Making America Great Again? The Economic Impacts of Liberation Day Tariffs*

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Abstract

On April 2, 2025, President Trump declared "Liberation Day," announcing broad tariffs to reduce trade deficits and revive U.S. industry. We analyze the long-term economic impacts of these tariffs. If trading partners do not retaliate, the tariffs could decrease the U.S. trade deficit and improve its terms of trade, yielding modest welfare gains when tariff revenues reduce the income tax burden for American workers. However, reciprocal retaliation results in net welfare losses for the U.S. economy. We derive the unilaterally optimal tariff policy and find that the USTR proposed tariffs, based on bilateral trade deficits, diverge markedly from the optimal design. The optimal tariff is 19%, uniformly applied across all trading partners, and determined solely by the aggregate trade deficit, rather than bilateral imbalances. Under optimal foreign retaliation to the USTR tariffs, U.S. welfare declines by up to 3.4% when accounting for input-output linkages, while global employment contracts by 0.58%.

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1 Introduction

On April 2, 2025, President Donald Trump proclaimed "Liberation Day," implementing tariffs on imports from virtually all countries, with the stated goal of revitalizing American industry and reducing trade deficits. These tariffs include a 10% baseline on all imports, adjusted to a higher level for countries that run a trade surplus with the U.S., e.g., 20% for European Union products and 54% for Chinese goods (see USTR Reciprocal Tariff Calculations), with exceptions for USMCA trade partners as well as certain products, such as automobiles, steel, aluminum, and smartphones.[1] While the administration asserts that these measures will bolster domestic manufacturing, protect American jobs and eliminate the U.S. deficit, many economists and industry leaders warn of potential negative consequences. This article examines the economic implications of the Liberation Day tariffs, analyzing their potential impact on the U.S. and the global economy.

Model and Methods. We develop a quantitative trade model that incorporates three essential elements: tariff pass-through differing from unity, trade imbalances, and employment effects under different tariff-revenue rebate specifications. These features make the model particularly well-suited for analyzing the Liberation Day tariffs, which were designed based on perceived pass-through rates and targeted reductions in bilateral U.S. trade deficits with trade partners. In our framework, trade deficits arise from two sources: (i) exogenous transfers, capturing intertemporal substitution or external factors outside of the model, and (ii) local labor embodied in exports, because export penetration requires local labor services from the destination country. While the former component is unaffected by tariff changes, the latter adjusts endogenously to policy change. We focus on a single-sector model, consistent with the uniform application of Liberation Day tariffs across goods, excluding a few exceptional cases under Section 232. We also conduct robustness checks by introducing multiple sectors and an input-output structure.

Within our single-sector framework, we derive the theoretical formula for unilaterally optimal tariffs—i.e. tariffs that maximize U.S. welfare—and show that they are non-discriminatory across trading partners, and depend on the variety-adjusted tariff pass-through, the trade elasticity, and the aggregate trade deficit. Crucially, the optimal tariff is independent of bilateral trade imbalances, standing in sharp contrast to the proposed Liberation Day tariffs,

[1] See The White House Fact Sheets for official summary of tariff schedules and exemptions. As of April 9, tariffs on all countries (but China) have been reduced to 10% for 90 days. As of May 12, the reciprocal tariff on China is 10% in addition to the 20% fentanyl tariff. As of May 30, the 10% tariffs on all nations (except USMCA-compliant products and industries subject to Section 232 tariffs) are temporarily in place, as they have been legally challenged.

which were explicitly designed to vary based on the size of each country's bilateral trade deficit with the U.S.

We calibrate our model to bilateral trade and GDP data for 194 countries from 2023, and employ exact hat algebra to simulate the long-term counterfactual impacts of tariffs under various scenarios. Our simulations require information on several structural parameters, most notably the trade elasticity and the tariff pass-through rate. We adopt these values from Simonovska and Waugh (2014a) and Cavallo et al. (2021), both of which are referenced in the Executive Summary of the Reciprocal Tariff Calculations released by the Office of the United States Trade Representative (USTR). In robustness exercises that employ a multi-sector model, we restrict the analysis to 181 countries with sectoral trade and value-added data available for 2019, and estimate sectoral trade elasticities following Fontagné et al. (2022).

Summary of results. We find that tariffs imposed by the U.S. could improve its terms of trade and reduce its trade deficit, provided, critically, that trading partners refrain from retaliating. Across various scenarios and model specifications, we estimate that the USTR's proposed tariffs could reduce the trade deficit by approximately 11-19 percent. However, the associated welfare gains are modest and even non-existent once input-output linkages are considered, or if the reduction in income-tax burden due to tariff revenues is excluded. Furthermore, these limited beggar-thy-neighbor benefits to the U.S. come at substantial costs to its trading partners, particularly Canada and Mexico, Ireland and Norway in Europe, and several Southeast Asian economies such as Thailand, Malaysia and Vietnam, for whom exports to the U.S. constitute a significant share of GDP.

The modest welfare gains from the USTR tariffs, even without retaliation, reflect their flawed design. These tariffs are not structured optimally to maximize the terms of trade gains, revenue collection, or deficit reduction. An optimally designed tariff would involve a uniform rate of approximately 19% applied equally across all trading partners. Such a non-discriminatory tariff would increase the welfare gains for the U.S. by 60%, while also generating higher revenues and achieving larger reductions in the trade deficit.

Critically, any U.S. welfare gains disappear if trading partners retaliate bilaterally. In this case, the U.S. not only forfeits initial gains, but also ends up significantly worse off. When accounting for input-output linkages, the U.S. suffers a welfare loss of 3.38 percent. Although retaliation mitigates some losses for U.S. trade partners, it does not eliminate them; they still face welfare losses of around 1.17 percent. The resulting tariff war constitutes a Prisoner's Dilemma situation, harming all parties involved. Ultimately, global trade falls by at least 4.9 percent relative to GDP, and global employment drops by up to 0.58 percent.

Relation to the literature. We view our analysis as one that describes the long-run; i.e. an equilibrium in which tariffs are permanent and factor prices fully adjust to their equilibrium levels (see Alessandria et al. (2025a) for effects of temporary vs. permanent tariffs on the deficit and GDP, and Auclert et al. (2025) and Rodríguez-Clare et al. (2025) for an analysis with nominal rigidities). As such, our analysis abstracts from any frictions, most notably labor/inventory adjustment frictions and supply chain restructuring frictions such as relationship-building costs. These transitional dynamics would further reduce welfare gains.

Additionally, we do not model any uncertainty regarding the implementation or the persistence of tariffs (Alessandria et al. (2025b), Global Trade Outlook, April 2025), nor do we capture intertemporal decisions. Specifically, tariffs can reduce investment and the capital stock (Cuñat and Zymek (2024a), Baqaee and Malmberg (2025)). Furthermore, we abstract from the analysis of financial markets or monetary policy responses (Bianchi and Coulibaly (2025); Kalemli-Ozcan et al. (2025); Monacelli (2025)), so we cannot quantify any losses in income and wealth that may occur due to changes in asset prices (see Itskhoki and Mukhin (2025) for asset valuation effects on deficits). Thus, our findings should be interpreted as a lower bound on the potential costs of the Liberation Day tariffs to the U.S. and the rest of the world.

We view our analysis as a first attempt to quantify the welfare impact of the Liberation Day tariffs.[2] Methodologically, we relate to Ossa (2014) and Lashkaripour (2021), who employ quantitative trade models to assess the welfare costs of tariff wars. Our tariff revenue analysis complements recent work, including Lashkaripour (2020) and Alessandria et al. (2025a).

2 Model

We employ a generalized trade model consistent with multiple micro-foundations in the spirit of Demidova et al. (2024). This framework enables us to characterize global trade in terms of international supply and demand of labor services.

Demand for Labor Services. There are N countries indexed by $i, j, n = 0, 1, \ldots, N$. Let w_i and L_i represent the wage and labor supply in country i, A_i the constant productivity shifter of country i, d_{ni} the ad-valorem trade cost from country n to country i, and t_{ni} the ad-

[2] A growing literature has examined the consequences of the 2018-2019 U.S.-China trade war (e.g. Amiti et al. (2019, 2020); Flaaen and Pierce (2019); Waugh (2019); Fajgelbaum et al. (2020); Ma et al. (2021, 2025); Caliendo and Parro (2023).)

valorem tariff imposed by country i on imports from country n. Without loss of generality, assume $d_{ii} = 1 + t_{ii} = 1$.

Trade shares are defined as $\lambda_{ni} \equiv X_{ni}/E_i$, where X_{ni} is country i's expenditure on varieties from country n, with $E_i = \sum_j X_{ji}$ denoting total expenditure. As elaborated in Appendix A, in a Melitz-Pareto model with destination-specific markups, free entry, and fixed costs paid in local labor, trade shares can be specified as:

$$\lambda_{ni} = \frac{\left(d_{ni}/(A_n L_n^{\psi})\right)^{-\varepsilon} (1+t_{ni})^{-\varphi_i \cdot \varepsilon} w_n^{-\varepsilon}}{\sum_j \left(d_{ji}/(A_j L_j^{\psi})\right)^{-\varepsilon} (1+t_{ji})^{-\varphi_i \cdot \varepsilon} w_j^{-\varepsilon}} \tag{1}$$

This expression also encompasses a range of standard models, such as Armington, Eaton-Kortum, and Krugman, as special cases. The formulation of bilateral trade shares involves three *structural* parameters, defined as follows:

1. ε: the trade elasticity, i.e., the elasticity of trade flows with respect to trade costs d_{ni};

2. ψ: the scale elasticity—the elasticity of aggregate real TFP with respect to employment size, L_n—capturing the variety gains from firm entry;

3. φ_i: the pass-through of tariffs to the *price index* of imported varieties in destination i, which is composed of two components: the firm-level pass-through, denoted by $\tilde{\varphi}_i \leq 1$, and the import variety effect, given by $\varphi_i - \tilde{\varphi}_i \geq 0$.[3] In general, we focus on the case where the tariff pass-through to firm-level prices is complete (i.e., $\tilde{\varphi}_i = 1$), with overshifting effects on the price index (i.e., $\varphi_i > 1$). However, we also experiment with incomplete firm-level pass-through.

The total demand for labor services in country i consists of two components: labor for domestic production and labor for fixed costs of firms (domestic and foreign) selling in i. Specifically, let ν_n represent the constant, but *destination-specific*, fraction of sales allotted to fixed cost payments to local labor at the location of sales, n. Total demand for labor services in country i is:

$$L_i^D = \frac{1}{w_i}\left[\sum_n \frac{1-\nu_n}{1+t_{in}} \lambda_{in} E_n + \nu_i \sum_n \frac{1}{1+t_{in}} \lambda_{ni} E_i\right] \tag{2}$$

The first term on the right-hand side captures the total labor demand associated with production and entry activities by domestic firms. For each destination n, a fraction $1 - \nu_n$ of sales is allocated to domestic labor costs related to these activities, while the remaining share

[3] We provide a micro-founded definition for φ_i in Appendix A and additional discussion in Appendix A.1.

ν_n covers fixed costs paid to local labor from n.[4] The second term on the right-hand side, accordingly, represents the demand for country i's labor due to fixed costs incurred by both domestic and foreign firms selling to market i. As we demonstrate shortly, the assumption that fixed costs are expensed in destination-country wages yields bilateral deficits that are endogenous. This assumption is not new to the trade literature—Arkolakis (2010) develops a model where firms incur market access costs composed of domestic and foreign wages, estimating that foreign wages represent 71% of the total for French firms.[5]

Tariffs reduce demand for foreign labor and boost demand for domestic labor by altering trade shares. These effects are captured by the tariff elasticity $\frac{\partial \ln \lambda_{ni}}{\partial \ln(1+t_{ni})} = \varphi_i \cdot \varepsilon$. This elasticity indicates that changes in tariffs impact the import price index with elasticity φ_i, and the resulting price adjustments affect trade flows with elasticity ε. As explained below, we can simulate the counterfactual effect of tariffs with information on trade and production, and the parameters listed above, without taking a stance on the remaining parameters, A_n or d_{ni}.

Supply of Labor Services. The representative agent in country i has preferences over consumption and labor given by $U = C_i - \frac{\kappa}{\kappa+1} L_i^{1+\frac{1}{\kappa}}$, where C_i denotes consumption utility, whose maximization yields the equilibrium trade shares specified above. The parameter κ represents the labor supply elasticity. Labor supply in country i is, thus, given by

$$L_i^S = \left(\frac{(1-\tau_i^L) w_i}{P_i} \right)^{\kappa}, \tag{3}$$

where τ_i^L is the share of labor income that is deducted as income taxation, and P_i is the unit price index of the optimal consumption bundle, C_i, which is given by

$$P_i = \Upsilon_i \left[\frac{E_i}{w_i} \right]^{1-\varphi_i} \left[\sum_n \left(\frac{d_{ni}}{A_n L_n^{\psi}} \right)^{-\varepsilon} (1+t_{ni})^{-\varphi_i \cdot \varepsilon} \, w_n^{-\varepsilon} \right]^{-\frac{1}{\varepsilon}} \tag{4}$$

where Υ_i is a constant formally defined in Appendix A.

[4]Fixed cost are paid with variable profits, which are a fraction of sales. Thus, ν_n is the product of two shares: the share of variable profits in sales times the share of variable profits depleted by fixed costs.

[5]While these payments should appear as service imports in the data, the Bureau of Economic Analysis recognizes that firms often employ foreign labor services via local affiliates. As a result, such payments to foreign factors are classified as domestic transactions. These payments are ultimately deducted from the profits repatriated to the parent company. So, our formulation effectively features cross-border claims on profits/assets, and is related to the portfolio model in Caliendo et al. (2018).

General Equilibrium. General equilibrium is a set of wages such that labor supply equals demand

$$L_i^S = L_i^D$$

and goods' markets clear so that total expenditure in country i is the sum of factor income and tariff revenue. In particular,

$$E_i = w_i L_i + R_i + \bar{T}_i, \tag{5}$$

Following Dekle et al. (2007), $\bar{T}_i$ is a lump-sum transfer, equal to a constant share of world GDP, with $\sum_i \bar{T}_i = 0$; and R_i denotes tariff revenues:

$$R_i = \sum_{n \neq i} \frac{t_{ni}}{1 + t_{ni}} \lambda_{ni} E_i. \tag{6}$$

Trade Deficit. As shown in Appendix B, the trade deficit of country i is given by:

$$D_i \equiv \sum_{n \neq i} \left(\frac{1}{1 + t_{ni}} X_{ni} - \frac{1}{1 + t_{in}} X_{in} \right) = \bar{T}_i + \sum_{n \neq i} \left[\frac{\nu_i}{1 + t_{ni}} X_{ni} - \frac{\nu_n}{1 + t_{in}} X_{in} \right]. \tag{7}$$

Two key factors determine D_i in our framework. The first is the exogenous lump-sum transfer $\bar{T}_i$, which captures external mechanisms such as intertemporal substitution that lie beyond our model's scope. Static trade models have traditionally attributed the entire deficit to these transfers (Dekle et al., 2007). The second source arises endogenously because the proceeds from exports are not fully paid to domestic labor; a portion is instead redirected to foreign labor to cover fixed exporting costs. These fixed costs effectively transfer a share of variable export profits to foreign workers. Since the share of fixed cost payments in sales, ν_i, is *destination-specific*, these transfers are asymmetric. They disproportionately benefit countries with higher market penetration costs, allowing their factor income to exceed sales—see Appendix B for details.

The aggregate deficit is the sum of the bilateral deficits, $D_i = \sum_{n \neq i} D_{ni}$, where the bilateral deficit with partner n is defined as $D_{ni} \equiv \frac{1}{1+t_{ni}} X_{ni} - \frac{1}{1+t_{in}} X_{in}$. The following proposition characterizes the determinants of bilateral deficits.

