FALLING DOMINOES?
The Impact of the US Exit from Free Trade on the Sustainability of Trade Cooperation*

Barthélémy Bonadio
NYU-Abu Dhabi
and CEPR

Andrei A. Levchenko
University of Michigan
NBER and CEPR

Nitya Pandalai-Nayar
University of Texas at Austin
and NBER

March 2026

Abstract

This paper quantitatively evaluates other countries' optimal tariffs and the prospects of sustaining international trade cooperation when a large player – the United States – exits the cooperative trade regime. To guide the analysis, we rely on an analytical characterization of the optimal tariff in a simplified multi-country trade model with endogenous labor supply. A country's optimal import tariffs are a function of its trade partners' expenditure shares on its goods, and the trade and labor supply elasticities. In both the simplified model and the full quantitative multi-country, multi-sector global network model, the impact of the US withdrawal from free trade on other countries' optimal tariffs and the sustainability of the cooperative trade regime is minimal. This is because quantitatively, the key determinants of these objects – domestic and international trade shares of other countries – change little from the US withdrawal. This main finding is not sensitive to the trade or labor supply elasticities. Thus, the fall of the US free trade domino is unlikely to cause further dominoes to fall.

Keywords: optimal tariffs, cooperative trade regime, quantitative trade models

JEL Codes: F02, F13, F55

*Dedicated to the memory of John Leahy. We are grateful the editor (Gianluca Violante) and seminar participants at JHU-SAIS and Stanford for comments, to Manuel Diaz de la Fuente for excellent research assistance.

Email: bbonadio@nyu.edu, alev@umich.edu and npnayar@utexas.edu.

1. Introduction

A celebrated result in international trade is that from the perspective of an individual country, the welfare-maximizing import tariff is positive (Kahn, 1947; Johnson, 1951). More recent quantitative assessments of the level of unilaterally optimal tariffs put them at quite high levels, 20-60% (Ossa, 2014; Costinot and Rodríguez-Clare, 2014). For most country pairs, however, observed current import tariffs are much smaller, often as low as 3-4% (Bagwell, Bown, and Staiger, 2016). This observation is rationalized as the cooperative equilibrium of a repeated prisoner's dilemma game between countries. Moving from the static Nash equilibrium with unilaterally optimal tariffs to free trade produces mutual gains, but the cooperative equilibrium can only be sustained in a repeated game (Bagwell and Staiger, 2002). Of course, a cooperative outcome is only an equilibrium under the right values of payoffs and discount rates.

Recent US trade policy changes suggest a permanent (or at least protracted) US exit from the cooperative trade equilibrium that held prior to the first Trump administration. The US is a major player in global trade, accounting for 8.7% of world exports and 13.8% of world imports in 2024 (World Trade Organization, 2024). As a result, the sustainability of global free trade outside of the US has been a subject of an active debate in the policy and journalistic discourse.[1]

This paper evaluates analytically and quantitatively the impact of the US exit from the free trade regime on unilateral optimal tariffs of other countries, their cooperative versus noncooperative welfare levels, and thus the sustainability of the cooperative equilibrium between the remaining countries. We capture sustainability of cooperation as the minimum discount factor that ensures existence of a cooperative free trade equilibrium under the punishment of the noncooperative Nash tariffs for some (possibly infinite) future number of periods.

We first show analytically that in a simple version of a standard multi-country quantitative trade model, the unilaterally optimal tariff is a function of the export-share weighted foreign absorption share on that country's goods in other countries, the trade elasticity, and the Frisch elasticity of labor supply.[2] Further, a country's welfare in this setting is a function of its domestic absorption share, the trade and labor supply elasticities, and the optimal tariff, similar to Arkolakis, Costinot, and Rodríguez-Clare (2012, ACR). This implies that the sustainability of the cooperative equilibrium between the remaining world countries following US exit depends on two objects: (i) the change in the optimal tariffs following the US shock; and (ii) the changes in each country's domestic absorption share. Both of these are general equilibrium objects that depend on the entire reorganization of world

[1] For example, two *New York Times* articles appearing one day apart articulate opposing viewpoints on this: "Leaders around the world are struggling to decide whether to raise trade barriers to protect what is left of their countries' industrial sectors. [...] Other nations are on high alert for the possibility that Chinese exports could be diverted elsewhere, threatening the economies of longstanding US allies like the European Union and South Korea." (*The New York Times*, "'The Tsunami Is Coming': China's Global Exports Are Just Getting Started," 7 April, 2025; versus "... the rise of free trade may be irreversible, its benefits so powerful that the rest of the world finds a way to keep the system going, even without its central player," (*The New York Times*, "Trump's Tariffs Will Wound Free Trade, but the Blow May Not Be Fatal," 6 April, 2025.

