambda_{FH}}.$$

(i) First-Order Condition

The government chooses the vector $\{\tilde{p}_{FH,k}\}_k$ of sector-level buyer prices for imported varieties. The first-order condition w.r.t. $\tilde{p}_{FH,k}$ is

$$\frac{\mathrm{d}\ln W_H}{\mathrm{d}\ln \tilde{p}_{FH,k}} = \frac{\mathrm{d}\ln Y_H}{\mathrm{d}\ln \tilde{p}_{FH,k}} - \frac{\mathrm{d}\ln \tilde{P}_H}{\mathrm{d}\ln \tilde{p}_{FH,k}} = 0$$

Note that

$$Y_H = w_H L_H + \sum_k (\tilde{p}_{FH} - \bar{\tau}_k(\lambda_{FH,k})\tilde{d}_{FH,k}p_F)q_{FH,k}$$

Following the logic of our baseline analysis, the income derivative becomes

$$\begin{aligned}\frac{\mathrm{d}\ln Y_H}{\mathrm{d}\ln \tilde{p}_{FH,k}} = \frac{1}{Y_H}\Bigg[&w_H L_H \frac{\mathrm{d}\ln w_H}{\mathrm{d}\ln \tilde{p}_{FH,k}} + \tilde{p}_{FH,k}q_{FH,k} - p_{FH,k}q_{FH,k}\frac{\partial \ln \bar{\tau}_k(\lambda_{FH,k})}{\partial \ln \lambda_{FH,k}}\frac{\mathrm{d}\ln \lambda_{FH,k}}{\mathrm{d}\ln \tilde{p}_{FH,k}} \\ &+ \sum_g \left[\left(\tilde{p}_{FH,g} - \left(1 + \frac{\mathrm{d}\ln p_F}{\mathrm{d}\ln q_{FH}}\frac{\mathrm{d}\ln q_{FH}}{\mathrm{d}\ln q_{FH,k}}\right)\sum_{g'} p_{FH,g'}q_{FH,g'}\right)\frac{\mathrm{d}\ln q_{FH,g}}{\mathrm{d}\ln \tilde{p}_{FH,k}}\right]\Bigg].\end{aligned}$$

Which considering that $\frac{\mathrm{d}\ln q_{FH}}{\mathrm{d}\ln q_{FH,k}} = \frac{p_{FH,g}q_{FH,g}}{\sum_{g'} p_{FH,g'}q_{FH,g'}}$ yields

$$\frac{\mathrm{d}\ln Y_H}{\mathrm{d}\ln \tilde{p}_{FH,k}} = \left[\frac{w_H L_H}{E_H}\frac{\mathrm{d}\ln w_H}{\mathrm{d}\ln \tilde{p}_{FH,k}} + \lambda_{FH,k} + \frac{\lambda_{FH,k}}{\tau_{FH,k}}\frac{\partial \ln \bar{\tau}_k}{\partial \ln \lambda_{FH,k}}\epsilon_k \lambda_{HH,k} + \sum_g \left[\left(1 - \frac{1}{\tau_{FH,g}}(1 + \frac{1}{\varepsilon^S_{FH}})\right)\lambda_{FH,g}\varepsilon^D_{FH,g}\right]\right]\frac{E_H}{Y_H}.$$

With $\delta_H \approx 0$ and Cobb-Douglas aggregator across sectors, the cross-effects reduce to zero and the above equation simplifies to

$$\frac{\mathrm{d}\ln Y_H}{\mathrm{d}\ln \tilde{p}_{FH,k}} = \left[\frac{w_H L_H}{E_H}\frac{\mathrm{d}\ln w_H}{\mathrm{d}\ln \tilde{p}_{FH,k}} + \lambda_{FH,k} + \left(1 - \frac{1}{\tau_{FH,k}}[1 + \frac{1}{\varepsilon^S_{FH}} + \frac{\epsilon_k \lambda_{HH,k}}{\varepsilon^D_{FH,k}}\frac{\partial \ln \bar{\tau}_k}{\partial \ln \lambda_{FH,k}}]\right)\lambda_{FH,k}\varepsilon^D_{FH,k}\right]\frac{E_H}{Y_H}.$$

The price index and wage derivatives can be obtained following the same steps as in the baseline derivation. In particular, noting that $p_H = 1$, we get

$$\frac{\mathrm{d}\ln \tilde{P}_H}{\mathrm{d}\ln \tilde{p}_{FH,k}} = \lambda_{FH,k}, \qquad \frac{\mathrm{d}\ln w_H}{\mathrm{d}\ln \tilde{p}_{FH,k}} = -\frac{1-\beta}{\beta}\lambda_{FH,k}$$