Proposition 1. *Trade is bilaterally balanced if and only if the aggregate trade deficit is zero ($D_i = 0$ $\forall i$) and trade barriers are reciprocal ($d_{in} = d_{ni}$ and $t_{ni} = t_{in}$, $\forall n, i$).*

Proposition 1, proven in Appendix C, clarifies that bilateral trade imbalances do not provide meaningful information about the reciprocity of trade barriers, including tariffs, when there are aggregate trade imbalances.[6] The intuition is straightforward: if a country runs an aggregate trade deficit, whether due to macroeconomic factors captured by $\bar{T}_i$ or the foreign content embedded in overhead costs, then, by accounting identity, its trade must be imbalanced with at least some of its partners.

Corollary 1. *If country i runs an aggregate trade deficit ($D_i \neq 0$), its trade with some partners will be bilaterally imbalanced, even if trade barriers are reciprocal.*

Tariff Pass-through. In our model, φ_i represents the conditional pass-through of tariffs to the price index of imported varieties, holding aggregate wages, trade flows, and labor supply fixed. To clarify this, choose labor in country i as the numeraire. The price index for goods exported from country n to i is

$$P_{ni} = \mathcal{C}_{ni} \times (1+t_{ni})^{\varphi_i} \, (w_n/w_i) \, L_n^{-\psi} X_{ni}^{1-\varphi_i},$$

where $\mathcal{C}_{ni}$ encompasses all the constant price shifters. The total derivative of prices with respect to tariffs is thus

$$\frac{d\ln P_{ni}}{d\ln(1+t_{ni})} = \varphi_i + \underbrace{\frac{d\ln(w_n/w_i)}{d\ln(1+t_{ni})} - \psi \frac{d\ln L_n}{d\ln(1+t_{ni})} + (1-\varphi_i)\frac{d\ln X_{ni}}{d\ln(1+t_{ni})}}_{\text{GE effects}}$$

This decomposition separates the conditional pass-through on the price index, holding wages and other aggregate equilibrium values constant, from general equilibrium (GE) adjustments arising primarily through shifts in relative wages. This distinction matters because tariffs can improve a country's terms of trade even if the conditional pass-through exceeds one ($\varphi_i \geq 1$), as tariffs inflate the domestic wage relative to the foreign wages, i.e., $\frac{d\ln(w_n/w_i)}{d\ln(1+t_{ni})} < 0$, thereby improving the factoral terms of trade.

Extensions. In Appendix A.3, we introduce intermediate inputs in the form of roundabout production and a blanket tariff applied to all goods imported from a given origin, regardless of intended use. In Appendix A.4, we introduce multiple sectors with sector-specific trade elasticities, with and without input-output linkages.

[6]In principle, asymmetric trade costs can affect *bilateral* trade imbalances without altering *aggregate* imbalances—particularly when aggregate imbalances are driven solely by external transfers ($\bar{T}$). However, in our framework, the endogenous component of the aggregate deficit is sensitive to trade cost asymmetries, which are shown to be empirically significant by Cuñat and Zymek (2024a).

2.1 Unilaterally-Optimal Tariff Under Trade Imbalances

As an intermediate step, we characterize the unilaterally optimal tariff under trade imbalances. The optimal tariffs for country i solve the following planning problem, taking policy choices in the rest of the world as given:

$$\max_{\{t_{ni}\}} \; U_i(t_{ni}) \quad s.t. \quad \text{Equilibrium constraints } (1-6)$$

We assume that other countries operate under laissez-faire. As proven in Appendix D, the optimal tariff for country i is different from the standard formula without imbalances and firm-selection effects, which equates the tariff to the inverse trade elasticity, ε. The following proposition summarizes this result.

Proposition 2. *The optimal tariff for country i is uniform across partners and given by*

$$t^*_{ni} = t^*_i = \frac{1}{(1+\mathscr{E}_i)\,\varphi_i - 1} \qquad \forall (n)$$

where $\mathscr{E}_i \equiv \sum_{n \neq i} \left[\frac{(1-\nu_n) X_{in}}{(1-\nu_i)\sum_{n\neq i} X_{ni}} (1-\lambda_{in}) \right] \varepsilon$.

The proposition above asserts that while aggregate trade imbalances matter for the optimal tariff design, bilateral imbalances are irrelevant. To see this, consider a small open economy for which $\lambda_{in} \to 0$, implying an optimal tariff:

$$t^*_{ni} = \frac{1}{(1+\varepsilon)\varphi_i - 1 - \frac{\varphi_i \varepsilon \bar{T}_i / E_i}{(1-\lambda_{ii})(1-\nu_i)}}, \qquad \forall (n,i)$$

Without fixed transfers, i.e., $\bar{T}_i = 0$, this expression reduces to the optimal tariff derived for a small open economy without trade imbalances in Caliendo and Feenstra (2024) and Demidova et al. (2024).

The formula shows that countries with aggregate trade deficits ($\bar{T}_i > 0$) set higher optimal tariffs. The intuition is that tariffs exploit a country's monopoly power over its differentiated labor services by curbing demand for foreign labor and raising domestic wages relative to foreign ones. As such, they allow the government to elicit an optimal markup on the international price of its labor services. With trade deficits, a larger import reduction is needed to achieve the optimal domestic wage inflation.[7] However, *bilateral* trade imbalances do not affect optimal tariffs: from a pure terms-of-trade perspective, there is no basis for adjusting tariffs based on bilateral deficits. The following corollary formalizes this insight.

[7] Pujolas and Rossbach (2024) make a similar point in a two-country endowment economy.

Corollary 2. *The optimal tariff is increasing in the aggregate trade deficit, but is independent of the bilateral deficits.*

3 Simulating the Impact of Tariffs

We simulate several counterfactual outcomes, beginning with the scenario in which the U.S. ($i = US$) imposes the "reciprocal" Liberation Day tariff, raising tariffs from zero according to the USTR formula (see USTR Tariff Calculator and Appendix F.3). For Canada and Mexico, we apply a 10% rate, corresponding to the lower bound reported by the USTR, which falls between the fentanyl tariff rates and the duty-free rate for USMCA-compliant goods. We retain embargo-level tariffs on Russia, since our analysis uses 2023 data. For China, we assume an effective tariff of 54%, which is the sum of the fentanyl and Liberation Day reciprocal tariff.

Using exact hat algebra, we compute counterfactual changes in equilibrium outcomes to assess the policy impacts on welfare, exports, imports, deficit, employment, and real consumer prices, with details provided in Appendix E.[8]

4 Data and Calibration

To perform counterfactual analyses using our baseline model, we need data on aggregate output (Y_i in the model), trade shares (λ_{ni}), fixed cost margins (ν_i) that regulate deficits, as well as estimates of the elasticity parameters.

National Accounts. First, we note that national expenditure, $E_i = \text{GDP}_i + \bar{T}_i$, is the sum of GDP and fixed transfers, where GDP represents net factor income: $Y_i = w_i L_i = \text{GDP}_i$. Second, to allocate the deficit between overhead cost payments and exogenous transfers ($\bar{T}_i$), we use the following accounting property:

$$\bar{\mathbf{T}} = (\mathbf{X}^T - \mathbf{X})(\mathbf{1} - \boldsymbol{\nu}) \tag{8}$$

where $\mathbf{X}$ is a trade matrix and $\boldsymbol{\nu}$ is set to match the share of *Sales, general & administrative expenses* in total sales of manufacturing firms in the U.S. and the rest of the world (see Appendix F.4 for details). For completeness, we experiment with alternative micro-

[8]Since we calibrate the model to bilateral trade data from 2023, observed trade shares implicitly reflect baseline-year trade costs and tariffs. Following Costinot and Rodríguez-Clare (2014), we assume tariff revenues are negligible relative to GDP for accounting purposes.

foundations, in which $\nu = \mathbf{0}$. The latter parameter choice allocates the entire deficit to factors outside of the model: $\bar{T}_i = \sum_{j \neq i} X_{ji} - \sum_{j \neq i} X_{ij}$, which corresponds to the specification in Dekle et al. (2007)—see Appendix H.

Trade Shares. Given trade and expenditure data, we compute the share, λ_{ni}, as

$$\lambda_{ni} = \frac{X_{ni}}{E_i} \tag{9}$$

where X_{ni} denotes exports from country n to country i, and E_i is country i's expenditures. We infer domestic absorption as $X_{ii} = E_i - \sum_{n \neq i} X_{ni}$.

Data Sources. We source GDP data (current USD) for 2023 or latest available year from World Bank's WDI, and bilateral goods trade data (excluding services) from CEPII's 2023 BACI dataset (Gaulier and Zignago, 2010). We use balance sheet data for manufacturing firms in COMPUSTAT and WORLDSCOPE for year 2020 to calibrate ν for the US and other markets. We estimate $\nu_{\text{US}} = 0.27$ for the U.S. market, and $\nu_{\text{non-US}} = 0.11$ for other markets (see Appendix F for details). Together, these data allow us to calibrate a model for 194 countries, which account for 96.5% of global trade.[9]

Structural Parameters. We set the following elasticity parameters from the literature:

- $\varepsilon = 4$ (Simonovska and Waugh, 2014a,b), see Appendix F.1.2 for discussion
- $\kappa = 0.5$ (Chetty et al., 2011)
- $\varepsilon \cdot \psi = 0.67$ (Lashkaripour and Lugovskyy, 2023)

Following the evidence in Amiti et al. (2019), Cavallo et al. (2021), and Fajgelbaum et al. (2020), we assume that the firm-level pass-through is complete (i.e., $\tilde{\varphi} = 1$) and infer the variety-adjusted pass-through as

$$\varphi_i = \tilde{\varphi}_i + \frac{\nu_i}{1 - \nu_i}(1 + \psi)$$

This expression clarifies that, when the firm-level pass-through is complete, there is *over-shifting* at the aggregate price index level due to product variety effects. For robustness, in Appendix H, we also experiment with an incomplete firm-level passthrough of $\tilde{\varphi} = 0.25$, based on the USTR's report on reciprocal tariff calculations.[10]

[9]We treat EU members as independent tariff setters.

[10]We interpret the USTR passthrough of 0.25 as firm-level passthrough estimated in Cavallo et al. (2021).

I-O Linkages and Multiple Sectors. We use bilateral trade flows by sector from the International Trade and Production Database for Simulation (ITPD-S) (Borchert et al., 2024). We aggregate sectors into four broad categories: Agriculture, Manufacturing, Mining, and Services. Sector-level value-added shares are drawn from the OECD Inter-Country Input-Output (ICIO) database for year 2019. We estimate sector-specific trade elasticities following Fontagné et al. (2022), using tariff data from Teti (2024), and standard gravity controls from the Dynamic Gravity Dataset (Gurevich, 2018), as detailed in Appendix F.

5 Results

This section reports the simulated impacts of the USTR-proposed reciprocal tariffs under various scenarios, comparing them to outcomes attainable under optimal tariffs.

5.1 Tariff Outcomes *without* Retaliation

Table 1 presents the pre-retaliation effects of Liberation Day tariffs under two distinct specifications for the use of tariff revenue: (1) income-tax burden relief, (2) lump-sum rebate.

Table 1: The simulated impacts of Liberation Day tariffs

Case 1: USTR tariffs + income tax relief + no retaliation						
Country	Δ welfare	Δ deficit	Δ $\frac{\text{exports}}{\text{GDP}}$	Δ $\frac{\text{imports}}{\text{GDP}}$	Δ employment	Δ prices
USA	1.13%	-18.1%	-52.7%	-43.6%	0.32%	12.8%
non-US (average)	-0.58%	11.6%	-3.2%	-3.3%	-0.14%	-4.7%
Case 2: USTR tariffs + lump-sum rebate + no retaliation						
USA	-0.01%	-18.4%	-52.5%	-43.3%	-0.41%	13.1%
non-US (average)	-0.57%	11.7%	-3.3%	-3.4%	-0.14%	-4.8%
Case 3: optimal US tariffs + income tax relief + no retaliation						
USA	1.79%	-19.1%	-55.3%	-45.6%	0.51%	12.6%
non-US (average)	-0.61%	17.1%	-4.2%	-3.7%	-0.16%	-4.6%

Notes: This table reports changes in economic variables (relative to pre-Liberation Day) if partners do not retaliate against the USTR tariffs. The "non-US (average)" reflects GDP-weighted averages across non-U.S. countries. In scenarios (1) and (3), tariff revenues are used to reduce income taxes, while in scenario (2) they are rebated lump-sum without lowering the income tax. The change in "prices" represents the change in the country's CES price index P_i relative to the global GDP-weighted average price index.

Without retaliation, U.S. welfare would increase by 1.13 percent, accompanied by an

18 percent contraction in the trade deficit and a modest 0.32 percent expansion in U.S. employment. The trade deficit reduction manifests primarily through sizable contractions in both exports and imports. The simultaneous decline in exports and imports resonates with the Lerner symmetry, whereby an import tariff functions effectively as an implicit tax on exports. Importantly, domestic wage growth leads to a staggering 13 percent increase in real consumer prices, relative to a global GDP-weighted price index, although reduced product variety and elevated import prices also contribute to price growth.

The welfare gains for the U.S. stem from improvements in factoral terms of trade and reductions in income taxes. To clarify the first channel, unilateral U.S. tariffs raise domestic wages relative to foreign wages:

$$\left\{\frac{w_{US}}{w_1}, \frac{w_{US}}{w_2}, \cdots, \frac{w_{US}}{w_N}\right\} \uparrow$$

As a result, even if tariffs are fully passed through to import prices (holding aggregate wages fixed), imports effectively become cheaper because foreign wages fall or U.S. wages rise. These terms of trade gains are further amplified by the efficiency gains from income tax reduction. For the USTR tariffs, these two effects collectively outweigh the efficiency losses from reduced trade, resulting in net welfare gains without retaliation.

Without the efficiency gains from income tax cuts, USTR tariffs yield no net benefit for the U.S. economy, highlighting their flawed design. The second panel of Table 1 shows results for a scenario where tariff revenues are rebated lump-sum rather than used to cut income taxes. In this scenario, welfare gains vanish, as the benefits from lower income taxes are lost (see Alessandria et al. (2025a) for a similar argument). Additionally, the employment gains that previously arose from increased labor supply due to lower income taxes are reversed.

Other countries typically experience welfare losses averaging 0.6 percent, although, as we elaborate later, the losses are substantial for some countries. The rest of the world's trade deficit grows due to significant reductions in exports and imports to and from the U.S. Additionally, foreign employment declines modestly, accompanied by a pronounced drop in real prices due to downward pressure on foreign wages.

Optimal U.S. tariffs. The last panel in Table 1 displays results under the optimal tariff design without retaliation. As demonstrated by Proposition 1, optimal tariffs are uniform and independent of bilateral trade imbalances. For the U.S., the optimal tariff equals 19 percent, contrasting markedly with the reciprocity-based tariffs proposed by the USTR. The optimal tariff generates superior welfare gains for the U.S. (1.8 percent), a greater reduction in the trade deficit (19 percent), and more favorable employment outcomes with nearly identical aggregate price-level changes.

Trade Deficit Treatment. Our calibration targets the higher share of overhead fixed costs among U.S. firms compared to the rest of the world. Since the majority of firm sales are domestic, this target implies that $\nu_{\text{US}} > \nu_{\text{non-US}}$. Consequently, in our calibrated model, the trade deficit has an endogenous component (represented by the second term in Equation (7)) that responds to tariff changes. However, if fixed-cost shares, and hence the ν parameters, were identical across countries, this endogenous term would cancel out entirely. A clear illustration of this is the conventional Dekle et al. (2007) framework, which assumes zero fixed costs and no firm-selection effects ($\nu_i = 0$, $\varphi = 1$). In that setup, the trade deficit is solely driven by fixed transfers that do not adjust with tariff changes.

