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

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Abstract

On April 2, 2025, President Trump announced "Liberation Day," imposing broad tariffs on imports to reduce trade deficits and revive U.S. industry. We analyze the long-term economic effects of these tariffs, finding that while they may improve U.S.'s terms of trade if trading partners do *not* retaliate, any welfare gains vanish under reciprocal retaliation. Assuming no retaliation, we derive the optimal U.S. tariff rate, which is approximately 33% and uniformly applied across all trade partners. This optimal structure stands in stark contrast to the USTR's proposed tariff schedule, which varies by trading partner and is based on bilateral trade deficits. When trading partners retaliate optimally against the USTR-proposed tariffs, the U.S. experiences a welfare loss of nearly 1%, while partner countries offset virtually all the initial losses. The resulting tariff war, however, reduces global employment and introduces a net deadweight loss. Although the tariffs do succeed in modestly reducing the U.S. trade deficit, the resulting deadweight losses underscore the inefficiency of using protectionist trade policy as a tool for deficit reduction.

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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, with exceptions for USMCA trade partners as well as certain industries, such as automobiles.[1] The official summary of tariff schedules and exemptions is available on this link: The White House Fact Sheet. The official report that explains the calculations of reciprocal tariffs is available on this link: USTR Reciprocal Tariff Calculations. The reader can replicate USTR’s calculations using U.S. Census data and explore the sensitivity of their results with respect to different parameter values using our online calculator available on this webpage: USTR Interactive Tariff Calculator. 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 global economy.

Model and Methods. We develop a quantitative trade model that incorporates three key features: tariff pass-through differing from unity, the presence of trade imbalances, and employment effects. These features make the model particularly well-suited for analyzing the Liberation Day tariffs, which were designed based on perceived pass-through rates and aimed at reducing the U.S. trade deficit. Despite introducing several novel elements, our framework nests a broad class of standard quantitative trade models as special cases. We also present results for these canonical special cases. We focus on a single-sector model, as the Liberation Day tariffs were uniform across all goods and did not involve any sectoral variation.

Within our framework, we derive the theoretical formula for optimal tariffs and show that they are non-discriminatory across trading partners and largely independent of trade imbalances. The optimal design stands in sharp contrast to the proposed Liberation Day tariffs, 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 using bilateral trade and GDP data for 123 countries from 2023 and we assess the long-term effects of tariffs under various scenarios, employing exact hat algebra. Our simulations require information on several structural parameters, most notably

[1] As of April 9, the tariff on Chinese goods increased to 125% due to retaliations. Similarly, as of April 9, tariffs on all other countries have been reduced to 10% for 90 days.

the trade elasticity and the tariff pass-through. We adopt these values from Simonovska and Waugh (2014) 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).

Summary of results. Tariffs imposed by the United States could, in theory, improve its terms of trade and reduce its trade deficit, assuming, crucially, that its trading partners abstain from retaliation. However, these beggar-thy-neighbor benefits come at significant losses to U.S. trading partners, particularly Canada, Mexico, and various South American economies, whose exports to the U.S. represent a substantial share of their GDP.

Yet, the tariffs proposed by the USTR fall short of what economists would regard as an optimal tariff structure. An optimally designed tariff would involve a uniform rate of approximately 25% applied equally across all trading partners. Such a non-discriminatory tariff would not only generate significantly greater (beggar-thy-neighbor) welfare gains for the United States but would also be more effective in reducing the U.S. trade deficit, if that remains the primary policy objective.

Crucially, any potential welfare gains for the United States vanish if all trade partners respond with bilateral retaliation. In such a scenario, the U.S. would not only forfeit its initial gains but would also end up significantly worse off. Ironically, collective retaliation by all partner countries would, on average, offset nearly all of these countries' welfare losses—though this would come at the cost of a contraction in global GDP due to reduced gains from trade.

Scope and Limitations. 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. (2025) for an analysis of temporary vs. permanent tariffs on the deficit and GDP). As such, the analysis abstracts from any frictions, most notably labor adjustment frictions and supply chain restructuring frictions such as relationship building costs. These transitional dynamics would further reduce computed welfare gains. Additionally, we do not model any uncertainty regarding the persistence of tariffs, nor do we capture intertemporal decisions such as savings and investment. Finally, in this paper, we abstract from the analysis of financial markets, so we cannot quantify any losses in income and wealth that may occur due to changes in asset prices. 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.

Relation to the literature. A growing literature has examined the trade and welfare consequences of the 2018-2019 U.S.-China trade war across the United States, China, and other countries (Amiti et al., 2019, 2020; Fajgelbaum et al., 2020; Ma et al., 2021; Caliendo and Parro, 2023). A consistent finding is the near-complete pass-through of U.S. tariffs into import prices, implying that the costs were borne almost entirely by U.S. firms and consumers, with limited evidence of foreign exporters lowering their prices in response (Amiti et al., 2019; Fajgelbaum et al., 2020; Cavallo et al., 2021). While the direct impact at the border was substantial, retail price increases were more muted, suggesting that firms absorbed part of the cost through reduced margins (Cavallo et al., 2021). The rise in prices had regressive effects, disproportionately impacting low-income households (Ma et al., 2025).

The tariffs also triggered sharp declines in both imports and exports, amplified by foreign retaliatory measures (Fajgelbaum et al., 2020). Despite their protectionist intent, the tariffs were associated with lower employment growth in U.S. manufacturing sectors, as any gains from import protection were outweighed by higher input costs and retaliatory pressures (Flaaen and Pierce, 2019). Broader labor market effects included increased unemployment and reduced labor force participation in more exposed regions.

Chinese retaliation further exacerbated the domestic impact, leading to significant drops in local consumption and employment, particularly in counties heavily exposed to Chinese tariffs (Waugh, 2019). Overall, the trade war imposed substantial welfare losses, had limited positive effects on employment, and failed to reverse the distributional consequences of the earlier China shock (Caliendo and Parro, 2023).

Our paper also relates to Ossa (2014) and Lashkaripour (2021), who employ quantitative trade models to assess the welfare costs of full-scale tariff wars. In addition, we investigate the revenue-generating potential of the recently proposed tariffs, complementing prior work in this area, including Lashkaripour (2020) and Alessandria et al. (2025).