[2] This result extends the Lashkaripour (2021) and Ignatenko et al. (2025) formula to a case with flexible labor supply.

trade following the US shock, and thus require counterfactual analysis.

We use a multi-country multi-sector model with production networks (Bonadio et al., 2021; Huo, Levchenko, and Pandalai-Nayar, 2025) implemented on the EU, China, and 40 other countries to simulate the US exit from the free trade regime.[3] The model is calibrated with standard parameters and using data from the OECD input-output tables. We first work with a simplified, one-sector version of the model in which both the unilateral optimal tariff formula, and the ACR-like welfare formula apply. This allows us to transparently demonstrate the determinants of the quantitative results. We compute unilaterally optimal noncooperative tariffs and Nash equilibrium noncooperative tariffs, both before and after the US moves to autarky.[4] When the US exits, unilaterally optimal tariffs and welfare in the Nash non-cooperative equilibrium change, and the gains from free trade between the remaining players change as well. Thus, all payoffs in the tariff prisoner's dilemma game for the remaining countries are affected.

However, our main quantitative finding is that the US exit from the world trading system has limited impact on those objects, and therefore on the sustainability of cooperative equilibria. Optimal tariffs and relative welfare levels in the noncooperative and cooperative equilibria change very little. The analytical results help understand this quantitative outcome. The optimal noncooperative tariffs depend on the inner product of the vector of a country's export shares and the vector of other countries expenditure shares on its goods. Quantitatively, this number, and consequently the optimal tariff changes little for most countries in the world.[5] (In the small open economy limit, this product of shares equals zero throughout, and the optimal tariff is constant and equals the inverse of the trade elasticity. It turns out that it does not change much even in the largest economies in the world, such as the EU and China, when the US exits.)

When it comes to sustaining cooperation, what matters is the relative welfare levels in the cooperative vs. noncooperative regime. The US exit affects sustainability of cooperation to the extent that it changes these welfare levels. In turn, welfare can be expressed in terms of the domestic absorption shares and the optimal tariff. Quantitatively, neither of those objects change much in most economies following the US exit. Thus, the sustainability of cooperation is largely unaffected by the US exit. We also quantify a more realistic scenario where the US imposes the average tariffs observed in the aftermath of April 2025 ("Liberation Day"). Again, this has a modest impact on the sustainability of cooperative equilibria outside of the US.

The results are insensitive to the trade elasticity – for higher trade elasticities, trade shares see larger changes, but these are offset by the lower optimal tariff under the higher absolute value of the elasticity. We then consider several extensions of our baseline model. First, we study inelastic

[3] To make the analysis as stark as possible, in the baseline we assume the US moves to autarky in this exercise. We also consider the "Liberation Day" tariffs.

[4] Nash equilibrium tariffs are each country's unilaterally optimal tariff when all other countries have their optimal tariffs. We solve for them using a recursive fixed point approach.

[5] To be precise, the optimal tariff formula is implicit and is expressed a function of the trade shares *under the optimal tariff*. In practice, the actual optimal tariff that we compute numerically is well-approximated by the formula under the pre-tariff trade shares.

labor supply, which is a common assumption in the trade literature. The formula for the unilaterally optimal tariff under fixed labor supply is found in Lashkaripour (2021) and Ignatenko et al. (2025). With flexible labor supply, the terms of trade improvement when a country imposes tariffs results in lower real wages and lower hours worked in the foreign countries. This reduction in demand for the importing country's goods mitigates the incentive to impose tariffs, and the implied optimal tariffs are slightly lower for the largest economies such as the EU and China. However, even in this setting, while the implied discount factors that sustain cooperation are modestly higher, they change very little when the US exits.