We report the results from this conventional specification in the top panel of Table 10 in Appendix H. Compared to our baseline model, the fixed-deficit framework generates larger welfare gains for the U.S. in response to the USTR tariffs. The intuition is that improvements to the terms-of-trade through trade contraction no longer entail a corresponding loss in consumption expenditure through deficit reduction. These results reveal that deficit reduction attenuates the welfare gains from unilateral tariffs, highlighting that the objective of narrowing the deficit conflicts with terms of trade objectives.

An alternative approach for handling trade deficits in static frameworks is employed by Ossa (2014), who removes the trade imbalances from the data prior to conducting counterfactual policy simulations. As shown in Appendix H, the balanced-trade approach implies smaller U.S. welfare gains from USTR tariffs compared to the Dekle et al. (2007) approach.

Ultimately, our predictions about the trade deficit should be viewed with care. Our static framework treats international transfers, $\bar{T}_i$, as exogenously fixed. But in reality, these transfers are shaped by deeper macroeconomic forces and emerge endogenously in equilibrium. Capturing these forces requires a dynamic model as in a growing body of literature exemplified by Costinot and Werning (2025) and Baqaee and Malmberg (2025). In this vein, Cuñat and Zymek (2024b) show small effects of tariffs on deficits for relatively closed countries such as the USA using a small-open economy model with an overlapping-generations structure; whereas, relative to our findings, Caliendo et al. (2025) predict nearly double the reduction in the U.S. deficit employing an infinite-horizon Eaton-Kortum framework with aggregate uncertainty and complete markets.

5.2 The Consequences of Global Retaliation

Table 2 presents the outcomes when other nations respond with retaliatory tariffs. We assume that these retaliatory measures target only the U.S. and do not escalate into a broader global trade war.

Table 2: Impact of retaliatory tariffs

(1) USTR tariff + reciprocal retaliation				
Country	Δ welfare	Δ deficit	Δ employment	Δ prices
USA	-0.36%	-26.7%	-0.18%	7.5%
CHN	-0.82%	6.2%	-0.16%	-3.7%
EU	-0.22%	15.4%	-0.09%	-2.6%
non-US (average)	-0.46%	19.8%	-0.13%	-2.7%
(2) USTR tariff + optimal retaliation				
USA	-0.75%	-29.0%	-0.32%	6.0%
CHN	-0.65%	6.3%	-0.13%	-3.3%
EU	-0.23%	16.6%	-0.09%	-2.1%
non-US (average)	-0.43%	22.4%	-0.13%	-2.2%
(3) optimal tariff + optimal retaliation				
USA	-0.32%	-28.4%	-0.20%	4.2%
CHN	-0.36%	4.2%	-0.08%	-2.1%
EU	-0.23%	16.9%	-0.09%	-1.5%
non-US (average)	-0.39%	25.1%	-0.13%	-1.5%

Notes: This table reports changes in economic variables (relative to pre-Liberation Day) after partners retaliate against the USTR tariffs. The "non-US (average)" reflects GDP-weighted averages across non-U.S. countries. In all scenarios, tariff revenues are used to reduce income taxes. The change in "prices" represents the change in the CES price index P_i relative to the global GDP-weighted average price index.

We analyze three scenarios: (1) reciprocal retaliation against USTR tariffs, consistent with the WTO's reciprocity principle, (2) optimal retaliation against USTR tariffs, and (3) optimal retaliation against optimal U.S. tariffs. For each scenario, we present results for the U.S., EU, China, as well as the non-U.S. average.

Table 2 paints a clear picture: the tariff gains are fully reversed once retaliation occurs. Under all scenarios, U.S. welfare falls below pre-Liberation Day levels, and all employment gains are undone. Retaliation also curbs real consumer price growth in the U.S., primarily due to downward pressure on domestic wages. As expected, the losses for the U.S. are even more pronounced when other countries retaliate optimally rather than reciprocally.

While the rest of the world manages to recover some of the initial losses caused by the USTR tariffs, it is unable to fully offset them, even under optimal retaliation. Ultimately, the post-retaliation equilibrium resembles a Prisoner's Dilemma, where all parties are strictly worse off compared to the pre-Liberation Day tariffs. In cases (1) and (3), China appears to suffer the most severe losses among the three major economies.

Overall, these findings highlight the pitfalls of unilateral tariffs. Although the U.S. may achieve short-term gains in welfare and employment, these benefits are completely erased once trading partners retaliate. While the U.S. deficit may decline by more than 25%, this reduction comes with a significant loss in consumer welfare, even after accounting for the income tax reductions enabled by tariff revenues.

Localized Tariff War between the U.S., EU, and China. Appendix G analyzes a scenario in which the United States reaches a trade truce with most countries (i.e. 10% bilateral tariff), apart from the EU and China. Compared to a full-scale tariff war, where all countries face USTR tariffs and retaliate, this partial truce leads to smaller welfare losses for the U.S., China, and the rest of the world, and marginally larger losses for the EU—see Table 8. This outcome is driven by reduced trade diversion benefits for certain EU countries. China's smaller welfare losses stem from the lifting of tariffs on Southeast Asian countries, which raises wages in these economies and mitigates some of China's loss of market access. Appendix G also explores a "peace" scenario in which the U.S. lifts tariffs on the EU but not on China, reducing losses for the U.S. and EU, while China continues to face steep costs. Further escalations in the trade war with China (i.e. bilateral tariffs of 108%), however, reduce U.S. welfare marginally faster than Chinese welfare.

5.3 How Big are the Resulting Tariff Revenues?

This section examines the extent to which the USTR tariffs can generate revenues. To put this exercise into context, the Congressional Budget Office estimates an increase in the deficit over the next decade due to the One Big Beautiful Bill Act of $2.8 trillion.[11] Table 3 presents tariff revenues across several scenarios, expressed both as a share of GDP and as a share of the U.S. federal budget, which accounts for 23% of GDP (as reported by St. Louis Fed). The results clearly illustrate the limited fiscal role that tariffs can play in the U.S. economy.

Before retaliation, revenues from USTR tariffs amount to 1.1 percent of GDP, or approx-

[11] See official estimates here.

Table 3: Tariff Revenue as Share of GDP and Federal Budget

	USTR tariff	optimal tariff	retaliation to USTR tariff: optimal	retaliation to USTR tariff: reciprocal
% of GDP	1.14%	1.35%	0.74%	0.82%
% of Federal Budget	4.95%	5.88%	3.24%	3.57%

Notes: The "retaliation" scenario reports outcomes when the U.S. applies the USTR tariffs and all partners respond with reciprocal or optimal retaliatory tariffs.

imately 5 percent of the federal budget. Hence, tariff revenue can cover at most 12 percent of the funding gap that is projected to arise due to the proposed bill above. These figures improve under optimal tariffs, which could replace nearly 6 percent of the income tax revenues used to finance the federal budget. Retaliation by trading partners dilutes the tariff revenues as it shrinks the tariff base. Under optimal retaliation, revenues fall to 0.7 percent of GDP or 3.2 percent of the federal budget. Under reciprocal retaliation, the drop is similar, but marginally smaller. These results are consistent with findings by Lashkaripour (2020).

5.4 Unpacking Global Impacts

Figure 1 shows the USTR tariff impacts by country: without retaliation (top panel), and with optimal retaliation by trading partners (bottom panel).

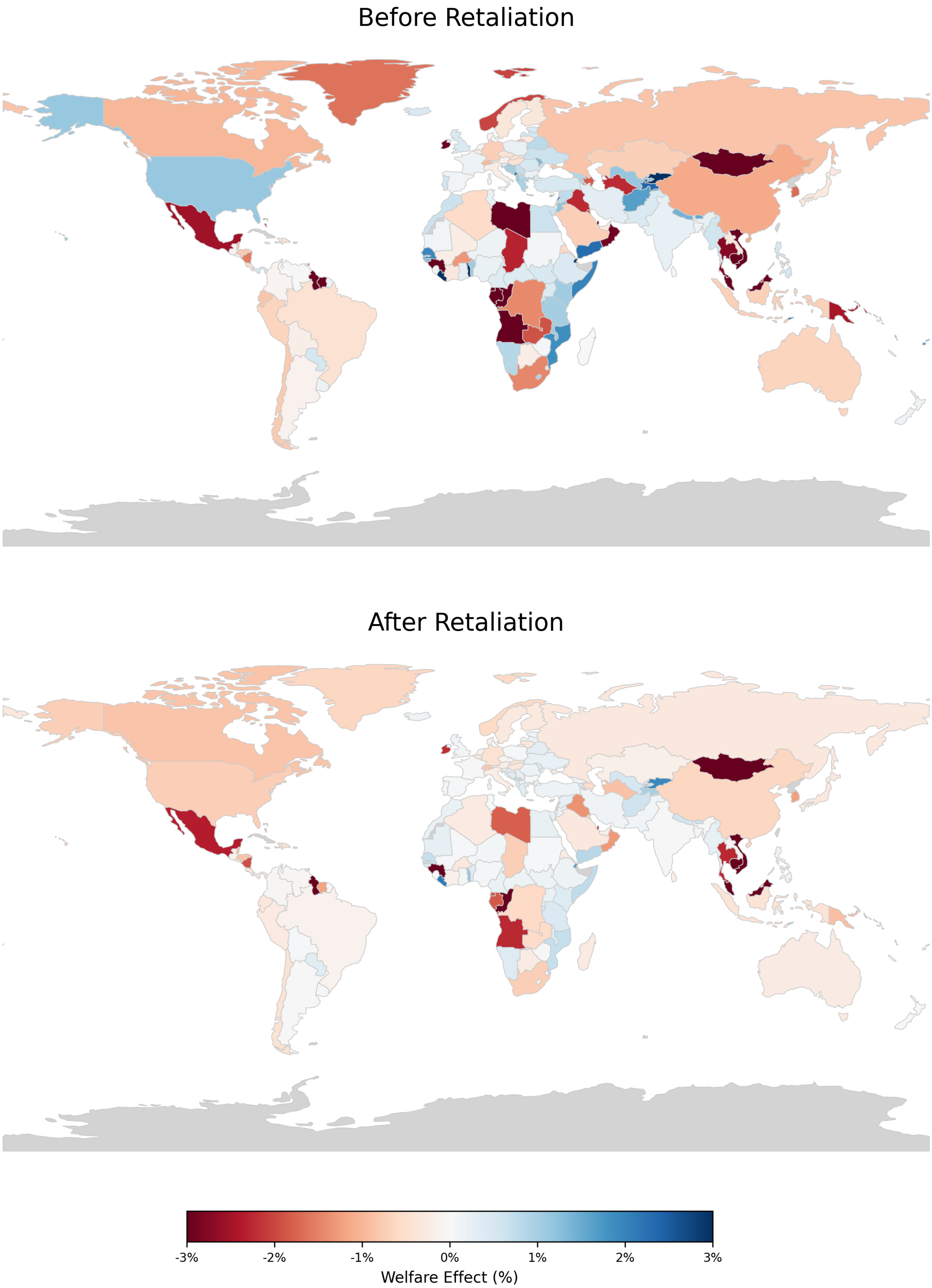
Smaller countries such as Mexico, Ireland, and several Southeast Asian nations, whose exports to the U.S. represent a significant share of their GDP, are the most adversely affected by the USTR tariffs. Some countries with limited trade ties to the U.S. benefit from these tariffs, primarily due to trade diversion and downward pressure on labor wages outside of the U.S. However, after retaliation, both the losses and gains become more muted, ultimately leaving the United States and most other countries worse off.[12]

5.5 Accounting for Input-Output Linkages

Table 4 shows the counterfactual results under input-output linkages, using the augmented single-sector model detailed in Appendix A.3 and multi-sector model outlined in A.4. The first panel shows that accounting for input-output effects greatly reduces the unilateral gains from the USTR-proposed tariffs before retaliation. This is because the USTR tariffs, which average around 25% (on a trade-weighted basis), greatly exceed the U.S. unilaterally optimal

[12]Some countries (e.g., Greece, Portugal) see lower welfare gains post-retaliation, as collective retaliation leads to trade diversion and wage suppression despite their optimal unilateral response.

Figure 1: The projected global welfare impacts of USTR tariffs



Notes: This map displays changes in welfare relative to pre-Liberation Day levels. In both scenarios, the U.S. implements the USTR tariffs. The "After Retaliation" scenario corresponds to optimal retaliatory tariffs by other countries.

rate of 12.5% that arises in the presence of input-output linkages. These elevated tariff levels lead to inefficient trade contractions, with the associated costs amplified through input-output linkages.

Table 4: Tariff Impacts under Input-Output Linkages

Pre-Retaliation Scenarios	Δ welfare	Δ deficit	$\Delta \frac{\text{exports}}{\text{GDP}}$	$\Delta \frac{\text{imports}}{\text{GDP}}$	Δ emp	Δ prices
(1) *USTR tariffs + one sector*						
USA	0.86%	-18.4%	-53.9%	-44.4%	0.24%	12.7%
non-US (average)	-1.31%	12.0%	-3.5%	-4.0%	-0.29%	-5.0%
(2) *Optimal tariff + one sector*						
USA	2.15%	-13.0%	-39.2%	-32.1%	0.65%	6.9%
non-US (average)	-0.87%	11.7%	-3.0%	-2.9%	-0.22%	-2.9%
(3) *USTR tariffs + multiple sectors*						
USA	0.60%	-13.4%	-24.2%	-22.6%	0.01%	7.1%
non-US (average)	-1.38%	4.2%	-2.2%	-2.2%	-0.12%	-1.5%
Post-Retaliation Scenarios						
(1) *reciprocal retaliation + one sector*						
USA	-3.38%	-27.1%	-71.4%	-56.6%	-1.20%	9.3%
non-US (average)	-1.17%	20.1%	-6.5%	-6.3%	-0.32%	-2.0%
(2) *optimal retaliation + one sector*						
USA	-5.26%	-30.9%	-79.9%	-62.5%	-1.86%	7.5%
non-US (average)	-1.13%	24.2%	-7.7%	-7.0%	-0.34%	-0.5%
(3) *reciprocal retaliation + multiple sectors*						
USA	-1.02%	-21.3%	-32.6%	-30.1%	-0.55%	4.4%
non-US (average)	-0.71%	7.8%	-3.8%	-3.5%	-0.15%	0.1%

Notes: This table reports changes in economic variables (relative to pre-Liberation Day) under input-output linkages. The "non-US (average)" reflects GDP-weighted averages across non-U.S. countries. In all scenarios, tariff revenues are used to reduce income taxes. The change in "prices" represents the change in the country's CES price index P_i relative to the global GDP-weighted average price index.

The second panel shows that the gains from optimal tariffs remain similar to our baseline model, underscoring that the USTR tariffs deviate even more from optimal design once input-output linkages are considered. The reason why input-output connections have minimal impact on the gains from optimal tariffs can be intuitively explained. First, since imports contain domestic labor content, tariffs become a less effective tool for increasing the relative demand for domestic labor and raising local wages, which reduces the gains. Conversely, the same relative wage increase leads to larger welfare improvements when input-output effects are present. Ultimately, these two contrasting forces counterbalance each other, leaving the gains from optimal tariffs largely unaffected.

However, under input-output effects, the negative externalities of tariffs on trading partners and the welfare costs of retaliation are markedly magnified. The headline finding is that if trading partners retaliate reciprocally against USTR tariffs, it would diminish U.S. welfare by over 1% under all scenarios, while cutting the welfare losses for other countries by nearly one-half.[13] Due to the ensuing trade war, worldwide employment would shrink by up to 0.6%, as reported in Table 11 of the Appendix.

6 Conclusion

We provide an initial assessment of the long-term effects of the Liberation Day tariffs on the U.S. and its trading partners. While these tariffs temporarily improve the U.S.'s terms of trade and reduce its trade deficit, any welfare gains are offset by losses if trading partners retaliate. Even without retaliation, U.S. welfare gains are limited due to the tariffs' flawed design, while trading partners face significant negative impacts. In the end, the U.S. may modestly decrease its trade deficit following the tariff war, but only at a high economic cost to itself and its partners.