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

Trade shares are defined as $\lambda_{in} \equiv X_{in}/E_n$, where X_{in} is country n's expenditure on varieties from country i, with $E_n = \sum_j X_{jn}$ denoting total expenditure. As elaborated in Appendix 1, in a Melitz-Pareto model with destination-specific markups, free entry, and fixed cost payments that are incurred in terms of labor in the destination country, trade shares can be specified as:

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

The trade share expression above is consistent with a broad spectrum of micro-foundations, extending beyond the Melitz-Pareto framework outlined in Appendix 1. It nests standard models, such as Armington, Eaton-Kortum, and Krugman, as special cases, as we will elaborate shortly. 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. φ_i: the partial tariff passthrough, which represents the partial equilibrium elasticity of the imoort *price index* with respect to tariffs $(1 + t_{ni})$ in destination i;[2]
3. ψ: the scale elasticity, which is the elasticity of aggregate real TFP with respect to employment size, L_n, capturing the variety gains from firm entry.

A change in tariffs affects prices with elasticity φ_i, and the resulting change in prices influences trade flows with elasticity ε. Consequently, the elasticity of trade flows with respect to tariffs is given by the product $\varphi_i \cdot \varepsilon$.

The total demand for labor services in country i consists of two components: the labor required to produce goods domestically, and the labor services needed for the fixed cost payments by foreign firms selling to market i. Specifically, let ν_i represent the constant, but *destination-specific*, fraction of sales allotted to fixed cost payments to local labor at the location of sales, i. 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 above expression states that the demand for country i's labor services is the sum of the demand for production and entry activities (the first term), plus the demand by foreign

[2]The concept of pass-through used here refers to price changes that account for adjustments in product variety. This measure differs from φ_i, which reflects pass-through while holding the set of firm-specific varieties constant, as detailed in Appendix 1.

firms for fixed cost payments (the second term).

Notice that the above framework is consistent with a wide range of micro-foundations, beyond the variant of the Melitz-Pareto model discussed in Appendix 1. In some of the models, $\varphi_i = 1$ and ν_i is either zero or uniform across markets, thus eliminating any room for model-consistent trade deficits. Our Melitz-Pareto model, in contrast, has the attractive property that it allows for the tariff pass-through to diverge from unity and for trade deficits to emerge endogenously, making it particularly useful to examine the impacts of tariffs that were applied based on the policy maker's perception of pass-through and with the intent to reduce the trade deficit.

As we explain below, we can simulate the counterfactual effect of tariffs with information on trade and production data as well as the parameters listed above. We need not take 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, the maximization of which yields the equilibrium trade shares specified above. Labor supply in country i is, thus, given by

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

where τ_i 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

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

where Υ_i is a constant formally defined in Appendix 1.

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, wherein total expenditure in country i is the sum of factor income and tariff revenue. In particular,

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

where $\bar{T}_i$ is a constant lump-sum transfer in the spirit of Dekle et al. (2007) , 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. The trade deficit of country i is given by:

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

Two key factors determine the deficit 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. The second source arises endogenously because export values incorporate labor costs from the destination market. Additionally, fixed costs consume varying proportions of export revenues across different destinations $\{\nu_i\} \neq 0$. Consequently, a country may maintain overall budget balance despite having unbalanced trade flows, even in the absence of lump-sum transfers.

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 states that when a country runs an aggregate trade deficit, it will inevitably run a bilateral deficit with some partners, even if trade barriers are reciprocal.

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 $t_{ni} = t_{in}$, $\forall n, i$).*

The proposition above clarifies that bilateral trade imbalances do not provide meaningful information about the reciprocity of trade barriers, including tariffs, when there are aggregate trade imbalances. 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 general equilibrium model, tariff pass-through is defined in terms of price indexes and carries a different interpretation than the partial equilibrium notion of passthrough. 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 partial 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 partial pass-through equals one ($\varphi_i = 1$), 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.

Returning to the interpretation of φ_i, it differs from the passthrough estimated by researchers using panel data on firm-level prices and design-based methods. In our model, the partial passthrough to individual firm prices (excluding general equilibrium effects) equals one. However, the passthrough to consumer price indexes is higher because of firm selection. Specifically, tariffs reduce the number of firms exporting to the tariff-imposing market. This reduction in available varieties raises the consumer price index, even though the partial passthrough at the firm level remains at one.

2.1 Micro-foundations

Our preferred microfoundation, detailed in Appendix 1, allows for tariff pass-through to deviate from unity and permits trade imbalances to respond endegenously 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 partial tariff pass-through is complete, i.e., $\varphi_i = 1$, and trade is balanced, since $\nu_i = 0$ for all i.

2. The Krugman model: Here, ε represents the cross-national elasticity of substitution,

and ψ reflects the degree of love for variety. As with the previous case, the partial pass-through is complete ($\varphi_i = 1$), and trade is balanced across countries, since $\nu_i = 0$ for all i.

The key advantage of the Melitz-Pareto microfoundation presented in Appendix 1 is that it generates trade imbalances endogenously, allowing those imbalances to adjust in response to tariff changes. In contrast, the other microfoundations do not explicitly accommodate trade imbalances. Hence, performing counterfactual analyses under those models necessitates additional assumptions regarding the nature of imbalances, which we examine in Section 5.4.

2.2 Optimal Tariff Under Trade Imbalances

As an intermediate step, we characterize the optimal tariff under trade imbalances.[3] 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 are passive. As proven in Appendix C, the optimal tariff for country i is different from the standard formula without imbalances, 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 trade imbalances are irrelevant to the optimal design of tariffs in the case of a small open economy. In such a scenario, we have $\lambda_{in} \to 0$, which yields $\mathscr{E}_i = \varepsilon$, implying an optimal tariff:

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

[3] As in Lashkaripour and Lugovskyy (2023) and Farrokhi and Lashkaripour (2025), we assume that country i derives no first-order gains from distorting relative wages in the rest of the world. This assumption holds trivially in a two-country model. As demonstrated in the aforementioned studies, it is also virtually satisfied in multi-country settings, since any single country has limited ability to influence foreign relative wages. Moreover, such wage changes typically result in factoral terms-of-trade transfers between two foreign countries, with negligible impact on Home's welfare.

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 above clearly indicates that a country running an aggregate trade deficit ($\bar{T}_i > 0$) will find it optimal to set a higher tariff. The intuition is straightforward: within our framework, each country has unexploited monopoly power over its differentiated labor services. By applying tariffs, the home economy curtails imports and, as a result, contracts exports, thereby raising domestic wages relative to foreign wages. The artificial trade contraction effectively allows the government to impose an optimal markup on the international price of its labor services. In the presence of trade deficits, a more pronounced reduction in imports is required to achieve the optimal contraction in exports and the corresponding increase in domestic wages.[4]

However, *bilateral* trade imbalances have no bearing on the optimal tariff choice. From a pure terms-of-trade standpoint, there is no justification for differentiating tariff rates based on bilateral trade deficits. The following corollary formalizes this insight.