Second, we consider a multi-sector extension of our model with global input-output linkages. While there is no analytical formula for uniform optimal tariffs in this more general multi-sector setting, the optimal tariffs and the sustainability of cooperation can be computed numerically. This model implies lower unilaterally optimal tariffs, but the discount factor sustaining cooperation is minimally impacted by the US exit.

Related literature. Our work builds on a vast literature on optimal trade policy, that would be impractical to fully review here. As is well known, the unilateral welfare-maximizing import tariff is positive (Kahn, 1947; Johnson, 1951; Gros, 1987). The static tariff policy game has a prisoner's dilemma structure, and it has been noted that a cooperative free trade regime can be sustained as a repeated game equilibrium. In this context, a common approach has been to assume a breakdown in cooperation with produce a reversion to Nash equilibrium optimal tariffs (McMillan, 1986; Dixit, 1987).[6] Repeated games have been used to study the role of multilateral institutions sustaining cooperation (Maggi, 1999) and changing levels of protectionism to sustain a cooperative equilibrium in response to changes in trade volumes (Bagwell and Staiger, 1990). Bagwell, Bown, and Staiger (2016) and Grossman (2016) review this literature. Quantifications of the levels of the optimal tariffs include Alvarez and Lucas (2007), Ossa (2014), and Costinot and Rodríguez-Clare (2014). While most analysis of repeated games is theoretical, closely related recent work by Mei (2020) uses a quantitative multi-country multi-sector Krugman model in a repeated game to find the minimum discount factor consistent with sustaining cooperative equilibria. While the focus of that paper is how the minimum discount factor sustaining cooperation can vary based on possible punishment, our quantitative emphasis here is on the sustainability of cooperation when the U.S. exits the cooperative equilibrium.

The recent increase in protectionism worldwide, beginning in 2016 with Brexit and the first Trump administration have renewed the interest in the welfare impacts of tariffs. Lashkaripour (2021), Caliendo et al. (2023) Caliendo and Feenstra (2024), Alessandria, Ding, and Khan (2025), Bai et al. (2025a,b); Bai, Lu, and Wang (2025), Blanchard, Bown, and Johnson (2025), Ignatenko et al. (2025), Itskhoki and Mukhin (2025), Dávila et al. (2025), Becko, Grossman, and Helpman (2025), Hu,

[6] Cooperation can be sustained in a repeated prisoner's dilemma game if the long-term discounted loss from a breakdown in cooperation is larger than the short-term benefit from deviation. Fudenberg and Maskin (1986) shows that any cooperative solution is sustainable for a sufficiently high discount factor, where the punishment from deviation is the Nash equilibrium in all future periods.

Mei, and Ni (2025) among others, provide optimal tariff analytics and quantifications. Our optimal tariff formula is heavily based on Lashkaripour (2021) and Ignatenko et al. (2025), extending it to flexible labor supply. Our focus is not on unilaterally optimal tariffs per se, but on the sustainability of free trade cooperation outside of the US.

Finally, our quantitative implementation builds on our research program that studies shock propagation in the global input-output network economy (Bonadio et al., 2021, 2025; Huo, Levchenko, and Pandalai-Nayar, 2025). Here, we extend the framework to include tariffs and apply it to questions related to optimal trade policy and trade cooperation.

The rest of the paper is organized as follows: Section 2 describes the theoretical framework and states the closed-form optimal tariff and welfare formulas. Section 3 sketches the repeated trade policy game and derives the formula for the minimum discount factor required for sustainable cooperation. Section 4 quantifies the model, and Section 5 concludes. The Appendix collects additional details on data, theory, and quantification.

2. Theoretical Framework

This section first introduces the multi-country, multi-sector quantitative framework that builds on Bonadio et al. (2021, 2025) and Huo, Levchenko, and Pandalai-Nayar (2025). We then present the optimal tariff and welfare formulas in a simplified single-sector version of the model. Note that the framework below is static. As such, our analysis should be interpreted as comparing cooperative versus non-cooperative steady-state equilibria.

The model world economy is comprised of N countries indexed by n, m, and ℓ and J sectors indexed by j, i, and k. Each country n is populated by households that consume the final good available in country n and supply labor to firms. Production uses labor and bundles of sectoral intermediate inputs. There is international trade in both intermediate and final goods, subject to iceberg trade costs and possibly tariffs. Tariff revenue is rebated back to households and used in consumption.