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[13]The multi-sector model predicts smaller U.S. losses from retaliation compared to the single-sector model, possibly because it exempts services–an important component of U.S. exports–from retaliatory tariffs. However, differences in underlying data and parameters complicate direct comparisons between models.

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Appendix

A Micro-Foundation

This appendix provides the micro-foundation for our model. We begin by constructing consumption indices. Varieties originating from each source n are aggregated using a Constant Elasticity of Substitution (CES) function with elasticity σ_i to form a bilateral consumption composite C_{ni}. These bilateral composites are then aggregated by another CES function with elasticity $\eta_i > 1$ to yield the overall consumption utility C_i. We assume that the difference between the cross-national and within-national elasticities is constant, so that $\frac{1}{\eta_i - 1} = \frac{1}{\sigma_i - 1} + \varsigma$, with $\varsigma \geq 0$. This assumption is without much loss of generality, but allows us to get more compact expressions for equilibrium variables. Notice that in the traditional non-nested Melitz framework, $\varsigma = 0$, by assumption, which is a special case of the restriction we are imposing.

To make the notation concise, define $\tau_{ni} \equiv 1 + t_{ni}$, where t_{ni} is the tariff rate imposed by country i on goods from n.Under monopolistic competition, firms maximize profits by setting destination-specific prices with a markup over marginal cost.[14] In particular, the price charged by a firm with productivity ϕ in market i is given by

$$p_{ni}(\phi) = \mu_i \frac{\tau_{ni} \tilde{d}_{ni} w_n}{\phi}, \qquad \text{with} \qquad \mu_i \equiv \frac{\sigma_i}{\sigma_i - 1}.$$

where $\tilde{d}_{ij}$ represents iceberg trade costs from n to i and w_n is the wage in country n. The zero-profit condition requires that

$$\pi_{ni}(\phi) = \frac{1}{\sigma_i} \frac{1}{\tau_{ni}} p_{ni}(\phi) c_{ni}(\phi) - w_i f_{ni} = 0.$$

[14]In our model, mark-ups are destination-specific but invariant across firms from a given source to a given destination. Destination-specific mark-ups that also vary in firm characteristics would arise in a model with Kimball (1995) preferences, homothetic translog preferences as in Bergin and Feenstra (2009) and Feenstra and Weinstein (2017), homothetic preferences that satisfy the quadratic mean of order r (QMOR) expenditure function as in Feenstra (2018), and homothetic preferences beyond CES outlined in Matsuyama and Ushchev (2017). Alternatively, one can specify non-homothetic preferences (see ex. Melitz and Ottaviano (2008), Sauré (2012), Zhelobodko et al. (2012), Behrens and Murata (2012), Behrens et al. (2014), Simonovska (2015), Bertoletti et al. (2018), Jung et al. (2019), Dhingra and Morrow (2019), and Macedoni and Weinberger (2025) among others). Since we focus on aggregate, rather than firm-level, predictions in this model, we opt for the simplest possible variable-mark-up specification.

where $c_{ni}(\phi)$ is the quantity sold by a firm with productivity ϕ in market i and f_{ni} denotes the fixed cost of exporting from n to i, expressed in destination labor units. This condition implies a cutoff productivity level given by

$$\phi_{ni} = \mu_i \, \tau_{ni}^{\frac{\sigma_j}{\sigma_i - 1}} \, \frac{\tilde{d}_{ni} w_n}{P_{ni}} \left(\frac{X_{ni}}{\sigma_i w_i f_{ni}} \right)^{-\frac{1}{\sigma_i - 1}} . \tag{10}$$

where X_{ni} are the value of exports from n to i. P_{ni} is the price index defined as

$$P_{ni} = \left[\int_{\phi_{ni}}^{\infty} p_{ni}(\phi)^{1-\sigma_i} \, dG_n(\phi) \right]^{\frac{1}{1-\sigma_i}},$$

and $G_n(\phi)$ is the productivity distribution. Assume now that $G_n(\phi)$ takes the following Pareto form

$$G_n(\phi) = 1 - \left(\frac{b_n}{\phi} \right)^{\theta}.$$

where b_n is the shift parameter and θ is the shape parameter. After plugging firm-level prices into the definition of P_{ni} and integrating, the price index can be expressed as

$$P_{ni} = \mu_i \, \left(\frac{\theta - (\sigma_i - 1)}{\theta} \right)^{\frac{1}{\sigma_i - 1}} \, \tau_{ni} \tilde{d}_{ni} w_n \, b_n^{-\frac{\theta}{\sigma_i - 1}} \, [M_n^e]^{\frac{-1}{\sigma_i - 1}} \, \phi_{ni}^{\frac{\theta - (\sigma_i - 1)}{\sigma_i - 1}}, \tag{11}$$

where M_n^e is the mass of entrants in country n. Substituting this expression into the cutoff condition (Equation 10) and solving for ϕ_{ij} yields

$$\left(\frac{\phi_{ni}}{b_n} \right)^{-\theta} = \frac{\theta - (\sigma_i - 1)}{\theta \sigma_i} \, \frac{1}{M_n^e} \, \frac{X_{ni}/\tau_{ni}}{w_i f_{ni}}.$$

The mass of firms from country n serving destination i is obtained by

$$M_{ni} = [1 - G_n(\phi_{ni})] M_n^e = \left(\frac{\phi_{ni}}{b_n} \right)^{-\theta} M_n^e = \frac{\theta - (\sigma_i - 1)}{\theta \sigma_i} \, \frac{X_{ni}/\tau_{ni}}{w_n f_{ni}}.$$

Total profit margins in market i from origin n are given by

$$\frac{X_{ni}}{\sigma_i \tau_{ni}} - w_i f_{ni} M_{ni} = \frac{\sigma_i - 1}{\theta \sigma_i} \, \frac{X_{ni}}{\tau_{ni}}.$$

The free entry condition equates the cost of entry with the net profits across all destinations.

That is,

$$M_n^e f_n^e = \sum_i \frac{\sigma_i - 1}{\theta\sigma_i}\frac{X_{ni}/\tau_{ni}}{w_n} = \sum_i (1-\nu_i)\frac{X_{ni}}{\tau_{ni}},$$

with the destination-absorbed profit margin defined as

$$\nu_i \equiv \frac{\theta - (\sigma_i - 1)}{\theta\sigma_i},$$

and with f_n^e denoting the fixed cost of entry. Thus, the free entry condition may be rewritten as

$$M_n^e = \sum_i [(1-\nu_i)\rho_{ni}]\frac{L_n}{f_n^e},$$

where $\rho_{ni} \equiv \frac{X_{ni}/\tau_{ni}}{w_n L_n}$ is the Domar weight of good (n,i) in country n's economy and L_n is the mass of workers in n. We further assume that there are congestion effects in the barriers to entry, such that the entry cost increases when the country collects more profits from imported content[15]: $f_n^e(\rho_n;\nu) = \theta\bar{f}^e[\sum_i(1-\nu_i)\rho_{ni}]^{-1}$. Under this assumption, the aggregate number of firms in country n is given by

$$M_n^e = \frac{L_n}{\theta\bar{f}^e}.$$

Let P_i denote the price index in i and E_i aggregate expenditures in i. Plugging Equation (10) into Equation (11), and invoking the CES import demand specification, $X_{ni} = (P_{ni}/P_i)^{1-\eta_n}E_n$, yields the following expression for the price index

$$P_{ni}^{1-\eta_i} = \Upsilon_i^{-\varepsilon}\left(\frac{P_i^{\eta_i-1}E_i}{w_i}\right)^{(\varphi_i-1)\varepsilon}\left(\frac{d_{ni}w_n}{A_n L_n^{\psi}}\right)^{-\varepsilon}(1+t_{ni})^{-\varphi_i\varepsilon},$$

where $\Upsilon_i \equiv \mu_i[\theta(\sigma_i-1)(\varphi_i-1)]^{\psi}(\sigma_i f_{ii})^{\varphi_i-1}$ is a constant price shifter, $A_n = b_n[f^e]^{-\psi}$ is variety-adjusted productivity, $d_{ni} \equiv (f_{ni}/f_{ii})^{\varphi_i-1}\tilde{d}_{ni}$ is the composite trade cost, and the structural elasticities are defined as

$$\varepsilon \equiv \frac{\theta}{1+\varsigma\theta}, \qquad \varphi_i \equiv \frac{\sigma_i}{\sigma_i-1} - \frac{1}{\theta}, \qquad \psi \equiv \frac{1}{\theta}.$$

[15]This assumption is made for tractability and ensures that the mass of entrants is proportional to the size of the labor force, as is standard in models with Pareto-distributed firm heterogeneity. This simplification has negligible quantitative impact in our setting: the parameter ν takes only two values (U.S. vs. non-U.S.) in the calibration, and because U.S. import penetration is modest, changes in expenditure shares have only a limited effect on the average $1-\nu$ that determines entry.

Combining this result with the CES import demand function gives

$$\lambda_{ni} = \left(\frac{P_{ni}}{P_i}\right)^{1-\eta_i} = \frac{(1+t_{ni})^{-\varphi_i\varepsilon}\left(d_{ni}w_n/A_nL_n^{\psi}\right)^{-\varepsilon}}{\sum_j (1+t_{ji})^{-\varphi_i\varepsilon}\left(d_{ji}w_j/A_jL_j^{\psi}\right)^{-\varepsilon}}.$$

Substituting the expression for $P_{ni}^{1-\eta_i}$ into $P_i^{1-\eta_i} = \sum_j P_{ji}^{1-\eta_i}$ and solving for P_i, we get the following expression for the consumer price index:

$$P_i = \Upsilon_i \left[\frac{E_i}{w_i}\right]^{1-\varphi_i}\left[\sum_j \left(\frac{d_{ji}}{A_jL_j^{\psi}}\right)^{-\varepsilon}(1+t_{ji})^{-\varphi_i\cdot\varepsilon}\,w_j^{-\varepsilon}\right]^{-\frac{1}{\varepsilon}}.$$

A.1 More general pass-through specification

In the baseline model, the pass-through of tariffs to firm-level prices is complete. However, the aggregate tariff pass-through deviates from unity, as tariffs affect the price index through extensive margin adjustments or firm-selection effects. To see this, note that the price of a firm variety ω is determined by firm productivity ϕ. Specifically, we have: $p_{ni}(\phi) = \mu_i \frac{\tau_{ni}\tilde{d}_{ni}w_n}{\phi}$, where $\tau_{ni} \equiv 1 + t_{ni}$ denotes the tariff in a compact form. Under this specification, the pass-through at the firm level is complete—i.e., $\frac{\partial \ln p_{ni}(\omega)}{\partial \ln \tau_{ni}} = 1$.

We can, however, generalize the model to allow for incomplete pass-through at the firm level. In this more flexible framework, prices are given by:

$$p_{ni}(\phi) = \mu_i \frac{(\tau_{ni}\tilde{d}_{ni})^{\tilde{\varphi}_i}w_n}{\phi},$$

where the exponent $\tilde{\varphi}_i$ serves as a reduced-form parameter that captures curvature in the cost function, arising from the presence of quasi-fixed inputs. The key idea is that firms utilize destination-specific factors in production, leading to a non-finite elasticity of transformation between varieties sold in different markets, in the spirit of Baier and Bergstrand (2001). A higher tariff exerts downward pressure on the price of (quasi-fixed) specific factors, and this specification provides a tractable reduced-form representation of these effects.[16] In this generalized setting, the equilibrium has the same macro-level representation,

[16]Incomplete pass-through at the firm-level can also be explained by additive local distribution costs (Burstein et al., 2003; Corsetti and Dedola, 2005; Nakamura and Zerom, 2010). Such costs result in heterogeneous pass-through rates across firms that differ in their productivity (as in Berman et al. (2012)). To focus on the aggregate rather than firm-level implications of the incomplete pass-through, we assume it is driven by quasi-fixed inputs, which imply an incomplete pass-through that is common across firms.

with a revised pass-through formulation:

$$\varphi_i = \tilde{\varphi}_i + \frac{1}{\sigma_i - 1} + \frac{1}{\theta}$$

and an aggregate price index given by $P_i = \Upsilon_j \left[\frac{E_i}{w_i}\right]^{\varphi_i - \tilde{\varphi}_i} \left[\sum_j \left(\frac{d_{ji}}{A_j L_j^{\psi}}\right)^{-\varepsilon} (1 + t_{ji})^{-\varphi_i \cdot \varepsilon} w_j^{-\varepsilon}\right]^{-\frac{1}{\varepsilon}}$, where the bilateral non-tariff barriers are now given by $d_{ji} \equiv (f_{ji}/f_{ii})^{\varphi_i - \tilde{\varphi}_i} \tilde{d}_{ji}^{\tilde{\varphi}_i}$.

A.2 Alternative Micro-foundations

Our preferred microfoundation, detailed above, allows for tariff pass-through to the price index to deviate from unity and allows trade imbalances to respond endogenously to tariff changes. Nonetheless, our framework is sufficiently flexible to encompass a broad class of microfoundations commonly used in the trade literature. Specifically, it nests the following canonical models:

1. Eaton-Kortum model with external economies of scale: In this case, ε denotes the shape parameter of the Fréchet distribution in the Eaton-Kortum framework, while ψ captures the scale elasticity driven by Marshallian externalities. The tariff pass-through to the price index is one ($\varphi_i = 1$), and trade imbalances are driven entirely by fixed transfers determined outside of the model, since $\nu_i = 0$ for all i.

2. The Krugman model: in this interpretation, ε represents the cross-national elasticity of substitution, and ψ reflects the degree of love for variety. As with the previous case, the tariff pass-through to the price index is one ($\varphi_i = 1$), and trade imbalances are driven entirely by fixed transfers determined outside of the model, as $\nu_i = 0$ for all i.

The key advantage of our Melitz-Pareto microfoundation is that it generates trade imbalances endogenously, allowing those imbalances to adjust in response to tariff changes. In contrast, the other microfoundations do not admit trade imbalances and allot the entire imbalance to fixed factors outside of the model. Hence, performing counterfactual analyses under those models necessitates additional assumptions regarding the scaling of fixed transfers, which we examine in Appendix H.