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 counter-factual tariff outcomes when tariffs are increased from zero to the "reciprocal" Liberation Day tariff rate for $i = US$. The reciprocal tariff rate is based on the USTR tariff formula:

$$\tilde{t}_{ni} = \frac{D_{in}}{\varepsilon \times \varphi \times X_{ni}}, \qquad \text{with} \qquad D_{in} \equiv X_{in} - X_{ni} \tag{7}$$

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

$$100 \times t_{ni} = \max\left\{100 \times \frac{1}{2}\tilde{t}_{ni},\, 10\%\right\} \tag{8}$$

A few notes are in order. Since Canada and Mexico incur zero duties on USMCA-compliant products, which account for 40-50% of U.S. imports from these countries, we set the tariff rate for Canada and Mexico to 10%, which corresponds to the lower bound of tariffs

[4] Pujolas and Rossbach (2024) makes a similar point in the context of a two-country endowment economy.

reported by the USTR. Furthermore, since our analysis uses 2023 data, we maintain tariff levels consistent with an embargo on Russia.

We want to compute the impacts of a tariff change starting from tariffs that are universally nearly zero to the reciprocal tariffs applied based on the above formula.

We compute counterfactual change in equilibrium outcomes using exact hat-algebra. In particular, the change in trade shares is given by

$$\hat{\lambda}_{ni} = \frac{\hat{L}_n^{-\psi\varepsilon}\,(1+t_{ni})^{-\varphi_i\cdot\varepsilon}\,\hat{w}_n^{-\varepsilon}}{\sum_j \lambda_{ji}\,\hat{L}_j^{-\psi\varepsilon}\,(1+t_{ji})^{-\varphi_i\cdot\varepsilon}\,\hat{w}_j^{-\varepsilon}} \tag{9}$$

The labor market clearing condition in changes can be expressed as

$$\hat{w}_i\hat{L}_i w_i L_i = \sum_n \frac{1-\nu_i}{1+t_{in}}\hat{\lambda}_{in}\lambda_{in}\hat{E}_n E_n + \sum_n \frac{\nu_n}{1+t_{ni}}\hat{\lambda}_{ni}\lambda_{ni}\hat{E}_i E_i, \tag{10}$$

where the change in labor supply is

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

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

$$\hat{P}_i = \left[\sum_n \frac{\hat{\lambda}_{ni}\lambda_{ni}}{(1+t_{ni})}\right]^{\varphi_i-1}\left[\sum_i \lambda_{ni}\,\hat{L}_n^{\psi\varepsilon}\,(1+t_{ni})^{-\varphi_i\cdot\varepsilon}\,\hat{w}_n^{-\varepsilon}\right] \tag{11}$$

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

$$\hat{E}_i E_i = \hat{w}_i\hat{L}_i Y_i + \underbrace{\sum\sum_n \frac{t_{ni}}{1+t_{ni}}\hat{\lambda}_{ni}\lambda_{ni}\hat{E}_n E_n + \bar{T}_i}_{R_i'} \tag{12}$$

where $Y_i = w_i L_i$. We take the optimistic approach where tariffs can fully substitute for income tax revenues. More specifically, $\tau_i Y_i = R_i$, which implies that the change in the share of labor income that is deducted for income tax purposes changes after tariff imposition as $(\widehat{1-\tau_i}) = 1/(1-R_i/Y_i)$. The system specified by Equations 9–12 solves for the two independent unknowns $\{\hat{w}_i\}_i$ and $\{\hat{E}_i\}_i$, from which we can calculate the policy impacts as

- 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 $\hat{P}_i$

4 Data and Calibration

For our counterfactual analysis, we need data on aggregate output and expenditures (Y_i and E_i in the model), trade shares (λ_{in}), fixed cost margins (ν_i) that regulate deficits, as well as estimates of the elasticity parameters.

National Accounts. We handle expenditure, income, and deficit data in two ways. First, we note that national expenditure GDP, $E_i = \text{GDP}_i + \bar{T}_i$, is the sum of GDP and fixed transfers, where the GDP represents net factor income: $Y_i = w_i L_i = \text{GDP}_i$. We can then construct the trade matrix, $\mathbf{X}$, based on available data for the off-diagonal elements from the BACI dataset, which we discuss shortly. We then recover $\{\nu_i\}_i$ by solving the following system of equations:

$$(\mathbf{X}^T - \mathbf{X})(\mathbf{1} - \boldsymbol{\nu}) = \mathbf{T} \tag{13}$$

This system requires knowledge of $\mathbf{T}$, which is not directly observable. To handle the identification issue, we assume that a constant fraction of the global deficit is attributed to overhead cost payments. We calibrate this number so that the average ν_i is 0.23, matching the 23% share of overhead costs from sales among manufacturing firms in COMPUSTAT North America. Leveraging on this choice, we could infer $\mathbf{T}$ from the aggregate gross deficit and invert the above system to identify $\boldsymbol{\nu}$. Since the matrix $\mathbf{X}^T - \mathbf{X}$ is skew-symmetric, by *Jacobi's theorem*, it can be non-singular only if it is even-order. We ensure this property by selecting an even sample of countries.

For completeness, we also experiment with $\nu = \mathbf{0}$, which allocates the entire deficit to factors outside of the model. In this setting, the entire trade imbalance is assigned to fixed lump-sum transfers, such that: $\bar{T}_i = \sum_{j\neq i} X_{ji} - \sum_{j\neq i} X_{ij}$. This choice, however, has strong and unpleasant implications for welfare analysis. In particular, introducing tariff shocks while holding the entire deficit fixed tends to overstate the benefits for countries like the US that run a net deficit, while understating them for others. This point has been emphasized by Ossa (2014), and we revisit it in Section 5.4.

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

$$\lambda_{ni} = \frac{X_{ni}}{E_i} \tag{14}$$

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

Data Sources. GDP data in current USD are sourced from the World Bank's World Development Indicators (WDI). The most recent data available refer to 2023; for countries with missing values for that year, the latest available observations are used instead. Trade flow data are sourced from the 2023 BACI data from CEPII (Gaulier and Zignago, 2010), which report bilateral flows of merchandise trade aggregated at the country-pair level (origin and destination). Hence, the data include only trade in goods and exclude services trade. Merging the BACI trade data with GDP data allows us to analyze bilateral trade flows among 123 countries. These countries account for 76 percent of global trade.

European Union. We treat EU member states as independent tariff-setting authorities. On one hand, this assumption reduces the collective market power of the EU, potentially understating the implied cost of retaliation for the U.S., a point formally illustrated in Lashkaripour (2021). However, for the EU to fully leverage its collective bargaining power, intra-EU transfer mechanisms would be required to redistribute the surplus gains from coordinated action, an assumption that is quite strong and not guaranteed in practice. Moreover, by modeling EU countries separately, we are able to quantify the individual exposure of each member state to U.S. tariffs, which offers valuable insight. Weighing these trade-offs, we have chosen to assign tariff autonomy to EU members, while acknowledging the limitations that this approach entails.