The above two equations ensure that $\frac{w_H L_H}{E_H}\frac{\mathrm{d}\ln w_H}{\mathrm{d}\ln \tilde{p}_{FH,k}}\frac{E_H}{Y_H} - (\frac{E_H}{Y_H} - 1)\lambda_{FH,k} = 0$, which simplifies the first-order condition a

$$\begin{aligned}\frac{\mathrm{d}\ln W_H}{\mathrm{d}\ln \tilde{p}_{FH,k}} &= \frac{\mathrm{d}\ln Y_H}{\mathrm{d}\ln \tilde{p}_{FH,k}} - \frac{\mathrm{d}\ln \tilde{P}_H}{\mathrm{d}\ln \tilde{p}_{FH,k}} \\ &= \left[\left(1 - \frac{1}{\tau_{FH,k}}\left(1 + \frac{1}{\varepsilon^S_{FH}} + \frac{\epsilon_k \lambda_{HH,k}}{\varepsilon^D_{FH,k}}\frac{\partial \ln \bar{\tau}_k}{\partial \ln \lambda_{FH,k}}\right)\right)\lambda_{FH}\frac{\mathrm{d}\ln q_{FH}}{\mathrm{d}\ln \tilde{p}_{FH}}\right]\frac{E_H}{Y_H} = 0.\end{aligned}$$

The solution to this system yields the optimal tariff formula:

$$t^*_{FH,k} \equiv \tau^*_{FH,k} - 1 = \frac{1}{\varepsilon^S_{FH}} + \frac{\epsilon_k \lambda_{HH,k}}{\varepsilon^D_{FH,k}}\frac{\partial \ln \bar{\tau}_k(\lambda_{FH,k})}{\partial \ln \lambda_{FH,k}}$$

E China Exposure and U.S. Tariff Protection in 2018

This appendix examines whether sectors that were more dependent on Chinese imports before the trade war subsequently received larger increases in U.S. tariff protection in 2018. The exercise follows the cross-sectional logic in Fajgelbaum et al. [2020], but the presentation here is self-contained and framed in terms of public data sources. We combine monthly U.S. import data by source country and product with public tariff

schedules, the Bureau of Economic Analysis input-output accounts, and the Census classification system to construct sectoral exposure and tariff outcomes.

Our regressor of interest is each sector's import share sourced from China in 2017, measured before the main tariff escalation. We report results under both a trade aggregation and an industry aggregation in order to verify that the relationship is not an artifact of a single concordance. The sample is restricted to products that experienced a positive increase in U.S. tariffs in 2018, and it excludes steel and aluminum products covered by the Section 232 actions. The identifying variation therefore comes from how the China-related tariff measures were allocated across sectors, not from tariff changes that were applied broadly across the economy.

We study both tariff levels and tariff changes. In the baseline specification, the tariff measure is the applied tariff, defined as duties collected relative to customs value. The level outcome is the logarithm of one plus the sectoral applied tariff in 2018. The change outcome is a chained annual tariff-inflation index that cumulates monthly changes in the log of one plus the applied tariff over 2018. This construction preserves the timing of the tariff increases within the year while keeping an annual interpretation. We then compare that baseline with three alternatives: a chained annual index based on statutory tariff rates, a simple annual change in one plus the applied tariff, and a simple annual change in one plus the statutory tariff.

For each tariff outcomey_i, we estimate

$$y_i = \alpha + \beta \, \text{China Exposure}_{i,2017} + \varepsilon_i.$$

We report three variants of this specification. The first is an unweighted regression. The second rescales China exposure by import expenditure, using domestic sales from the input-output accounts to capture the sector's spending base. The third is a weighted regression that uses contemporaneous imports for level outcomes and lagged imports for change outcomes. Inference is based on HC3 heteroskedasticity-robust standard errors and two-sided asymptotic p-values, with Holm-adjusted p-values reported for the family of slope estimates in a given run.

Figure A1 summarizes the main coefficient from all tariff-change regressions in one display. Two patterns stand out. First, the relationship between pre-trade-war China exposure and subsequent tariff protection is positive in every specification and statistically precise throughout. Second, the chained specifications yield larger coefficients than the simple annual specifications. That difference is mechanical rather than substantive: chained measures cumulate tariff inflation over the sequence of policy actions in 2018,

whereas simple annual measures compress the same episode into a single year-over-year change. The economic conclusion is unchanged. Sectors that were more exposed to Chinese imports before the trade war received larger tariff increases once protection rose.

The magnitude of the estimated slope varies systematically across specifications. Under the chained annual applied baseline, the coefficient ranges from about 7.5 to 12.9. Under chained annual statutory tariffs, it ranges from about 8.7 to 13.9. Under the simple annual applied and simple annual statutory constructions, the corresponding ranges are about 2.0 to 3.6 and 2.6 to 4.2. Weighted estimates are generally somewhat smaller than their unweighted counterparts, but the ranking of sectors and the sign of the relationship remain stable across both aggregation systems. The coefficient plot therefore shows that the central pattern is robust even when the tariff outcome is redefined in economically meaningful ways.