A.3 Input-Output Linkages

We introduce input-output linkages by assuming a round-about production structure, which employs labor and a composite input bundle with the same aggregation and price index as the final good. Hence, the price of the goods supplied by a firm with productivity ϕ in location n selling to destination i is given by

$$p_{ni}(\phi) = \mu_i \frac{\tau_{ni}\,\tilde{d}_{ni}}{\phi} w_n^{\beta} P_n^{1-\beta}$$

where β is the share of labor. Assuming that fixed overhead costs are paid in terms of only labor in the destination country, we can follow the same steps as in the main model to obtain the following expression for the price index of exported varieties from location n to destination i:

$$P_{ni} = \frac{\mu_i}{b_n} \left(\frac{\theta - (\sigma_i - 1)}{\theta} \right)^{\psi} \left(\frac{1}{\sigma_i} \right)^{1-\varphi_i} \tilde{d}_{ni} f_{ni}^{(\varphi_i - 1)} \tau_{ni}^{\varphi_i} w_n^{\beta} P_n^{1-\beta} \left(\frac{X_{ni}}{w_i} \right)^{1-\varphi_i} [M_n^e]^{\psi}.$$

We can deduce from the past derivation that a constant fraction ν_i of sales in country i is absorbed by the overhead costs paid in terms of labor in that country, which implies the free-entry condition:

$$M_n^e f_n^e w_n^{\beta} P_n^{1-\beta} = \sum_j \left[\nu_j \rho_{nj} \right] w_n L_n,$$

where $\rho_{nj} \equiv \frac{X_{nj}/\tau_{nj}}{w_n L_n}$ is the Domar weight. Assuming the same congestion effect in entry as before, the above condition yields:

$$M_n^e = \left(\frac{w_n}{P_n} \right)^{1-\beta} \frac{L_n}{\theta \bar{f}^e}.$$

Plugging the expression for M_i^e back into our earlier expression for the origin-specific price index, and leveraging the CES demand system, where $X_{ni} = (P_{ni}/P_i)^{1-\eta_i} E_i$ and $P_i^{1-\eta_i} = \sum_j P_{ji}^{1-\eta_i}$, we obtain the following expression for trade shares

$$\lambda_{ni} = \frac{(1+t_{ni})^{-\varphi_i \varepsilon} \left(d_{ni} w_n^{1-(1-\beta)(1+\psi)} P_n^{(1-\beta)(1+\psi)} / A_n L_n^{\psi} \right)^{-\varepsilon}}{\sum_j (1+t_{ji})^{-\varphi_i \varepsilon} \left(d_{ji} w_j^{1-(1-\beta)(1+\psi)} P_j^{(1-\beta)(1+\psi)} / A_j L_j^{\psi} \right)^{-\varepsilon}}$$

and the following expression for the aggregate price index in market i:

$$P_i = \Upsilon_i \left[\frac{E_i}{w_i} \right]^{1-\varphi_i} \left[\sum_j \left(\frac{d_{ji}}{A_j L_j^{\psi}} \right)^{-\varepsilon} (1+t_{ji})^{-\varphi_i \cdot \varepsilon} \left(w_j^{1-(1-\beta)(1+\psi)} P_j^{(1-\beta)(1+\psi)} \right)^{-\varepsilon} \right]^{-\frac{1}{\varepsilon}}.$$

The national-level budget constraint is now given by

$$E_i = w_i L_i + (1-\beta)\sum_n \frac{1-\nu_n}{1+t_{in}}\lambda_{in}E_n + R_i + \bar{T}_i,$$

where the second term on the right-hand side denotes total expenditure on intermediate inputs, which is a fraction $1-\beta$ of sales net of overhead, per cost minimization. The labor market clearing condition is

$$L_i^D = \frac{1}{w_i}\left[\beta\sum_n \frac{1-\nu_n}{1+t_{in}}\lambda_{in}E_n + \sum_n \frac{\nu_i}{1+t_{ni}}\lambda_{ni}E_i\right],$$

where the first term on the right-hand side represents labor demand for production and entry, with the second term representing labor demand for overhead cost payments.

A.4 Multiple Sectors

We further extend our baseline model to incorporate multiple sectors, where the economy consists of sectors indexed by $k = 1, \ldots, K$ sectors. Preferences across sectors are represented by a Cobb-Douglas utility aggregator, with $e_{i,k}$ denoting the constant share of expenditure on sector k goods in country i. We present the multi-sector extension in two stages: first, the version without input-output (IO) linkages, followed by the version including IO linkages.

Multi-Sector Model without IO linkages. The trade shares in industry k are given by

$$\lambda_{ni,k} = \frac{\left(d_{ni,k}/(A_{n,k}L_{n,k}^{\psi})\right)^{-\varepsilon_k}(1+t_{ni,k})^{-\varphi_i\cdot\varepsilon_k}\,w_n^{-\varepsilon_k}}{\sum_j\left(d_{ji,k}/(A_{j,k}L_{j,k}^{\psi})\right)^{-\varepsilon_k}(1+t_{ji,k})^{-\varphi_i\cdot\varepsilon}\,w_j^{-\varepsilon_k}}$$

where ε_k is the sector-level trade elasticity. Total demand for country i's labor services sums over demand from all countries in all sectors:

$$L_i^D = \frac{1}{w_i}\left[\sum_n\sum_k \frac{1-\nu_n}{1+t_{in,k}}\lambda_{in,k}e_{n,k}E_n + \nu_i\sum_n\sum_k \frac{1}{1+t_{in,k}}\lambda_{ni,k}e_{i,k}E_i\right]$$

Labor supply is $L_i^S = \left(\frac{(1-\tau_i^L)w_i}{P_i}\right)^{\kappa}$, where the aggregate price index is

$$P_i = \Upsilon_i\left[\frac{E_i}{w_i}\right]^{1-\varphi_i}\prod_k\left[\sum_n\left(\frac{d_{ni,k}}{A_{n,k}L_{n,k}^{\psi}}\right)^{-\varepsilon_k}(1+t_{ni,k})^{-\varphi_i\cdot\varepsilon_k}\,w_n^{-\varepsilon_k}\right]^{-\frac{e_{i,k}}{\varepsilon_k}}$$

The labor market clearing condition equates labor supply with demand across all sectors, $L_i^D = L_i^S$, and the balanced budget condition equates total expenditure with factor income, tariff revenues, and fixed transfers, $E_i = w_i L_i + R_i + \bar{T}_i$. Tariff revenues are the sum of revenues across all partners and sectors:

$$R_i = \sum_{n \neq i} \sum_k \frac{t_{ni,k}}{1 + t_{ni,k}} \lambda_{ni,k} e_{i,k} E_i.$$

Multi-Sector Model with IO linkages. Next, we present the multi-sector model with IO linkages. We assume that the value-added share β_k is sector-specific but common across countries. As before the trade elasticity is also sector-specific, but the scale elasticity is common across sectors and the tariff pass-through onto the price index is destination-specific but sector blind. Interpolating from the IO model in the single-sector case, the sector-level trade shares are

$$\lambda_{ni,k} = \frac{(1 + t_{ni,k})^{-\varphi_i \varepsilon_k} \left(d_{ni,k} w_i^{1-(1-\beta_k)(1+\psi)} P_n^{(1-\beta_k)(1+\psi)} / A_n L_n^{\psi} \right)^{-\varepsilon_k}}{\sum_j (1 + t_{ji,k})^{-\varphi_i \varepsilon_k} \left(d_{ji,k} w_j^{1-(1-\beta_k)(1+\psi)} P_j^{(1-\beta_k)(1+\psi)} / A_j L_j^{\psi} \right)^{-\varepsilon_k}}.$$

The aggregate price index in market i is given by:

$$P_i = \Upsilon_i \left[\frac{E_i}{w_i} \right]^{1-\varphi_i} \prod_k \left[\sum_n \left(\frac{d_{ni,k}}{A_{n,k} L_{n,k}^{\psi}} \right)^{-\varepsilon_k} (1 + t_{ni,k})^{-\varphi_i \cdot \varepsilon_k} \left(w_n^{1-(1-\beta_k)(1+\psi)} P_n^{(1-\beta_k)(1+\psi)} \right)^{-\varepsilon_k} \right]^{-\frac{e_{i,k}}{\varepsilon_k}}.$$

where $e_{i,k}$ denotes the expenditure share on industry k goods, which is the same share for consumption and intermediate expenditure, given our simple roundabout production framework.

The national-level budget constraint is now given by

$$E_i = w_i L_i + \sum_k \sum_n (1 - \beta_k) \frac{1 - \nu_n}{1 + t_{ni,k}} \lambda_{ni,k} e_{i,k} E_n + R_i + \bar{T}_i,$$

where the second term on the right-hand side denotes total expenditure on intermediate inputs, which is a fraction $1 - \beta_k$ of sales net of overhead in each sector per cost minimization. The labor market clearing condition is

$$L_i^D = \frac{1}{w_i} \left[\sum_k \sum_n \beta_k \frac{1 - \nu_n}{1 + t_{in,k}} \lambda_{in,k} e_{n,k} E_n + \sum_n \frac{\nu_i}{1 + t_{ni,k}} \lambda_{ni,k} e_{i,k} E_i \right],$$

where the first term on the right-hand side represents labor demand for production and entry, with the second term representing labor demand for overhead cost payments.

We do not provide a formal characterization of optimal tariffs under multiple sectors and IO linkages. We only compute the optimal tariffs in a single sector model with IO linkages and find that they are lower than in our baseline model. In the multi-sector case, optimal tariffs may display additionally cross-product heterogeneity. More specifically, optimal tariffs would likely discriminate across goods or sectors, depending on the domestic content of imported goods. Blanchard et al. (2016) demonstrate that such considerations lead to non-trivial variation in optimal tariffs across goods in a setting with sector-specific factors and upward-sloping supply curves. Closer to our framework, Lashkaripour and Lugovskyy (2023) show that trade taxes vary with the domestic content of taxed goods in a multi-sector quantitative trade model featuring IO linkages.

B National Budget and Deficit Accounting

This appendix formalizes the national accounting relationships and elucidates how trade imbalances can arise even when the national budget is balanced.

Definitions. Let X_{in} denote total sales by country i's firms to market n. Define the following aggregate variables:

- (tariff-adjusted sales) $X_i \equiv \sum_n \frac{1}{1+t_{in}} X_{in}$
- (expenditure) $E_i \equiv \sum_n X_{ni}$
- (factor income) $Y_i \equiv w_i L_i$

National-level budget constraint. Accounting for fixed transfers $\bar{T}_i$, country i's representative consumer's budget constraint is

$$E_i = Y_i + R_i + \bar{T}_i, \tag{12}$$

where $\sum_i \bar{T}_i = 0$ and the tariff revenues are $R_i = \sum_n \frac{t_{ni}}{1+t_{ni}} X_{ni}$, with $t_{ii} = 0$ by construction.

Allocating proceeds from sales to production factors. Next, we allocate the revenues from sales by country i's firms to factors employed at various stages. First, aggregate sales can be decomposed into variable profits plus production wage payments:

$$X_i = \Pi_i + w_i L_i^{(p)}, \tag{13}$$

where

- Π_i denotes variable profits which are a constant fraction of sales
- $L_i^{(p)}$ denotes the labor used for production.

Variable profits cover (1) the sunk entry cost paid in terms of domestic wages, and (2) fixed overhead costs paid in terms of the local wages in the market being served. Namely,

$$\Pi_i \; = \; w_i L_i^{(e)} \; + \; \sum_n w_n L_{ni}^{(f)}, \tag{14}$$

where:

- $L_i^{(e)}$ represents labor used for entry
- $L_{ni}^{(f)}$ is the labor employed in market n to cover the fixed cost in that market.

Because fixed costs constitute a constant fraction $\nu_n \in (0,1)$ of sales in destination n, we have

$$\sum_n w_n L_{ni}^{(f)} \; = \; \sum_n \nu_n X_{in}. \tag{15}$$

Factor Income ≠ Total Sales. Total factor income in country i is the sum of labor payments for production and entry activity by domestic firms plus fixed cost payments by foreign and domestic firms serving market i:

$$\begin{aligned} Y_i \equiv w_i L_i &= w_i \left(L_i^{(p)} + L_i^{(e)} \right) + w_i \sum_n L_{in}^{(f)} \\ &= \sum_n (1 - \nu_n) X_{in} \; + \; \nu_i \sum_n X_{ni}. \end{aligned} \tag{16}$$

One can immediately see that unless $\nu_i = \nu_n$ for all n, then sales are not equal to factor income (i.e., $Y_i \neq \sum_n X_{in}$). In fact, if $\bar{T}_i = 0$, it is straightforward to verify that

$$\begin{cases} \nu_i > \nu_n \; \forall n \neq i & \Longrightarrow \quad Y_i > X_i, \\ \nu_i < \nu_n \; \forall n \neq i & \Longrightarrow \quad Y_i < X_i. \end{cases} \tag{17}$$

Hence, even in the absence of explicit transfers, factor income can exceed, or fall short of, national sales due to cross-border fixed cost payments.

Endogenous Deficit. The fact that factor income can diverge from sales leads to trade deficits in equilibrium. To see this, combine Equation (12) (the budget constraint) with Equation (16) to obtain

$$\sum_n X_{ni} = \underbrace{\sum_n (1-\nu_n) X_{in} + \nu_i \sum_n X_{ni}}_{w_i L_i} + \sum_n \frac{t_{ni}}{1+t_{ni}} X_{ni} + \bar{T}_i.$$

Next, note that the trade deficit is the difference between net expenditure and sales:

$$D_i \equiv (E_i - R_i) - X_i = \sum_{n \neq i} \frac{1}{1+t_{ni}} X_{ni} - \frac{1}{1+t_{in}} X_{in}.$$

Appealing to this definition, we can combine and rearrange the above equations to specify the trade deficit as

$$D_i = \bar{T}_i + \sum_{n \neq i} \left[\frac{\nu_i}{1+t_{ni}} X_{ni} - \frac{\nu_n}{1+t_{in}} X_{in} \right].$$

The summation term in the above expression is endogenous. This term would collapse to zero if $\nu_i = \nu_n$ for all n, but is generally different from zero when the ν parameters are *not* internationally symmetric. Without fixed transfers ($\bar{T}_i = 0$), total expenditure net of tariffs equals factor income (i.e., $E_i - R_i = Y_i$), implying immediately per relationship (17) that

$$\begin{cases} \nu_i > \nu_n \ \forall n \neq i \implies D_i > 0, \\ \nu_i < \nu_n \ \forall n \neq i \implies D_i < 0. \end{cases} \tag{18}$$

It is important to note that while trade imbalances in our framework can arise endogenously from asymmetric fixed cost payments, these asymmetries explain only a fraction of the deficit in practice. We revisit the issue of measurement in Appendix F.

B.1 Deficit Adjustment in Response to Tariffs

Next, we elucidate how the deficit shrinks in response to tariffs. To this end, consider a setting where country i has a greater fixed cost margin, ν_i, than its partners. Moreover, suppose all of country i's partners have a common ν parameter, denoted by $\nu_{-i} < \nu_i$. Define country i's total imports adjusted for tariffs as

$$M_i \equiv \sum_{n \neq i} \frac{1}{1+t_{ni}} X_{ni}$$

and its total exports adjusted for tariffs as

$$M_{-i} \equiv \sum_{n \neq i} \frac{1}{1+t_{in}} X_{in}$$

Appealing to these definitions and our earlier expression for the deficit, country i's trade deficit can be represented as

$$D_i = \bar{T}_i + (\nu_i M_i - \nu_{-i} M_{-i})$$

Taking derivatives from the above equation *w.r.t.* a tariff instrument, t , yields

$$\frac{\partial D_i}{\partial(1+t)} = \nu_i \frac{\partial M_i}{\partial(1+t)} - \nu_{-i} \frac{\partial M_{-i}}{\partial(1+t)}$$

Note that the balanced budget condition, $(1-\nu_i)M_i = (1-\nu_{-i})M_{-i}$ requires that $\frac{\partial M_{-i}}{\partial(1+t)} = \frac{1-\nu_i}{1-\nu_{-i}} \frac{\partial M_i}{\partial(1+t)}$. Plugging this expression into the above equation delivers

$$\frac{\partial D_i}{\partial(1+t)} = \left[\nu_i - \frac{(1-\nu_i)}{(1-\nu_{-i})} \nu_{-i} \right] \frac{\partial M_i}{\partial(1+t)}$$

One can immediately check that, if $\nu_i > \nu_{-i}$, and tariffs shrink imports, $\frac{\partial M_i}{\partial(1+t)} < 0$, then they also shrink the deficit for country i: $\frac{\partial D_i}{\partial(1+t)} < 0$.