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

- $\varepsilon = 4$ (Simonovska and Waugh, 2014)
- $\kappa = 0.5$ (Chetty et al., 2011)
- $\varepsilon \cdot \psi = 0.67$ (Lashkaripour and Lugovskyy, 2023)
- $\varphi_i \approx 1 (\forall i)$ (Amiti et al., 2019; Cavallo et al., 2021)

The final parameter assignment warrants further explanation. In our model, tariff pass-through is destination-specific. However, globally representative estimates of partial tariff pass-through are not available. Most existing estimates pertain to the United States, particularly in the context of the 2018 U.S.-China trade war. This limitation poses no concern in scenarios where we analyze U.S. tariffs without retaliation, as the counterfactual simulations in those cases require only the the U.S. pass-through parameter. When considering retaliation, however, we also require pass-through estimates for the rest of the world. In the absence of such data, we calibrate these values using the U.S.-based estimate.[5]

As previously discussed, our parameter φ_i represents the pass-through of tariffs to the import price index. Strictly speaking, if firm-level pass-through is complete, this would result in overshifting (that is, a pass-through rate greater than one) at the aggregate price index level. To capture this scenario, we explore cases where $\varphi_i > 1$. Conversely, the USTR, in its report on reciprocal tariff calculations, assumes a pass-through rate below one. For completeness, we therefore also consider scenarios with $\varphi_i < 1$.[6]

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 reports simulated outcomes of the Liberation Day tariffs under two distinct scenarios: complete passthrough ($\varphi = 1$) and incomplete passthrough ($\varphi = 0.5$). Results highlight notable shifts in key economic variables within the United States and the rest of the world.

We first focus on the complete passthrough case, which is more economically viable. Here, U.S. welfare increases by 1.2 percent, accompanied by a substantial reduction in the trade deficit (-35 percent). This occurs primarily through significant declines in both exports

[5] It is worth noting a potential tension in assigning a common pass-through parameter across countries while allowing for heterogeneity in ν_i. From a theoretical perspective, cross-country variation in ν_i would naturally imply corresponding heterogeneity in φ_i. Nonetheless, we take some reassurance from our subsequent analysis, which suggests that the qualitative nature of policy outcomes is not particularly sensitive to the specific choice of pass-through. In future iterations of this paper, we intend to explore alternative calibration strategies, wherein pass-through levels are derived endogenously based on the ν_i values calibrated to match observed trade imbalances.

[6] We acknowledge that this parameter choice is not fully consistent with the requirements of a well-behaved theoretical model. Specifically, a well-behaved Melitz-Pareto model requires a passthrough parameter $\varphi_i \geq 1$. However, this choice can be justified with a reinterpretation of the model in which tariff pass-through partially captures selection effects à la Melitz, and partially reflects supply-side curvature arising from quasi-fixed inputs. In this view, φ_i serves as a reduced-form representation of both mechanisms.

(-32 percent) and imports (-33 percent). The concurrent reduction in exports and imports is a basic manifestation of the *Lerner* symmetry, whereby a tax on imports functions as an implicit tax on exports.

U.S. employment increases modestly by 0.22 percent, while real consumer prices rise by close to 6 percent. These price increases are driven mostly by domestic wage growth, as tariffs raise the demand for local labor in the U.S., thereby raising wages. In contrast, other countries typically experience welfare losses averaging -0.3 percent, although, as we elaborate later, the losses are substantial for some countries. The rest of the world's trade deficits grows by approximately 13 percent. These deficit effects are primarily due to significant reductions in exports (-8 percent) and imports (-6 percent). Additionally, employment abroad slightly declines by -0.1 percent, with a pronounced drop in real prices (-5.1 percent) due to downward pressure on local wages.

The welfare improvements in the U.S. stem from favorable *factoral* terms-of-trade effects. Specifically, unilateral U.S. tariffs raise domestic wages compared to those in other nations:

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

Thus, even when the partial tariff pass-through is complete (*conditional on aggregate wages*), imports become relatively cheaper due to falling foreign wages or rising U.S. wages. In other words, tariffs effectively allow the U.S. economy to leverage its monopsony position and impose an excessive markdown on foreign wages.

Table 1: The simulated impacts of Liberation Day tariffs

Case 1: complete passthrough ($\varphi = 1$)						
Country	Δ welfare	Δ deficit	Δ exports	Δ imports	Δ employment	Δ real prices
USA	1.03%	-10.4%	-36.9%	-27.3%	0.45%	8.81%
non-US (average)	-0.16%	2.4%	-6.1%	-6.0%	-0.12%	-4.06%
Case 2: incomplete passthrough ($\varphi = 0.9$)						
USA	1.36%	-9.6%	-34.8%	-25.7%	0.53%	8.02%
non-US (average)	-0.18%	2.3%	-5.8%	-5.6%	-0.12%	-3.84%
Case 2: overshifting passthrough ($\varphi = 1.1$)						
USA	0.71%	-11.2%	-39.1%	-29.1%	0.36%	9.67%
non-US (average)	-0.15%	2.6%	-6.5%	-6.3%	-0.12%	-4.30%

In the scenario with incomplete tariff pass-through, the qualitative outcomes remain consistent, though the magnitudes change. The U.S. achieves slightly greater welfare gains since tariffs are not fully passed on to domestic prices, even without considering general equilibrium wage adjustments. Also, prices in the U.S. increase less dramatically, and the resulting effects on exports, imports, and the deficit are more muted.

These findings align closely with standard textbook terms-of-trade theory. The U.S., being a large economy, can leverage market power to extract surplus or revenues from its trade partners, reallocating them domestically. Yet, from a global perspective, such policies are inefficient, reducing overall welfare. Indeed, free trade offers a Kaldor-Hicks improvement over the imposition of U.S. tariffs. A critical concern is that U.S. tariffs might provoke retaliatory actions, ultimately negating unilateral welfare benefits and harming all involved parties. This reflects a classic Prisoner's Dilemma scenario, which trade agreements are designed to avert.

5.2 Optimal Tariffs and Retaliation

In earlier analyses, we assumed that the U.S. implements reciprocal tariffs calculated using Equation 8, while other countries remain passive without retaliating.

Here, we explore additional scenarios. First, we simulate the outcomes when the U.S. applies its optimal tariff, assessing how much the reciprocal tariffs deviate from the optimal rate. Second, we analyze the outcomes when other nations retaliate by imposing their own optimal or reciprocal tariffs.