Figure A2 provides the visual counterpart to the coefficient plot. The four rows correspond to the four tariff constructions, and the two columns report results under the trade and industry aggregations. The fitted relationship is upward sloping in every panel. Although the scale of the vertical axis changes across tariff measures, the same sectors repeatedly appear in the upper-right portion of the figure. In other words, sectors with high pre-trade-war exposure to Chinese imports also tend to be the sectors that experienced the largest tariff increases in 2018.

Taken together, the evidence is both simple and robust. Across aggregation systems, weighting schemes, and tariff constructions, the sectors that depended more heavily on Chinese imports before the trade war were the sectors that received larger increases in U.S. tariff protection in 2018.

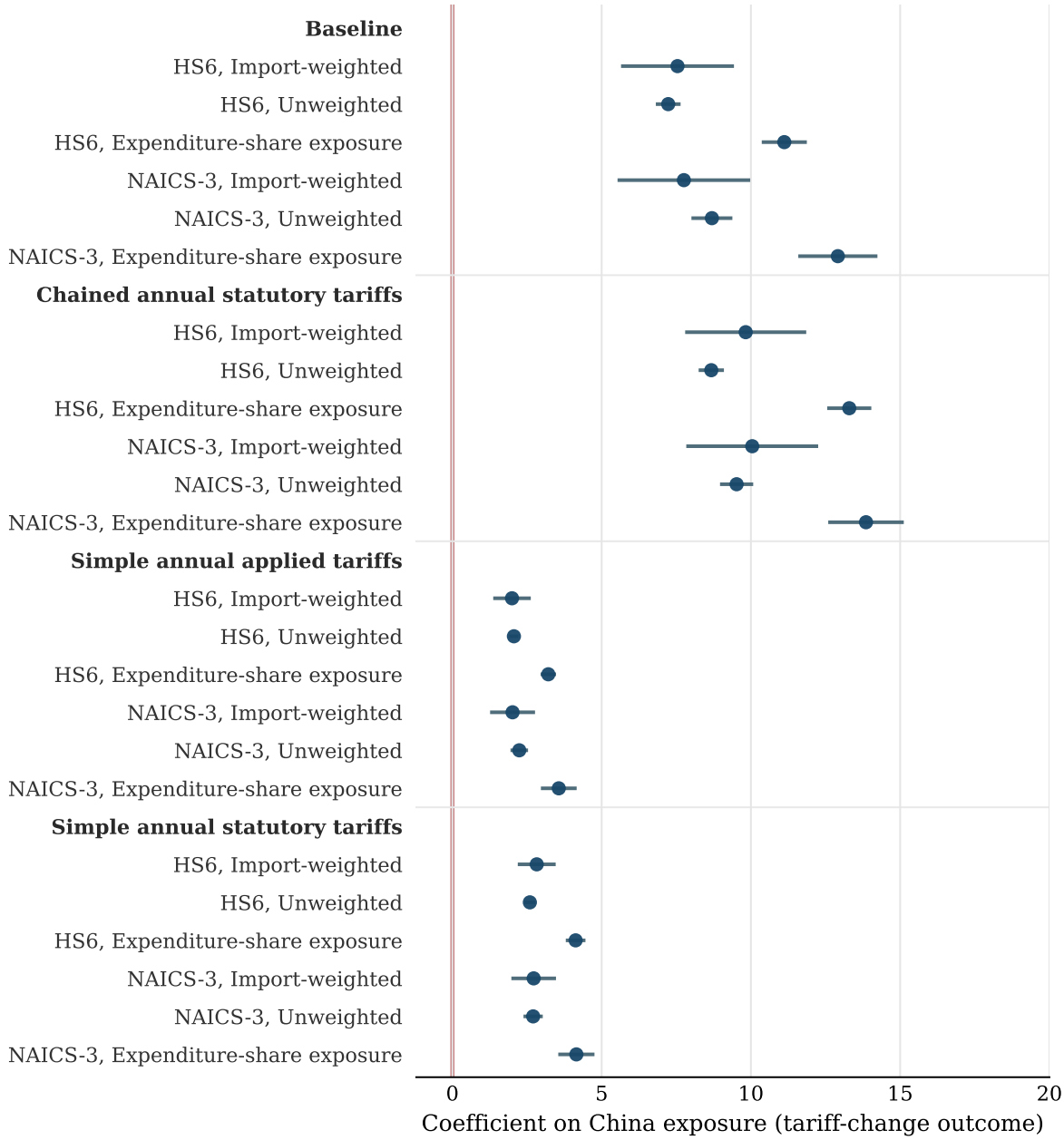


Figure 5: Robustness of the China-Exposure Slope in 2018 Tariff-Change Regressions

Notes: Each row reports one tariff-change regression. Markers show point estimates for the coefficient on 2017 China exposure, and whiskers show 95 percent confidence intervals based on HC3 standard errors. Rows are grouped by tariff construction and ordered within group by sectoral aggregation and weighting scheme. The vertical reference line marks zero.