C Proof of Proposition 1

First, we prove that if trade is balanced and trade frictions are reciprocal, then trade is bilaterally balanced. For trade to be balanced, it must be the case that ν is common across destinations and $\bar{T}_i = 0$ for all i. Appealing to the separability of the gravity equation, we can specify trade flows as

$$X_{ni} = \Phi_n \Omega_i \delta_{ni},$$

where Φ_n and Ω_i are exporter and importer fixed effects using the language of the gravity literature:

$$\Phi_n \equiv \left(w_n / (A_n L_n^{\psi}) \right)^{-\varepsilon}, \qquad \Omega_i \equiv \frac{E_i}{\sum_j \left(d_{ji} / (A_j L_j^{-\psi}) \right)^{-\varepsilon} (1+t_{ji})^{-\varphi_i \cdot \varepsilon} w_j^{-\varepsilon}}$$

and $\delta_{ni} \equiv d_{ni}^{-\varepsilon}(1+t_{ni})^{-\varphi_i \cdot \varepsilon}$ is the bilateral friction, which satisfies $\delta_{ni} = \delta_{in}$ under reciprocal barriers. The labor market clearing constraint implies that

$$(1-\nu)\Phi_i \sum_n \Omega_n \delta_{ni} + \nu\Omega_i \sum_n \Phi_n \delta_{ni} = Y_i$$

and the budget constraint can be specified as

$$\Omega_i \sum_n \Phi_n \delta_{in} = Y_i,$$

which together imply the following system of equations

$$\begin{cases} \Phi_i \sum_n \Omega_n \delta_{in} = Y_i \quad (\forall i) \\ \Omega_i \sum_n \Phi_n \delta_{in} = Y_i \quad (\forall i), \end{cases}$$

where Y_i and δ_{in} are strictly positive. Define

$$x_i \equiv \frac{\Phi_i}{\Omega_i} = \frac{\sum_n \Phi_n \delta_{in}}{\sum_n \Omega_n \delta_{in}} = \frac{\sum_n x_n \Omega_n \delta_{in}}{\sum_n \Omega_n \delta_{in}} = \sum_n \omega_{in} x_n, \tag{19}$$

where $\omega_{in} \equiv \frac{\Omega_n \delta_{in}}{\sum_n \Omega_n \delta_{in}} \in (0,1)$ with $\sum_n \omega_{in} = 1$. Define the matrix, $W \equiv [w_{ij}]_{i,j}$. Since every entry of W is strictly positive and each row sums to 1, W is a positive stochastic matrix. In vector notation, equation (19) becomes

$$Wx = x.$$

Thus, x is an eigenvector of W corresponding to the eigenvalue 1. By the Perron-Frobenius theorem for positive (and irreducible) matrices, we know that (1) the spectral radius of W is 1, and this eigenvalue is simple, and (2) any positive eigenvector corresponding to the eigenvalue 1 is unique up to multiplication by a positive scalar. The constant vector $\mathbf{1}$ is a positive eigenvector corresponding to the eigenvalue 1. By the uniqueness stated in the Perron-Frobenius theorem, any positive solution to $Wx = x$ must be a scalar multiple of $\mathbf{1}$. It thus trivially follows that all entries x_i must be equal. That is, we have $\Omega_i = \Phi_i$ for all i, which in turn implies bilateral trade balance:

$$X_{ni} = \Phi_n \Omega_i \delta_{ni} = \Omega_n \Phi_i \delta_{in} = X_{in}.$$

Next, we must show that if the aggregate trade deficit is not zero and trade costs are not reciprocal, then trade is bilaterally imbalanced. The proof for this follows trivially from the adding up condition, $D_i = \sum_{n\neq i} D_{ni}$, which asserts that if $D_i \neq 0$, then it must be the case that $D_{ni} \neq 0$ for at least some $n \neq i$.

D Proof of Proposition 2

To make the notation concise, define $\tau_{ni} \equiv 1 + t_{ni}$. Appealing to the optimal labor supply decision, the representative utility can be formulated as

$$U_i = \frac{1}{1+\kappa}\left(\frac{w_i}{P_i}\right)^{1+\kappa} + \frac{T_i}{P_i},$$

where T_i denotes tariff revenues:

$$T_i = \sum_n (\tau_{ni} - 1) X_{ni},$$

and κ is the labor supply elasticity. We can write the first-order condition *w.r.t.* $\tau_{ni} \equiv 1 + t_{ni}$ as

$$\frac{dU_i}{d\ln\tau_{ni}} = \left[\frac{d\ln w_i}{d\ln\tau_{ni}} - \frac{d\ln P_i}{d\ln n}\right]\left(\frac{w_i}{P_i}\right)^{1+\kappa} + \frac{T_i}{P_i}\left(\frac{d\ln T_i}{d\ln\tau_{ni}} - \frac{d\ln P_i}{d\ln\tau_{ni}}\right),$$

where $\left(\frac{w_i}{P_i}\right)^{1+\kappa} = \frac{w_i L_i}{P_i}$. Following Lashkaripour and Lugovskyy (2023) and Farrokhi and Lashkaripour (2025), we assume that country i derives no first-order gains from distorting relative wages abroad. This holds trivially in two-country models, and it is also virtually satisfied in multi-country settings, since any single country has limited influence on foreign relative wages. Moreover, such wage changes typically result in factoral terms-of-trade transfers between two foreign countries, with negligible impact on the home country's welfare. We can now plug these values back into the first-order condition to obtain:

$$\frac{1}{P_i}\left(w_i L_i \frac{d\ln w_i}{d\ln\tau_{ni}} + \frac{dT_i}{d\ln\tau_{ni}} - E_i \frac{d\ln P_i}{d\ln\tau_{ni}}\right) = 0.$$

Next, we will write the price index as, $P_i = \Upsilon_i \left(\frac{E_i}{w_i}\right)^{1-\varphi_i} \tilde{P}_i$, where $\tilde{P}_i$ is the price index net of the extensive margin adjustment. Hence, we can write $\frac{d\ln P_i}{d\ln\tau_{ni}}$ as

$$\frac{d\ln P_i}{d\ln\tau_{ni}} = \frac{d\ln\tilde{P}_i}{d\ln\tau_{ni}} + (1-\varphi_i)\left[\frac{d\ln E_i}{d\ln\tau_{ni}} - \frac{d\ln w_i}{d\ln\tau_{ni}}\right],$$

where the price derivative can be decomposed as

$$\frac{d\ln\tilde{P}_i}{d\ln\tau_{ni}} = \frac{\partial\ln\tilde{P}_i}{\partial\ln\tau_{ni}} + \frac{\partial\ln\tilde{P}_i}{\partial\ln w_i}\frac{d\ln w_i}{d\ln\tau_{ni}}.$$

Taking derivatives from the price index equation yields:

$$\frac{\partial\ln\tilde{P}_i}{\partial\ln\tau_{ni}} = \lambda_{ni}\varphi_i, \qquad\qquad \frac{\partial\ln\tilde{P}_i}{\partial\ln w_i} = \lambda_{ii}.$$

Plugging the expression for $\frac{d\ln P_i}{d\ln\tau_{ni}}$ back into the first-order condition yields the updated first-order condition:

$$\frac{1}{P_i}\left((\varphi_i w_i L_i + (\varphi_i - 1)E_i)\frac{d\ln w_i}{d\ln\tau_{ni}} + \varphi_i\frac{\partial T_i}{\partial\ln\tau_{ni}} - E_i\frac{d\ln\tilde{P}_i}{d\ln\tau_{ni}}\right) = 0.$$

The derivative of tariff revenues can be unpacked as follows:

$$\frac{\partial T_i}{\partial\ln\tau_{ni}} = \tau_{ni}X_{ni}\varphi_i + \sum_j\left(\tau_{ji} - 1\right)\frac{dX_{ji}}{d\ln\tau_{ni}}.$$

The price derivative can also be unpacked using the intermediate derivative presented above:

$$E_i\frac{d\ln\tilde{P}_i}{d\ln\tau_{ni}} = \lambda_{ni}\varphi_i E_i + \lambda_{ii}E_i\frac{d\ln w_i}{d\ln\tau_{ni}} = \tau_{ni}X_{ni}\varphi_i + X_{ii}\frac{d\ln w_i}{d\ln\tau_{ni}}.$$

Putting it altogether, we get

$$\left(w_i L_i - X_{ii} - (\varphi_i - 1)\sum_l t_{li}X_{li}\right)\frac{d\ln w_i}{d\ln\tau_{ni}} + \varphi_i\sum_j t_{ji}\frac{dX_{ji}}{d\ln\tau_{ni}} = 0. \tag{20}$$

Next we must characterize the wage derivative, which can be done by appealing to the labor market clearing condition, $w_i L_i = \sum_j(1-\nu_j)X_{ij} + \sum_j \nu_i X_{ji}$, which can be written alternatively as

$$\sum_j(1-\nu_i)X_{ji} = \sum_j(1-\nu_j)X_{ij}.$$

Taking derivatives from the above equation yields

$$\left[\sum_{n\neq i}(1-\nu_n)X_{in}\frac{d\ln X_{in}}{d\ln w_i}\right]\frac{d\ln w_i}{d\ln\tau_{ni}} - \sum_{j\neq i}(1-\nu_i)\frac{dX_{ji}}{\partial\ln\tau_{ni}}. \tag{21}$$

Assuming that country i's tariffs do not change, relative wages among countries in the rest of the world, the derivative of export sales *w.r.t.* the country i's wage rate is

$$\frac{d\ln X_{in}}{d\ln w_i} = \frac{d\ln \lambda_{in}}{d\ln w_i} = \varepsilon\left(1-\lambda_{in}\right).$$

Plugging this expression back into Equation 21, yields the following

$$\left(w_iL_i - X_{ii}\right)\frac{d\ln w_i}{d\ln \tau_{ni}} = \frac{1}{\mathscr{E}_i}\sum_{j\neq i}\frac{dX_{ji}}{d\ln d_{ni}}, \qquad with \qquad \mathscr{E}_i \equiv \frac{\varepsilon}{1-\nu_i}\sum_{n\neq i}\left[\left(1-\nu_n\right)\left(1-\lambda_{in}\right)\frac{X_{in}}{\sum_{n\neq i}X_{in}+D_i}\right],$$

where the derivation uses $w_iL_i - X_{ii} = \sum_{j\neq i} X_{ij} + D_i = \sum_{j\neq i} X_{ji}$. Plugging the above equation back into the equation (20), we get the following first-order conditions

$$\frac{1}{\sum_{l\neq i}X_{li}}\left(\sum_{l\neq i}X_{li} - \left(\varphi_i - 1\right)\sum_{l} t_{li}X_{li}\right)\frac{1}{\mathscr{E}_i}\sum_{l\neq i}\frac{dX_{li}}{d\tau_{ni}} + \varphi_i\sum_{l\neq i} t_{li}\frac{dX_{li}}{d\tau_{ni}} = 0.$$

The above equation immediately implies that the solution to the above system is a uniform tariff $t_{ni} = t_i$, which after defining total imports as $X_{-ii} = \sum_{l\neq i} X_{li}$, allows us to simplify the first-order condition to

$$\frac{1}{X_{-ii}}\left(X_{-ii} - (\varphi_i - 1)t_iX_{-ii}\right)\frac{1}{\mathscr{E}_i}\frac{dX_{-ii}}{d\tau_{ni}} + \varphi_i t_i\frac{dX_{-ii}}{d\tau_{ni}} = 0,$$

which, after rearranging, yields the following optimal tariff formula

$$t^*_{ni} = t^*_i = \frac{1}{\left(1+\mathscr{E}_i\right)\varphi_i - 1}.$$

E Exact Hat Algebra

Using exact hat algebra, we derive the change in trade shares as

$$\hat{\lambda}_{ni} = \frac{\hat{L}_n^{-\psi\varepsilon}\left(1+t_{ni}\right)^{-\varphi_i\cdot\varepsilon}\hat{w}_n^{-\varepsilon}}{\sum_j \lambda_{ji}\hat{L}_j^{-\psi\varepsilon}\left(1+t_{ji}\right)^{-\varphi_i\cdot\varepsilon}\hat{w}_j^{-\varepsilon}}. \tag{22}$$

The labor market clearing condition in changes can be expressed as

$$\hat{w}_i\hat{L}_iw_iL_i = \sum_j \frac{1-\nu_j}{1+t_{ij}}\hat{\lambda}_{ij}\lambda_{ij}\hat{E}_jE_j + \sum_j \frac{\nu_i}{1+t_{ji}}\hat{\lambda}_{ji}\lambda_{ji}\hat{E}_iE_i, \tag{23}$$

where the change in labor supply is

$$\hat{L}_i = \left[\widehat{(1-\tau_i^L)} \frac{\hat{w}_i}{\hat{P}_i} \right]^{\kappa},$$

and the resulting change in the consumer price index is given by

$$\hat{P}_i = \left[\frac{\hat{E}_i}{\hat{w}_i} \right]^{\varphi_i - 1} \left[\sum_j \lambda_{ji} \, \hat{L}_j^{\psi\varepsilon} \, (1+t_{ji})^{-\varphi_i \cdot \varepsilon} \, \hat{w}_j^{-\varepsilon} \right]. \tag{24}$$

Lastly, the balanced budget condition for each country can be specified as

$$\hat{E}_i E_i = \hat{w}_i \hat{L}_i Y_i + \bar{T}_i' + \underbrace{\sum_{j \neq i} \frac{t_{ji}}{1+t_{ji}} \hat{\lambda}_{ji} \lambda_{ji} \hat{E}_i E_i}_{R_i'}, \tag{25}$$

where $Y_i = w_i L_i$. Following Dekle et al. (2007), we assume that fixed transfers are proportional to global GDP, $Y = \sum_n Y_n$, so that $\bar{T}_i' = \bar{T}_i \times \hat{Y}, Y$. Our baseline treatment of tariff rebates takes the optimistic approach that tariff revenues fully substitute for income tax revenues. Specifically, $\tau_i^L Y_i = R_i'$, which implies a reduction in the income tax specified by $\widehat{(1-\tau_i^L)} = 1/(1 - R_i'/Y_i)$.[17]

The system specified by Equations 22–25 solves for the two independent unknowns $\{\hat{w}_i\}_i$ and $\{\hat{E}_i\}_i$, from which we can calculate the policy impacts:

- change in welfare is $\hat{U}_i = \delta_i \frac{\hat{E}_i}{\hat{P}_i} + (1-\delta_i)\frac{\hat{w}_i}{\hat{P}_i}$, where $\delta_i \equiv \frac{E_i}{E_i - \frac{\kappa}{1+\kappa}(1-\delta_i) Y_i}$
- change in gross exports is $\frac{\sum_{n \neq i} \hat{\lambda}_{in} \lambda_{in} \hat{E}_n E_n}{\sum_n \lambda_{in} E_n}$
- change in gross imports is $\frac{\sum_{n \neq i} \hat{\lambda}_{ni} \lambda_{ni} \hat{E}_i E_i}{\sum_{n \neq i} \lambda_{ni} E_i}$
- change in deficit is $\hat{D}_i = D_i'/D_i$, where $D_i' = \sum_{n \neq i} \left[\frac{1}{1+t_{ni}} \hat{\lambda}_{ni} \lambda_{ni} \hat{E}_i E_i - \frac{1}{1+t_{in}} \hat{\lambda}_{in} \lambda_{in} \hat{E}_n E_n \right]$
- change in employment is $\hat{L}_i$
- change in real consumer prices is $\hat{P}_i$.

[17] Income tax revenues finance public expenditure. More formally, we can decompose total expenditure as

$$E_i = \underbrace{\bar{T}_i + (1-\tau_i^L) w_i L_i}_{\text{private}} + \underbrace{\tau_i^L w_i L_i + R_i}_{\text{public}},$$

where the public component is the sum of income tax and tariff revenues. We assume that higher tariff revenues allow for lower income taxes, holding total public spending constant.

F Data and Calibration

F.1 Single-sector analysis

F.1.1 Data

GDP data (current USD) are sourced from the World Bank's World Development Indicators (WDI), using figures for the year 2023 or the latest available year. Bilateral trade data are obtained from the 2023 BACI dataset provided by CEPII (Gaulier and Zignago, 2010), covering goods trade exclusively and excluding services.

The final merged dataset comprises bilateral trade flows among 194 countries, representing 96.5% of global trade. This includes all 169 countries initially listed in the Liberation Day tariffs, except for four territories (Cook Islands, Saint Pierre and Miquelon, Wallis and Futuna, and Taiwan), which lack GDP or trade data. Additionally, the dataset includes 27 European Union countries, Russia, and the United States, resulting in a total of 194 countries (169 original countries minus 4 exclusions, plus 27 EU countries and 2 additional countries). Table 5 provides the list of countries.