Table 2 reports results related to these alternative scenarios. The top panel reports our benchmark results from Table 1 with liberation tariffs, complete pass-through, and no retaliation.

The second panel presents results under the optimal tariff design in the absence of retaliation. The optimal tariff follows the formula derived in Proposition 1. As previously discussed, these tariffs are largely independent of trade imbalances and are uniform across trading partners. The U.S. optimal tariff is approximately 25% and non-discriminatory, standing in sharp contrast to the reciprocal Liberation Day tariffs, which vary based on *bilateral* trade deficits.

Optimal tariffs deliver greater U.S. welfare improvements (1.65 percent) while also shrinking the trade deficit significantly more, by 39 percent. These effects come with near symmetric declines in exports and imports, accompanied by increased employment (0.37 percent). The upward pressure on consumer prices is also more pronounced than in the case of USTR tariffs, since the policy lifts local wages to a greater extent than sub-optimal tariffs. Non-U.S. countries face worsened welfare outcomes (-0.37 percent), markedly higher trade deficit hikes (45 percent), and more pronounced reductions in trade flows, employment, and real consumer prices.

Table 2: Impact of optimal tariff and retaliatory tariffs

(1) benchmark (full passthrough + no retaliation)						
Country	Δ welfare	Δ deficit	Δ exports	Δ imports	Δ employment	Δ real prices
USA	1.03%	-10.3%	-36.9%	-27.3%	0.45%	8.81%
non-US (average)	-0.16%	2.4%	-6.1%	-5.9%	-0.12%	-4.06%
(2) optimal tariff + no retaliation						
USA	1.42%	-15.5%	-50.7%	-38.0%	0.65%	18.04%
non-US (average)	-0.18%	3.6%	-9.2%	-8.4%	-0.18%	-0.89%
(3) liberation tariff + optimal retaliation						
USA	-0.93%	-20.6%	-68.9%	-51.6%	-0.14%	-0.07%
non-US (average)	0.33%	4.8%	-7.3%	-5.9%	-0.13%	-3.58%
(4) liberation tariff + reciprocal retaliation						
USA	-0.30%	-15.8%	-60.8%	-44.6%	0.02%	3.75%
non-US (average)	0.15%	3.7%	-7.0%	-6.2%	-0.12%	-2.64%

The bottom two panels highlight the drawbacks of unilateral tariffs, which frequently provoke retaliatory measures. When non-U.S. countries respond optimally to the Liberation Day tariffs, the outcome shifts negatively for the U.S., leading to a welfare loss of 0.97 percent. This is accompanied by a deeper reduction in the trade deficit (-60.24 percent), but also more pronounced drops in exports (-62 percent) and imports (-61 percent). Employment declines by 0.44 percent, while real consumer prices drop significantly due to local wage depression and the loss of product variety.

In contrast, non-U.S. countries manage to all but offset their welfare loss to just 0.05 percent. In this process they experience a substantial increase in trade deficit (62 percent), modest declines in exports (-9 percent), and minimal changes in imports (-5 percent). Reciprocal retaliation, where each country imposes counter-tariffs equivalent to U.S. rates, also partially negates U.S. welfare gains, though it imposes less economic damage compared to optimal retaliation on the U.S. economy.

Overall, these findings offer a nuanced view of the potential effects of tariff implementation. While the U.S. economy might see short-term gains in welfare and employment, those benefits are completely offset if the tariffs trigger widespread retaliation from trade partners. Moreover, it is clear that these discriminatory tariffs are neither optimal nor particularly effective at reducing the U.S. trade deficit. In fact, adopting optimal tariffs, those aimed at maximizing unilateral gains, would lead to better outcomes, not just in terms of welfare, but also in narrowing the trade deficit. Ultimately, if retaliation occurs, other countries may be hurt to some extent, but the U.S. would bear the largest losses due to trade isolation.

5.3 How Big are the Resulting Tariff Revenues?

Another important aspect of this policy is revenue generation. There are indications that tariff revenues could reduce the income tax burden on U.S. households. We analyze how much these revenues could replace income taxes in the federal budget. Alessandria et al. (2025) examine various scenarios of tariff revenue usage and the implications for GDP growth.

Table 3 reports tariff revenue under several scenarios, expressed both as a share of GDP and as a share of the U.S. federal budget, which is 23% of GDP (ac reported by St. Louis Fred). The results provide a clear picture of the limited fiscal role tariffs can play in the U.S. context, even under assumptions favorable to revenue generation.

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

				retaliation	
	$\varphi = 1$	$\varphi = 1.1$	optimal tariff	reciprocal	optimal
% of GDP	1.35%	1.30%	1.66%	0.85%	0.97%
% of Federal Budget	5.85%	5.64%	7.23%	3.68%	4.23%

In the baseline case with full pass-through to domestic prices ($\varphi = 1$), tariff revenues equal 1.2 percent of GDP, or 5 percent of the federal budget. When the pass-through is set to $\varphi = 0.5$, revenues increase to 1.5 percent of GDP and 6.6 percent of the budget. This rise reflects the fact that reduced pass-through lessens the domestic price impact, leading to smaller declines in import volumes and, in turn, a higher tariff base. However, optimal tariffs can raise similar revenue shares under the complete pass-through scenario.

Retaliation by trading partners dilutes the tariff revenues as it further shrinks the tariff base. Under optimal retaliation, revenues fall to 0.6 percent of GDP and 2.8 percent of the federal budget. Under reciprocal retaliation, the drop is similar, but marginally smaller. The decline highlights how foreign countermeasures can reduce the tariff base, limiting the effectiveness of unilateral trade taxes as a fiscal tool, echoing the resulst in Lashkaripour (2020).

5.4 Outcomes under Alternative Modeling Approaches

A frequently cited objective of the Liberation Day tariffs was to reduce, or potentially eliminate, the U.S. trade deficit. To analyze their impact, we employed a trade model capable of accommodating trade imbalances, albeit with certain limitations. Traditional trade policy analyses typically address trade deficits using one of two approaches:

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 by computing tariff effects from a counterfactual scenario without deficits. As Ossa (2014) argues, this may be a preferable strategy, since GDP contraction during a trade war can artificially inflate lump-sum transfers tied to the deficit. This inflation could distort welfare assessments by attributing spurious gains to deficit-financed transfers.

In this section, we experiment with both methodologies. Our findings align with results from a broader set of trade models, including the Eaton-Kortum and Krugman frameworks, both of which are also utilized in the aforementioned studies.