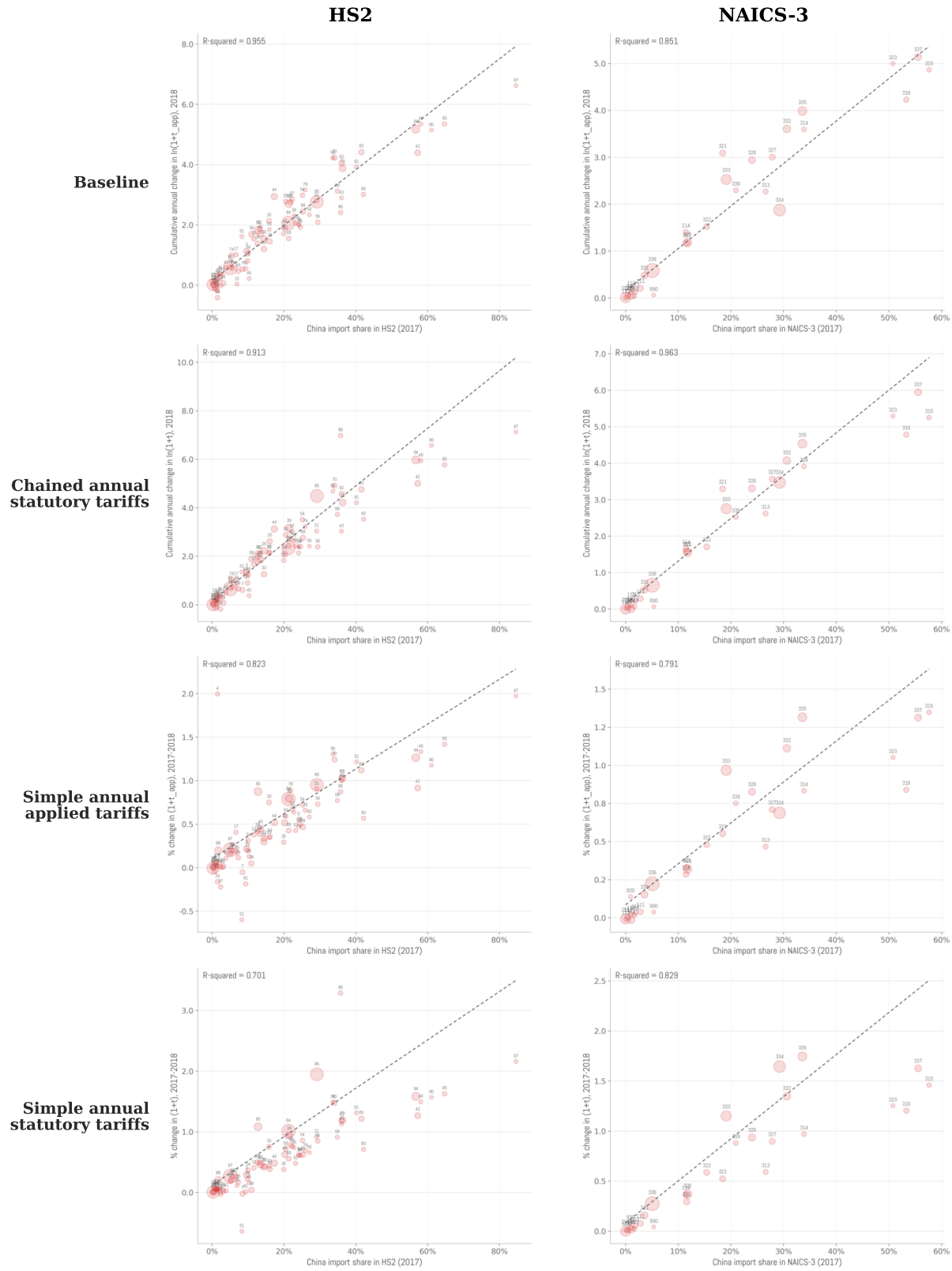


Figure 6: Visual Robustness of China Exposure and Tariff Change

Notes: Rows correspond to the chained annual applied specification, the chained annual statutory specification, the simple annual applied specification, and the simple annual statutory specification. Columns correspond to the trade and industry aggregations. In every panel, the horizontal axis is the sector's China import share in 2017, the vertical axis is the corresponding tariff-change measure, marker size is proportional to sector import value, and the dashed line is the weighted least-squares fit.

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