To align GDP data with the aggregation scheme used by CEPII, several country aggregates were implemented:

1. Monaco was combined with France;

2. Liechtenstein was combined with Switzerland;

3. U.S. territories, specifically Puerto Rico and the U.S. Virgin Islands, were combined with the United States.

We treat EU member states as independent tariff setters. While this may understate the EU's collective market power and the cost of U.S. retaliation (Lashkaripour, 2021), full coordination would require strong intra-EU transfer mechanisms, which are unlikely in practice. Modeling countries separately also allows us to measure each member's individual exposure to U.S. tariffs. Given these trade-offs, we assign tariff autonomy to EU members, acknowledging the limitations.

F.1.2 The Elasticity of Trade in a Single-Sector Model

To calibrate the key trade elasticity parameter, ε, we draw on estimates for the Melitz-Pareto model reported by Simonovska and Waugh (2014b). We demonstrate below that our model generates nearly identical estimating equations to the Melitz-Pareto model, and we discuss possible differences that may arise in parameter estimates.

Table 5: List of Countries

Afghanistan	Denmark	Laos	Rwanda
Albania	Djibouti	Latvia	Saudi Arabia
Algeria	Dominica	Lebanon	Senegal
Angola	Dominican Republic	Lesotho	Serbia
Antigua and Barbuda	East Timor	Liberia	Seychelles
Argentina	Ecuador	Libya	Sierra Leone
Armenia	Egypt	Lithuania	Singapore
Aruba	El Salvador	Luxembourg	Sint Maarten
Australia	Equatorial Guinea	Macau	Slovak Republic
Austria	Eritrea	Madagascar	Slovenia
Azerbaijan	Estonia	Malawi	Solomon Islands
Bahamas	Eswatini	Malaysia	Somalia
Bahrain	Ethiopia	Maldives	South Africa
Bangladesh	Fiji	Mali	South Korea
Barbados	Finland	Malta	South Sudan
Belarus	France	Marshall Islands	Spain
Belgium	French Polynesia	Mauritania	Sri Lanka
Belize	Gabon	Mauritius	St Kitts and Nevis
Benin	Gambia	Mexico	St Lucia
Bermuda	Georgia	Micronesia	St Vincent and the Grenadines
Bhutan	Germany	Moldova	Sudan
Bolivia	Ghana	Mongolia	Suriname
Bosnia and Herzegovina	Greece	Montenegro	Sweden
Botswana	Greenland	Morocco	Switzerland
Brazil	Grenada	Mozambique	Syria
Brunei	Guatemala	Namibia	Tajikistan
Bulgaria	Guinea	Nepal	Tanzania
Burkina Faso	Guinea-Bissau	Netherlands	Thailand
Burma	Guyana	New Caledonia	Togo
Burundi	Haiti	New Zealand	Tonga
Cabo Verde	Honduras	Nicaragua	Trinidad and Tobago
Cambodia	Hong Kong	Niger	Tunisia
Cameroon	Hungary	Nigeria	Turkey
Canada	Iceland	North Macedonia	Turkmenistan
Cayman Islands	India	Norway	Turks and Caicos Islands
Central African Republic	Indonesia	Oman	Uganda
Chad	Iran	Pakistan	Ukraine
Chile	Iraq	Palau	United Arab Emirates
China	Ireland	Panama	United Kingdom
Colombia	Israel	Papua New Guinea	United States
Comoros	Italy	Paraguay	Uruguay
Congo (Brazzaville)	Jamaica	Peru	Uzbekistan
Congo (Kinshasa)	Japan	Philippines	Vanuatu
Costa Rica	Jordan	Poland	Venezuela
Cote d'Ivoire	Kazakhstan	Portugal	Vietnam
Croatia	Kenya	Qatar	Zambia
Curacao	Kiribati	Republic of Yemen	Zimbabwe
Cyprus	Kuwait	Romania	
Czechia	Kyrgyzstan	Russian Federation	

Notes: This table reports countries included in the baseline counterfactual analysis.

Simonovska and Waugh (2014b) build on the methodology developed by Simonovska and Waugh (2014a) for the Eaton-Kortum model and they estimate the trade elasticity for several canonical models used by the trade literature, including the Melitz-Pareto model. The methodology relies on inferring bilateral trade costs from moments derived from the distribution of observed price gaps for identical goods across countries, combined with a standard gravity equation of trade, which relates bilateral trade shares to bilateral trade costs and country-specific objects that summarize technological parameters, wages, mark-ups, and fixed costs of production.

Specifically, Simonovska and Waugh (2014b) estimate the following expression:

$$\log\left(\frac{\lambda_{ni}}{\lambda_{nn}}\right) = -\varepsilon \log \tilde{d}_{ni} + FE_i - FE_n, \tag{26}$$

where λ_{ni} represents the bilateral trade share as in the present paper, ε is the key elasticity of interest, and FE_n (FE_i) represents a fixed effect for country n (i). Furthermore, $\tilde{d}_{ni}$, which corresponds to the bilateral iceberg trade cost in the model, is recovered from moments from the distribution of relative prices of identical goods between countries n and i, and uses the micro-structure of the model to generate these moments for each particular framework.

To see how our model maps into this framework, assume the following functional form for fixed entry costs: $f_{ni} = F \cdot f_{ii}$, where $F \geq 1$. Hence, we impose that market access costs are destination-specific but not source-country specific.[18] To derive the estimating equation, combine equations (1) and (4), which yield the following expression for $\log\left(\frac{\lambda_{ni}}{\lambda_{ni}}\right)$,

$$\log\left(\frac{\lambda_{ni}}{\lambda_{nn}}\right) = -\varepsilon \varphi_i \log(1 + t_{ni}) - \varepsilon \log \tilde{d}_{ni} + FE_i - FE_n, \tag{27}$$

where

$$\begin{aligned} FE_i &\equiv \varepsilon \log P_i - \varepsilon \log \Upsilon_i - \varepsilon(\varphi_i - 1)\log(E_i/w_i) - \varepsilon(\varphi_i - 1)\log F, \\ FE_n &\equiv \varepsilon \log P_n - \varepsilon \log \Upsilon_n - \varepsilon(\varphi_n - 1)\log(E_n/w_n). \end{aligned} \tag{28}$$

It is very easy to demonstrate that a similar argument applies to the variant of our model that includes a more general pass-through specification as well as input-output linkages.

Furthermore, for ease of exposition, applying the exactly-identified estimation method-

[18]Since we do not examine the extensive margin predictions of this model and we focus on aggregate outcomes alone, we believe that this assumption is not very limiting to the analysis. Moreover, the goal of this section is to derive a mapping between our model and models in the existing literature for the purpose of justifying our choice of the trade elasticity. We report robustness exercises that vary the trade elasticity parameter in Appendix H.

ology of Simonovska and Waugh (2014b) to estimate $\log \tilde{d}_{ni}$, the expression becomes

$$\log \hat{d}_{ni} \equiv \max_{l}(\log p_i(l) - \log p_n(l)) = \log(\mu_i) - \log(\mu_n) + \log(1 + t_{ni}) + \log \tilde{d}_{ni} \tag{29}$$

A few observations are in order. First, notice that the log mark-up terms can be absorbed by the fixed effects, so they do not bias the estimation.[19] Second, logged tariffs, t_{ni}, affect both the estimate of $\log \tilde{d}_{ni}$ and also appear in the estimating equation (27). This is the key difference between the estimating equation predicted by our model versus the simple Melitz-Pareto model estimated in Simonovska and Waugh (2014b), which does not explicitly account for tariffs. The variable $\log(1 + t_{ni})$ can be interpreted as measurement error in the estimation procedure. Simonovska and Waugh (2014a) and Simonovska and Waugh (2014b) perform several robustness exercises that demonstrate that the measurement error in the relative price moment is small, as trade costs estimated from relative prices yield elasticities with respect to standard gravity variables (border and distance) that are very much in line with the existing literature. Finally, the first term in expression (27) does not affect the estimates of ε. Simonovska and Waugh (2014b) show that, when both tariff and relative-price moments are used to estimate the trade elasticity from bilateral trade flows, the elasticity estimates are identical to the ones obtained using the relative-price moments alone.

The above discussion suggests that the elasticity estimates for the Melitz-Pareto model from Simonovska and Waugh (2014b) are applicable to our model. Since the parameter estimate of 4 falls within the range of estimates that Simonovska and Waugh (2014b) obtain for the Melitz-Pareto model, and since this estimate was used by the USTR to compute the "reciprocal tariffs", we opt for this parameter value in our benchmark exercise.

F.2 Multi-Sector Analysis

F.2.1 Data

We use the International Trade and Production Database for Simulation (ITPD-S) as our primary source of bilateral trade flows by sector (Borchert et al., 2024). This database provides harmonized data on international and domestic trade across 170 industries in 265 countries, covering the period from 1986 to 2019. Most observations are based on administrative records, while the remainder are estimated using the methodology described in the technical documentation.

[19]The argument holds true for any other moment from the logged relative price distribution as mark-ups are not firm specific in this model and are multiplicative of variable costs.

To improve tractability and reduce the incidence of missing data, we aggregate the detailed sectors into four broad categories: Agriculture, Manufacturing, Mining, and Services. For our counterfactuals, we use the sector-specific trade shares computed for the year 2019.

Sector-level value-added shares are drawn from the OECD Inter-Country Input-Output (ICIO) database for the year 2019. These shares are calculated as output-weighted averages across countries. The resulting value-added shares in gross output are 0.51 for agriculture, 0.32 for manufacturing, 0.49 for mining, and 0.56 for services.[20]

Due to data limitations, 13 countries are excluded from the analysis because of missing trade or production data in at least one of these four sectors. These are: Aruba, Comoros, Curacao, Djibouti, Greenland, Kiribati, Marshall Islands, Micronesia, Palau, Solomon Islands, Somalia, Sint Maarten, and Turks and Caicos Islands.

F.2.2 The Sectoral Elasticities of Trade in a Multi-Sector Model

The simulation requires estimates of sector-specific trade elasticities. Following Fontagné et al. (2022), we estimate trade elasticities for agriculture, manufacturing, and mining. This approach involves estimating sector-specific gravity equations, where bilateral trade flows are drawn from ITPD-S, MFN tariffs from Teti (2024), and standard gravity controls from the Dynamic Gravity Dataset (Gurevich, 2018). The elasticities are estimated for the year 2019.

Table 6 presents the estimated trade elasticities by sector. We do not estimate the trade elasticity for services, as they are not subject to tariffs. In the counterfactual analysis, we apply the Liberation Day tariffs uniformly across agriculture, manufacturing, and mining, but exclude services from any tariff imposition.

F.3 Calculation of the Liberation Day Tariffs

Following the USTR formula, we calculate the Liberation Day Tariffs as:

$$\tilde{t}_{ni} = \frac{D_{in}}{\varepsilon \times \varphi \times X_{ni}}, \qquad \text{with} \qquad D_{in} \equiv X_{in} - X_{ni} \tag{30}$$

The tariff rate is 10% for partners that run a trade deficit or a low surplus vis-à-vis the U.S., and is equal to the rate implied by the USTR formula otherwise:

$$t_{ni} \times 100 = \max\left\{-\frac{1}{2}\tilde{t}_{ni} \times 100,\ 10\%\right\} \tag{31}$$

[20]In the single-sector model, we set $\beta = 0.48$ based on the global average labor share in the 2020 ICIO, consistent with Caliendo et al. (2023), who report a sectoral average of 0.45 using 2023 EORA data.

Table 6: Estimation Results: Sector-Level Trade Elasticities

	(1) Agriculture	(2) Manufacturing	(3) Mining
$\ln(1+t_{ni})$	-3.339***	-3.801***	-4.056*
	(0.529)	(0.170)	(2.198)
$\ln(1+\text{Dist}_{ni})$	-1.079***	-1.438***	-1.090***
	(0.027)	(0.008)	(0.052)
Observations	109,617	864,844	137,411
Exporters	202	210	202
Importers	208	212	210
Exporter Product FE	Yes	Yes	Yes
Importer Product FE	Yes	Yes	Yes
Control for Common Border	Yes	Yes	Yes
Control for Common Language	Yes	Yes	Yes
Control for Trade Agreement	Yes	Yes	Yes
Control for Colonial Links	Yes	Yes	Yes

Notes: Each column reports the estimated elasticity of trade flows with respect to tariffs for agriculture (1), manufacturing (2), and mining (3), based on the approach in Fontagné et al. (2022). Bilateral trade flows are drawn from ITPD-S, MFN tariffs from Teti (2024), and standard gravity controls (trade agreement, common language, common border, colonial links, and distance) from the Dynamic Gravity Dataset (Gurevich, 2018). All data are for 2019. All specifications include exporter-product and importer-product fixed effects. Robust standard errors in parentheses. *, **, and *** denote significance at the 10, 5, and 1 percent levels, respectively.

These calculations reproduce the tariff rates announced on Liberation Day, with a few exceptions, which we discuss in Section 3.

F.4 Calibration of ν

We have data on GDP (Y_i) and trade flows (X_{ni}). We want to calibrate ν to mach the share of Selling, General & Administrative (SG&A) expenses in total sales among firms in each location. The identifying assumption is that ν is common across all countries other than the US. Let $E_{\text{non-US}} = \sum_{i \neq \text{US}} E_i$ denote total expenditure in the rest of the world. By accounting, $E_{\text{non-US}} = \sum_{i \neq \text{US}} Y_i - \bar{T}_{US}$ and $E_{\text{US}} = Y_{\text{US}} + \bar{T}_{US}$, which appealing to the expression for the deficit and implied transfers, yields:

$$E_{\text{US}} = Y_{\text{US}} + \sum_{i \neq \text{US}} \left[(1 - \nu_{\text{non-US}}) X_{\text{US},i} - (1 - \nu_{\text{US}}) X_{i,\text{US}} \right] \tag{32}$$

$$E_{\text{non-US}} = \sum_{i \neq \text{US}} Y_i + \sum_{i \neq \text{US}} \left[(1 - \nu_{\text{non-US}}) X_{\text{US},i} - (1 - \nu_{US}) X_{i,\text{US}} \right] \tag{33}$$

where $X_{i,US}$ and $X_{US,i}$ denote international trade flows to and from the US and, and Y_i are GDP levels, all of which are observable in the data. Subtracting imports from aggregate expenditure, we can compute the domestic flows for each region. The ratio of total SG&A to sales among US firms and among those in the rest of the world is

$$\frac{\nu_{\text{US}} \cdot X_{\text{US,US}} + \nu_{\text{non-US}} \cdot \sum_{i \neq \text{US}} X_{\text{US},i}}{\sum_i X_{\text{US},i}} = \left(\frac{\text{SG\&A}}{\text{Sales}} \right)_{\text{US}} \tag{34}$$

$$\frac{\nu_{\text{US}} \cdot \sum_{i \neq \text{US}} X_{i,\text{US}} + \nu_{\text{non-US}} \cdot \sum_{i,n \neq \text{US}} X_{i,n}}{\sum_{i \neq \text{US}} \sum_n X_{i,n}} = \left(\frac{\text{SG\&A}}{\text{Sales}} \right)_{\text{non-US}} \tag{35}$$

The equation above indicates that the SG&A-to-sales ratios in each region represent a weighted average of the ν values across the markets served by the firms, with greater weight assigned to the domestic market, which accounts for the majority of total sales. We calibrate ν to match $\left(\frac{\text{SG\&A}}{\text{Sales}}\right)_{\text{US}} = 0.24$ and $\left(\frac{\text{SG\&A}}{\text{Sales}}\right)_{\text{non-US}} = 0.13$ based on balance-sheet data for manufacturing firms in Compustat North America and Worldscope for year 2020. To this end, we solve the system of Equations specified by Equations 32-35. Doing so delivers $\nu_{\text{US}} = 0.270$ for the US and $\nu_{\text{non-US}} = 0.114$ for non-US markets. Table 7 summarizes these calibrated values as well as other summary statistics from the firm balance-sheet data.