Table 4 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)).[7] The amplification of welfare gains under the fixed-deficit specification supports Ossa's conjecture that holding the deficit constant tends to artificially overstate the tariff gains for a country running a trade deficit. At the same time, the results clearly indicate that deficit contraction serves as a mitigating factor, dampening the welfare gains from unilateral tariffs. This suggests that the objective of reducing the trade deficit may be fundamentally at odds with achieving terms-of-trade gains through tariff imposition.

Table 5 summarizes economic outcomes following retaliation. As in the previous case, the model assuming a constant deficit margin exaggerates the welfare gains for the United States, which is a country running a net trade deficit. Meanwhile the fixed-deficit model overstates the negative impacts on countries with a trade surplus in relation to the U.S.

[7] 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 4: Tariff impacts under alternative modeling approaches

Case 1: fixed deficit margin (Dekle et al. (2007))					
Country	Δ welfare	Δ exports	Δ imports	Δ employment	Δ real prices
USA	1.22%	-39.8%	-9.1%	0.48%	9.56%
non-US (average)	-0.48%	-3.8%	-7.3%	-0.09%	-5.63%
Case 2: balanced trade approach (Ossa (2014))					
USA	0.85%	-41.0%	-15.1%	0.17%	7.26%
non-US (average)	-0.40%	-4.3%	-6.7%	-0.10%	-4.01%

By artificially amplifying the gains from tariffs, the fixed-deficit approach predicts positive outcomes for the U.S. even after retaliation. However, as discussed in detail by Ossa (2014), these results are misleading and stem from structural limitations inherent to the fixed-deficit specification. In contrast, the balanced trade approach yields negative outcomes for the U.S. following retaliation, aligning more closely with our baseline analysis.

Overall, these findings reinforce our baseline prediction. Specifically, they demonstrate that employing an alternative modeling framework and treating the trade deficit differently (à la Ossa (2014)) still leads to the same core conclusions, despite some loss of realism in the underlying model.

Table 5: Tariff impacts after retaliation alternative modeling approaches

Case 1: fixed deficit margin (Dekle et al. (2007))					
Country	Δ welfare	Δ exports	Δ imports	Δ employment	Δ real prices
USA	0.16%	-66.4%	-32.0%	0.05%	2.10%
non-US (average)	-0.38%	-5.7%	-7.7%	-0.10%	-6.15%
Case 2: balanced trade approach (Ossa (2014))					
USA	-0.67%	-66.1%	-40.8%	-0.34%	-4.54%
non-US (average)	-0.08%	-5.2%	-5.3%	-0.05%	-3.49%

5.5 Unpacking Global Impacts

We now examine the effects of the Liberation Day tariffs on the global economy. Broadly speaking, these tariffs are expected to impact smaller countries with substantial trade exposure to the United States more severely than others.

Figure 1: The projected global welfare impacts of Liberation Day tariffs

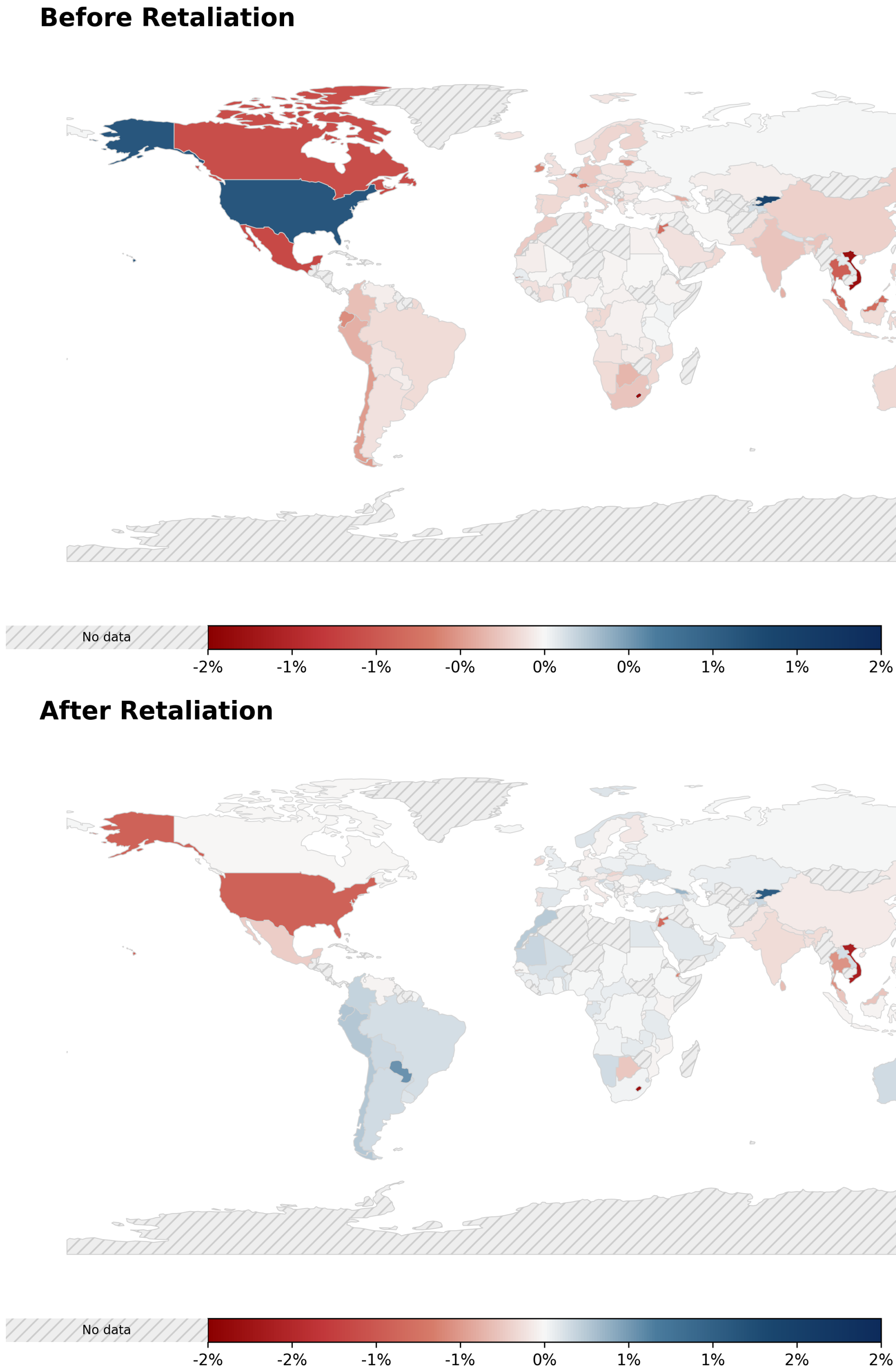

Figure 1 offers a detailed breakdown of the tariff impacts. The top panel illustrates the outcomes in the absence of retaliation by trading partners, while the bottom panel presents the effects following optimal retaliatory measures by those partners.

The figure clearly shows that Canada, Mexico, and several South American countries, whose exports to the United States represent a significant share of their GDP, experience the most substantial losses. In effect, the Liberation Day tariffs trigger a large-scale transfer of economic surplus from these nations to the U.S.

However, much of this transfer is effectively undone once trading partners implement retaliatory measures. While the most exposed countries are able to recover part of their initial losses, the imposition of tariffs results in significant deadweight losses, leading to marked inefficiencies at the global level. Ultimately, the United States emerges as the primary loser under multilateral retaliation. In such a scenario, retaliatory tariffs neutralize the U.S.'s terms-of-trade gains and substantially reduce its benefits from trade by inducing a major diversion of trade flows away from the American economy.

6 Conclusion

We make a first attempt to quantify the long-term effects of the Liberation Day tariffs on welfare changes for the U.S. and its trade partners. While these tariffs may improve U.S. factoral terms of trade temporarily, any welfare gains vanish under reciprocal retaliation.

We aim to continue to evaluate changes in U.S. trade policy. Notably, in future version of the draft, we will incorporate the effects of the tariff war escalation, and consider various concession scenarios.

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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 $\frac{1}{1-\eta_i} = \frac{1}{1-\sigma_i} + \varsigma$, 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 $\tau_{ni} \equiv 1 + t_{ni}$. Under monopolistic competition, firms maximize profits by setting destination-specific prices with a markup over marginal cost.[8]

[8]Destination-specific mark-ups 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

In particular, the price charged by a firm with productivity ϕ in market j is given by

$$p_{ij}(\phi) = \mu_j \frac{\tau_{ij}\tilde{d}_{ij}w_i}{\phi}, \qquad \text{with} \qquad \mu_j \equiv \frac{\sigma_j}{\sigma_j - 1}.$$

The zero-profit condition requires that

$$\pi_{ij}(\phi) = \frac{1}{\sigma_j}\frac{1}{\tau_{ij}} p_{ij}(\phi) c_{ij}(\phi) - w_j f_{ij} = 0.$$

This condition implies a cutoff productivity level given by

$$\phi_{ij} = \frac{1}{\mu_j} \tau_{ij}^{\frac{\sigma_j}{\sigma_j - 1}} \frac{\tilde{d}_{ij} w_j}{P_{ij}} \left(\frac{X_{ij}}{\sigma_j w_j f_{ij}} \right)^{-\frac{1}{\sigma_j - 1}}. \tag{15}$$

Assume now that firms draw productivity from the distribution

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

The corresponding price index is defined as

$$P_{ij} = \left[\int_{\phi_{ij}}^{\infty} p_{ij}(\phi)^{1-\sigma_j} \, dG_i(\phi) \right]^{\frac{1}{1-\sigma_j}},$$

which after plugging firm-level prices and integration, can be expressed as

$$P_{ij} = \left(\frac{\theta - (\sigma_j - 1)}{\theta} \right)^{\frac{1}{\sigma_j - 1}} \tau_{ij}\tilde{d}_{ij}w_i \, b_i^{\frac{\theta}{\sigma_j - 1}} \left[M_i^e \right]^{\frac{1}{\sigma_j - 1}} \phi_{ij}^{\frac{\theta - (\sigma_j - 1)}{\sigma_j - 1}}. \tag{16}$$

Substituting this expression into the cutoff condition (Equation 15) and solving for ϕ_{ij} yields

$$\left(\frac{\phi_{ij}}{b_i} \right)^{-\theta} = \frac{\theta - (\sigma_j - 1)}{\theta \sigma_j} \frac{1}{M_i^e} \frac{X_{ij}/\tau_{ij}}{w_i f_{ij}}.$$

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) and Dhingra and Morrow (2019) among others). The homothetic specification that we opt for in this paper is more transparent.

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

$$M_{ij} = \left[1 - G_i(\phi_{ij})\right] M_i^e = \left(\frac{\phi_{ij}}{b_i}\right)^{-\theta} M_i^e = \frac{\theta - (\sigma_j - 1)}{\theta\sigma_j} \frac{X_{ij}}{w_i f_{ij}}.$$

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

$$\frac{X_{ij}}{\sigma_j \tau_{ij}} - w_j f_{ij} M_{ij} = \frac{\sigma_j - 1}{\theta\sigma_j} \frac{X_{ij}}{\tau_{ij}}.$$

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

$$M_i^e f_i^e = \sum_j \frac{\sigma_j - 1}{\theta\sigma_j} \frac{X_{ij}/\tau_{ij}}{w_i} = \sum_j \left[\nu_j \rho_{ij}\right] \frac{\sum X_{ij}/\tau_{ij}}{w_i},$$

where $\rho_{ij} \equiv \frac{X_{ij}}{\tau_{ij}} / \sum_n \frac{X_{in}}{\tau_{in}}$ denotes net sales shares, with the origin-absorbed profit margin defined as

$$\nu_j \equiv \frac{\theta - (\sigma_j - 1)}{\theta\sigma_j}.$$

Using the labor market clearing condition, we have

$$\sum_j \frac{X_{ij}}{\tau_{ij}} = w_i L_i + \left(\sum_j \nu_j \frac{X_{ij}}{\tau_{ij}} - \sum_j \nu_i \frac{X_{ji}}{\tau_{ji}}\right) = w_i L_i + D_i.$$

where the last line follows from the fact that, per the balanced budget condition,

$$\sum_j \nu_j \frac{X_{ij}}{\tau_{ij}} - \sum_j \nu_i \frac{X_{ji}}{\tau_{ji}} = \sum_j \frac{X_{ji}}{\tau_{ji}} - \frac{X_{ij}}{\tau_{ij}} = D_i$$

Thus, the free entry condition may be rewritten as

$$M_i^e = \sum_j \left[\nu_j \rho_{ij}\right] \left(1 + \frac{D_i}{w_i}\right) \frac{L_i}{f_i^e}.$$

We further assume that there are congestion effects in the barriers to entry, such that the entry cost increases when the country runs a deficit and collects more profits from import content:

$$f_i^e\left(\rho_{ij}, \frac{D_i}{w_i L_i}\right) = \theta f^e \left[\left(1 + \frac{D_i}{w_i L_i}\right) \sum_j \nu_j \rho_{ij}\right]^{-1}.$$