Table 7: Summary Statistics: World-Scope Data

Region	SG&A/Sales	CoGS/Sales	# Firms	source	ν (inferred)
USA	0.24	0.54	2,226	Compustat	0.27
non-USA	0.13	0.74	20,879	Worldscope	0.11

Notes: This table reports the mean ratios of selling, general, and administrative expenses (SG&A) to sales and cost of goods sold (CoGS) to sales for U.S. and non-U.S. firms. Data are drawn from Compustat for the U.S. and Worldscope for non-U.S. countries; the third column shows the number of firms in each sample. The final column gives the implied parameter ν, inferred from the SG&A cost shares and aggregate trade flows as described in the text.

G U.S.-EU-China Trade War

In this Appendix, we explore a scenario where the U.S. manages to make a trade truce with other countries, apart from the EU and China. In particular:

- USTR tariffs are applied to goods imported from the EU and China, with reciprocal retaliation from both partners.
- Tariff levels between the United States and all other countries settle at the 10% minimum threshold under the USTR scheme.

The results for this scenario are reported in the top panel of Table 8. Comparing these results to the baseline scenario, where all countries face the USTR tariffs and retaliate reciprocally, reveals important differences. In the new scenario, the U.S., China and the rest of the world experience smaller welfare losses, while the EU suffers a marginally more pronounced loss.

This pattern emerges because some EU countries benefit from trade diversion effects under the full-fledged trade war, but these benefits evaporate once the U.S. makes a truce with other countries. The U.S. welfare loss shrinks (from −0.36% to −0.19%), which speaks to the benefits of freer trade. Interestingly, China also experiences fewer losses compared to the full-fledged war case, because the originally-applied USTR tariffs depress wages in small Southeast Asian countries competing with China in global markets. These wage effects encourage global buyers to shift from Chinese suppliers to Southeast Asian suppliers. When these countries are granted tariff reductions, their wages recover to some extent, and so does China's loss of market access.

In the second panel of Table 8, we examine a scenario in which the United States reduces tariffs on the European Union to 10% to match the minimum tariff applied to other countries, while maintaining the USTR tariff on China and facing reciprocal retaliation from the Chinese government. Both the U.S. and the EU benefit from this scenario, compared to the

Table 8: Outcome under regional U.S.-China-EU trade wars

Country	Δ welfare	Δ deficit	Δ employment	Δ prices
Case 1: US trade war with EU & China				
USA	-0.19%	-22.3%	-0.13%	4.5%
CHN	-0.69%	6.1%	-0.16%	-2.4%
EU	-0.25%	17.8%	-0.10%	-1.6%
RoW	-0.16%	19.8%	-0.07%	-1.3%
Case 2: US trade war with China				
USA	-0.09%	-20.5%	-0.10%	3.9%
CHN	-0.67%	6.1%	-0.16%	-2.2%
EU	-0.06%	9.4%	-0.03%	-1.2%
RoW	-0.17%	21.0%	-0.07%	-1.2%
Case 3: US trade war with China (108% tariff)				
USA	-0.29%	-20.8%	-0.16%	4.1%
CHN	-0.79%	6.5%	-0.19%	-2.3%
EU	-0.06%	9.2%	-0.03%	-1.3%
RoW	-0.16%	20.7%	-0.07%	-1.2%

Notes: This table reports changes in economic variables (relative to pre-Liberation Day) under regional U.S.-China-EU trade wars, assuming 10% tariffs on US imports from all other countries. The "RoW" reflects GDP-weighted averages across countries other than U.S., China, and EU. In all scenarios, tariff revenues are used to reduce income taxes. The change in "prices" represents the change in the CES price index P_i relative to the global GDP-weighted average price index.

case in which the U.S. engages in a trade war with EU and China, while China's welfare losses remain as high as before.

Moreover, as the bottom panel in Table 8 reveals, the losses for both U.S. and China are amplified when two-way tariffs are further escalated from 54% under the initial USTR tariffs to 108%, in line with recent developments. However, China's marginal loss from U.S. tariffs diminishes rapidly, with the cost to China increasing by only 0.1 percentage point when Chinese tariffs are doubled from 54% to 108%.

H Robustness Checks

In this Appendix, we explore four alternative model specifications to check the sensitivity of our results to model and parameter selection.

(1) Multiple Sectors

We simulate the effects of USTR tariffs using the multi-sector model described in Appendix A.4. The calibrated model includes four broad sectors: agriculture, mining, manufacturing, and services. In our simulation, USTR tariffs are applied uniformly across all non-service sectors but excluded from traded services.

As reported in the second panel of Table 9, the multi-sector model produces smaller gains for the U.S. and smaller losses for the rest of the world. Part of the diminished U.S. gains reflects narrower tariff coverage, as tariffs now apply only to non-service goods. But more importantly, excluding services causes the tariff to deviate further from the unilaterally optimal rate. Although taxing services is difficult in practice due to administrative constraints, doing so could yield additional terms-of-trade gains before retaliation. In line with the smaller welfare gains, the associated deficit reduction and employment gains for the U.S. are also notably lower in the multi-sector model.

(2) Alternative Parameter Selection

Next, we experiment with alternative parameterizations of the single sector model. We consider the following cases:

1. We consider a model with incomplete pass-through at the firm level. Specifically, we set $\tilde{\varphi} = 0.25$, consistent with the assumptions used in the USTR report on tariff calculations. Under this calibration, the pass-through to the price index increases but

remains below one. All other parameter assignments are the same as in our baseline model.

2. Since the trade elasticity is critical for welfare effects, we run a robustness exercise where ε is set to 8, closer to the cross-sectoral average of 7.3 used by Caliendo et al. (2023), but still below the long-run trade elasticity of 14 in Alessandria et al. (2025c). We keep all other parameters at their baseline values.

3. We compute results under the Eaton-Kortum-Krugman interpretation of the model, where the pass-through to the price index equals the complete pass-through at the firm level. Specifically, $\varphi_i = \tilde{\varphi} = 1$ for all i , because there are no firm-selection effects and $\nu_i = 0$ for all i since there are no overhead costs.

The results are presented in Table 9. Relative to the baseline, unilateral gains from the USTR tariffs are larger under an incomplete pass-through assumption, while the associated price increases are smaller. However, these differences remain modest. Importantly, the outcomes are highly sensitive to the assumed trade elasticity. Doubling the trade elasticity eliminates approximately 75% of the U.S. gains from the USTR tariffs in the pre-retaliation scenario. The Eaton-Kortum-Krugman specification yields larger gains, but these are artificially inflated due to the assumption that the entire deficit is financed through fixed transfers. We explore this issue in greater detail in the following subsection.

(3) Alternative Deficit Treatment

The treatment of trade deficits in static quantitative trade models remains a topic of ongoing debate. Early generations of these models typically treated the deficit as exogenously fixed. However, Ossa (2014) underscores two major drawbacks of this approach. First, it tends to generate unrealistically large trade responses and preserves transfers even under autarky. Second, the results become sensitive to the choice of numeraire, i.e., the currency in which initial transfers are denominated. More recent quantitative models address trade deficits using one of two alternative approaches that are less susceptible to these issues:

1. The first approach, exemplified by the method in Dekle et al. (2007), attributes the entire deficit to lump-sum transfers $\bar{T}_i$. When running counterfactual tariff simulations, it is assumed that the transfer remains constant as a share of global GDP.

2. The second approach, used by Ossa (2014) and Lashkaripour (2021), eliminates trade imbalances entirely, and computes tariff effects starting from a counterfactual baseline scenario without deficits.

Table 9: Tariff impacts under alternative parametrization

Country	Δ welfare	Δ deficit	Δ $\frac{\text{exports}}{\text{GDP}}$	Δ $\frac{\text{imports}}{\text{GDP}}$	Δ employment	Δ prices
Baseline model:($\tilde{\varphi} = 1$, $\varphi > 1$, $\varepsilon = 4$)						
USA	1.13%	-18.1%	-52.7%	-43.6%	0.32%	12.8%
non-US (average)	-0.58%	11.6%	-3.2%	-3.3%	-0.14%	-4.7%
Alternative 1: multiple sectors						
USA	0.68%	-16.8%	-30.5%	-28.6%	0.12%	8.3%
non-US (average)	-0.38%	5.4%	-2.5%	-2.5%	-0.10%	-2.6%
Alternative 2: incomplete passthrough to firm-level prices ($\tilde{\varphi} = 0.25$)						
USA	1.36%	-11.8%	-35.0%	-28.8%	0.30%	7.9%
non-US (average)	-0.23%	7.1%	-2.1%	-2.2%	-0.04%	-2.9%
Alternative 3: higher trade elasticity ($\varepsilon = 8$)						
USA	0.33%	-26.3%	-71.6%	-58.0%	0.10%	11.8%
non-US (average)	-0.44%	18.6%	-5.3%	-4.9%	-0.11%	-4.3%
Alternative 4: Eaton-Kortum-Krugman model ($\varphi = 1$, $\nu = 0$)						
USA	1.24%	-0.4%	-46.3%	-33.3%	0.41%	10.9%
non-US (average)	-0.50%	0.1%	-1.9%	-2.9%	-0.10%	-4.0%

Notes: This table reports changes in economic variables (relative to pre-Liberation Day) before and after retaliation to the USTR tariffs, under alternative parametrization. The "non-US (average)" reflects GDP-weighted averages across non-U.S. countries. In all scenarios, tariff revenues are used to reduce income taxes. The change in "prices" represents the change in the CES price index P_i relative to the global GDP-weighted average price index.

Before turning to these alternative modeling approaches, it is useful to clarify why they are not well suited to the type of analysis we aim to carry out in this paper. A central motivation behind the Liberation Day tariffs was to reduce, or even eliminate, the U.S. trade deficit. The second approach is not suitable in this context, as it removes the trade deficit by assumption. The first approach has its own drawbacks: it yields a mechanical reduction in the trade deficit through a contraction in global GDP. However, it preserves the ratio of deficit-related transfers to global GDP even under autarky. These considerations led us to develop a framework in which the trade deficit emerges endogenously from claims on foreign profits that are funneled via fixed overhead cost payments. These claims reflect international income flows not captured by standard trade accounting, as they occur between the domestic labor force and local affiliates of foreign-owned firms.

Nonetheless, it is instructive to experiment with these alternative models and compare their predictions to those generated by our framework. In this appendix, we examine the outcomes of tariffs under both methodologies outlined above. These earlier approaches are generally based on the Eaton-Kortum and Krugman models, both of which are nested by our model as special cases where $\varphi = 1$ and $\nu = 0$. For the sake of clarity and exposition, we carry out the following analysis under this specific parameterization.

Table 10 presents the results obtained from both modeling approaches prior to any retaliation. Compared to our benchmark results, the welfare gains for the U.S. appear more pronounced under the fixed-deficit framework (the Dekle et al. (2007) approach), but more muted in the balanced trade scenario (Ossa (2014)).[21]

The larger welfare gains under the fixed-deficit specification arise because there is no longer a trade-off between improving the terms of trade through trade contraction and the welfare loss from shrinking the deficit. After all, the trade deficit represents a net income transfer from the rest of the world to the U.S. economy. Taken together, the results suggest that deficit reduction dampens the welfare gains from unilateral tariffs. Put differently, the goal of reducing the trade deficit may fundamentally conflict with the pursuit of terms-of-trade improvements through tariff policy.

The bottom two panels of Table 10 present economic outcomes under a scenario of retaliation. Compared to our baseline, the fixed-deficit model produces more favorable welfare outcomes for the U.S., while the balanced trade model results in more adverse outcomes. Our framework can be seen as an intermediate case between these two polar cases. Notably, the trade war does not cause a net welfare loss for the U.S. under the fixed-deficit model. This can perhaps be understood through the argument underscored in Ossa (2014):

[21] To balance U.S. trade, we set the counterfactual deficit for the U.S. to zero, i.e., $D_i^{'} = 0$ if $i = US$. To balance the global budget, we set $D_n^{'} = D_n - D_{in}$ for all $n \neq US$, where i is the US. Doing so ensures that $\sum_n D_n^{'} = 0$.

Table 10: Tariff impacts under alternative modeling of deficits

(1) Pre-retaliation: fixed transfers to global GDP (Dekle et al., 2008)					
Country	Δ welfare	Δ $\frac{\text{exports}}{\text{GDP}}$	Δ $\frac{\text{imports}}{\text{GDP}}$	Δ employment	Δ prices
USA	1.24%	-46.3%	-33.3%	0.41%	10.9%
non-US (average)	-0.35%	-1.9%	-2.95%	-0.10%	-4.0%
(2) Pre-retaliation: balanced trade (Ossa, 2014)					
USA	0.92%	-54.9%	-42.7%	0.18%	11.2%
non-US (average)	-0.26%	-3.0%	-3.25%	-0.13%	-4.1%
(3) Post-retaliation: fixed transfers to global GDP (Dekle et al., 2008)					
USA	0.05%	-73.8%	-49.0%	-0.04%	5.3%
non-US (average)	-0.26%	-4.8%	-5.64%	-0.10%	-1.9%
(4) Post-retaliation: balanced trade (Ossa, 2014)					
USA	-0.84%	-72.8%	-56.6%	-0.39%	4.4%
non-US (average)	-0.26%	-6.1%	-5.38%	-0.09%	-1.6%

Notes: This table reports changes in economic variables (relative to pre-Liberation Day) before retaliation to the USTR tariffs, under alternative ways of modeling trade deficits. The "non-US (average)" reflects GDP-weighted averages across non-U.S. countries. In all scenarios, tariff revenues are used to reduce income taxes. The change in "prices" represents the change in the CES price index P_i relative to the global GDP-weighted average price index.

since US GDP contracts more sharply than global GDP during the trade conflict, the fixed transfer constitutes a larger share of U.S. national income. This amplification effect is sufficient to offset the efficiency loss from reduced trade. However, it is crucial to recognize that this outcome is highly sensitive to how the transfers are normalized. If transfers are instead specified as a constant share of U.S. GDP, the favorable welfare outcomes for the U.S. would largely dissipate. In this sense, there is a degree of arbitrariness in the resulting welfare implications—which may explain why studies of trade wars (e.g., Ossa (2014), Lashkaripour (2021)) often favor the balanced trade approach.

I Global Effects of USTR Tariffs

Previously, we reported the effects separately for the U.S. and the rest of the world. For completeness, Table 11 also presents the aggregate impacts on global employment and trade. The first row shows the decline in global trade-to-GDP under the USTR tariffs, both with and without reciprocal retaliation. The second row reports the reduction in global employment. Since we do not observe employment shares by country, we construct global employment effects using GDP weights. The first column "main" reports results from the baseline one-sector model without input-output linkages. The second column "multi" shows outcomes from the multi-sector model. The third column "IO" adds input-output linkages to the one-sector model. The final column "multi + IO" combines both the multi-sector structure and input-output linkages.

Table 11: *Global* trade and employment impacts of USTR tariffs

	before retaliation				after retaliation			
	main	IO	multi	multi + IO	main	IO	multi	multi + IO
Δ trade-to-GDP	-9.4%	-10.8%	-5.5%	-4.1%	-11.6%	-12.4%	-6.9%	-4.9%
Δ employment	-0.02%	-0.12%	-0.05%	-0.08%	-0.15%	-0.58%	-0.05%	-0.26%

Notes: This table reports changes in global trade (relative to GDP) and employment before and after retaliation to the USTR tariffs, under various modeling approaches.

The results reveal two general patterns. First, incorporating input-output linkages increases the global employment losses from tariffs. This is expected, as tariff distortions are magnified through input-output connections. Second, introducing multiple sectors reduces the predicted global trade contraction. This is due to the inclusion of an explicit service sector that is traded but not subject to tariffs. Since services make up a large share of the economy and are less affected by the tariffs, they dampen the overall decline in trade.