Under this assumption, the aggregate number of firms in country i is given by

$$M_i = \frac{L_i}{\theta f^e}.$$

Finally, plugging Equation 15 into Equation 16 , and invoking the CES import demand specification, $X_{ij} = (P_{ij}/P_i)^{1-\eta} E_i$, yields the the following expression for the price index

$$P_{ij}^{1-\eta_j} = \Upsilon_j^{-\varepsilon} \left(\frac{P_j^{1-\eta_j} E_j}{w_j} \right)^{(\varphi_j - 1)\varepsilon} \left(\frac{d_{ij} w_i}{A_i L_i^{\psi}} \right)^{-\varepsilon} \left(1 + t_{ij}\right)^{-\varphi_j \varepsilon},$$

where $\Upsilon_j \equiv \left(\frac{\theta}{\sigma_j - 1} - 1 \right)^{\frac{1}{\theta}} \sigma_j^{\sigma_j - 1} \mu_j^{-1} f_{jj}^{\varphi_j - 1}$ is a constant price shifter, $d_{ij} \equiv (f_{ij}/f_{jj})^{\varphi_j} \tilde{d}_{ij}$, and the structural elasticities are defined as

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

Combining this result with the CES import demand function gives

$$\lambda_{ij} = \left(\frac{P_{ij}}{P_j} \right)^{-\gamma_j} = \frac{(1 + t_{ij})^{-\varphi_j \varepsilon} \left(d_{ij} w_i / A_i L_i^{\psi} \right)^{-\varepsilon}}{\sum_n (1 + t_{nj})^{-\varphi_j \varepsilon} \left(d_{nj} w_n / A_n L_n^{\psi} \right)^{-\varepsilon}}.$$

Substituting the expression for $P_{ij}^{1-\eta}$ into $P_j^{1-\eta_j} = \sum P_{ij}^{1-\eta_j}$ and solving for P_j, we get the following expression for the consumer price index:

$$P_j = \Upsilon_i \left[\frac{E_j}{w_j} \right]^{\varphi_j - 1} \left[\sum_i \left(\frac{d_{ij}}{A_i L_i^{-\psi}} \right)^{-\varepsilon} (1 + t_{ij})^{-\varphi_j \cdot \varepsilon} w_i^{-\varepsilon} \right]^{-\frac{1}{\varepsilon}}$$

Invoking the balanced budget condition for country j, namely, $E_j = w_i L_i + \sum \frac{t_{ij}}{1+t_{ij}} \lambda_{ij} E_j$, we get

$$E_j = \frac{w_i L_i}{1 - \sum \frac{t_{ij}}{1+t_{ij}} \lambda_{ij}} = \frac{w_i L_i}{\sum \frac{1}{1+t_{ij}} \lambda_{ij}},$$

which simplifies the first term in the price index as $\frac{E_j}{w_j} = \left(\sum_i \frac{\lambda_{ij}/(1+t_{ij})}{L_j} \right)$.

A.1 More general passthrough specification

In the baseline model, the passthrough of tariffs to firm-level prices is complete. However, the aggregate tariff passthrough 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: $p_{ij}(\phi) = \mu_j \frac{\tau_{ij}\tilde{d}_{ij}w_i}{\phi}$, where $\tau_{ij} \equiv 1 + t_{ij}$ denotes the tariff in a compact form. Under this specification, the passthrough at the firm level is complete—i.e., $\frac{\partial \ln p_{ij}(\omega)}{\partial \ln \tau_{ij}} = 1$.

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

$$p_{ij}(\phi) = \mu_j \frac{(\tau_{ij}\tilde{d}_{ij})^{\tilde{\varphi}_j} w_i}{\phi}.$$

where the exponent $\tilde{\varphi}_j$ 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. In this generalized setting, the equilibrium has the same macro-level representation, but the effective passthrough becomes:

$$\varphi_j = \tilde{\varphi}_j + \frac{1}{\sigma_j - 1} + \frac{1}{\theta}$$

and the bilateral non-tariff barriers are now expressed as $d_{ij} \equiv (f_{ij}/f_{jj})^{\varphi_j} \tilde{d}_{ij}^{\tilde{\varphi}_j}$.

B 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 separability of the gravity equation, we can specify trade flows as

$$\frac{1}{1 + t_{ni}} X_{ni} = \Phi_i \Omega_n \delta_{ni},$$

where Φ_i and Ω_n are exporter and importer fixed effects using the language of the gravity literature:

$$\Phi_i \equiv \left(w_i/(A_i L_i^{\psi})\right)^{-\varepsilon}, \qquad \Omega_n \equiv \frac{E_n}{\sum_j \left(d_{jn}/(A_j L_j^{-\psi})\right)^{-\varepsilon} (1+t_{jn})^{-\varphi_i \cdot \varepsilon} w_j^{-\varepsilon}}$$

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

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

and the budget constraint can be specified as

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

which together imply he 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

$$x_i \equiv \frac{\Phi_i}{\Omega_i} = \frac{\sum_n \Phi_n \delta_{in}}{\sum_n \Omega_n \delta_{in}} = \frac{\sum_n x_n \Omega_n \delta_{in}}{\sum_n \Omega_n \delta_{in}} = \sum_n \omega_{in} x_n \tag{17}$$

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, $W \equiv [w_{ij}]_{i,j}$. S ince every entry of W is strictly positive and each row sums to 1, W is a positive stochastic matrix. In vector notation, equation (17) becomes

$$W x = x.$$

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 $W x = x$ 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:

$$X_{ni} = \Phi_n \Phi_i d_{ni} = \Phi_i \Phi_n d_{ni} = X_{in}.$$

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 $n \neq i$.

C 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:

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

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 $\left(\frac{w_i}{P_i} \right)^{1+\kappa} = \frac{w_i L_i}{P_i}$. We can now plug these values back into the first-order condition to obtain:

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

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 $\frac{d \ln P_i}{d \ln \tau_i}$ as

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

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:

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

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

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

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

$$\left(w_i L_i - X_{ii} - (\varphi_i - 1)\sum_l t_{li}X_{li}\right)\frac{d\ln w_i}{d\ln\tau_{ni}} + \varphi_i\sum_j t_{ji}\frac{dX_{ji}}{d\ln\tau_{ni}} = 0 \tag{18}$$

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

$$\left[\sum_{n\neq i}(1-\nu_n)X_{in}\frac{d\ln X_{in}}{d\ln w_i}\right]\frac{d\ln w_i}{d\ln\tau_{ni}} - \sum_{j\neq i}(1-\nu_i)\frac{dX_{ji}}{\partial\ln\tau_{ni}} \tag{19}$$

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 19, yields the following

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

where the derivation uses $w_i L_i - X_{ii} = \sum_{j \neq i} X_{ij} + D_i = \sum_{j \neq i} X_{ji}$. Plugging the above equation back into the equation 18, we get the following first-order conditions

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

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

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

which, after rearranging, yields the following optimal tariff formula

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