2.1 Households

There is a continuum of individuals of exogenous mass L_n in each region n. Each individual is indexed by ω and draws a sector-specific productivity $b_{nj}(\omega)$. The sector-specific productivity draws follow a Fréchet distribution with central tendency parameter ξ_{nj} and dispersion parameter μ. Each individual chooses which sector to work in, number of hours worked, and the consumption bundle to maximize the utility:

$$\max_{\mathcal{F}_n(\omega), H_n(\omega), j} \left(\mathcal{F}_n(\omega) - \frac{H_n(\omega)^{1+1/\psi}}{1+1/\psi} \right)$$

subject to

$$P_n \mathcal{F}_n(\omega) = W_{nj} b_{nj}(\omega) H_n(\omega) + \frac{R_n}{L_n}$$

where $\mathcal{F}_n(\omega)$ is the consumption bundle whose price index is P_n, W_{nj} is the price of an efficiency unit of labor supplied to sector j in country n, and R_n are aggregate tariff revenues rebated to the households.[7]

Sectoral choice and sectoral effective labor supply. Standard steps lead to the probability of a household choosing to supply labor to sector j:

$$\pi_{nj}^H = \frac{\xi_{nj} W_{nj}^{\mu}}{\sum_i \xi_{ni} W_{ni}^{\mu}}.$$

Denote by $W_n = \left(\sum_i \xi_{ni} W_{ni}^{\mu}\right)^{\frac{1}{\mu}}$ the wage aggregate for the economy. The total sectoral labor supply is given by:

$$H_{nj} = \xi_{nj} \left(\frac{W_n}{P_n}\right)^{\psi} \left(\frac{W_{nj}}{W_n}\right)^{\mu-1} \Gamma\left(1 - \frac{\psi+1}{\mu}\right) L_n, \tag{2.1}$$

where $\Gamma(.)$ is the Gamma function. Finally, the aggregate labor supply is

$$H_n = \left(\frac{W_n}{P_n}\right)^{\psi} \Gamma\left(1 - \frac{\psi+1}{\mu}\right) L_n. \tag{2.2}$$

The aggregate labor supply elasticity is given by ψ. The labor supply elasticity to a given sector j conditional on a fixed aggregate labor supply is $\mu - 1$ (eq. 2.1). Lower values of μ imply less labor mobility across sectors.

Our specification nests a variety of labor supply frameworks in macro and trade. In canonical trade models that reflect the long run, labor is assumed to be in fixed aggregate supply, but perfectly mobile across sectors. That would correspond to $\psi = 0$ and $\mu \to \infty$. Increasingly, the trade literature has worked with models in which labor is not perfectly mobile across sectors, as exemplified for instance by the "Roy-Fréchet" framework (e.g. Lagakos and Waugh, 2013; Hsieh et al., 2019; Galle, Rodríguez-Clare, and Yi, 2023). These models would correspond to $\psi = 0$ and a finite μ. In canonical macro models aggregate labor supply is variable, $\psi > 0$. Variable aggregate labor supply can coexist with either perfect labor mobility across sectors ($\mu \to \infty$), or frictional mobility across sectors (finite μ).

Sectoral consumption and final trade shares. The final consumption bundle consists of two nests. The upper nest is a CES aggregator of goods from each sector, and the lower nest is an Armington

[7] Exogenous unbalanced trade can be accommodated as an transfer D_n/L_n in the budget constraint, where $\sum_n D_n = 0$. See Pujolas and Rossbach (2024) on how trade deficits affect optimal trade policy.

aggregator of goods from all source countries. The final upper nest is:

$$\mathcal{F}_n = \left[\sum_j \zeta_{nj}^{\frac{1}{\rho}} \mathcal{F}_{nj}^{\frac{\rho-1}{\rho}}\right]^{\frac{\rho}{\rho-1}},$$

and the associated price index is P_n:

$$P_n = \left[\sum_j \zeta_{nj} \left(P_{nj}^f\right)^{1-\rho}\right]^{\frac{1}{1-\rho}}.$$

Trade is subject to iceberg costs τ_{mnj} to ship good j from country m to country n (throughout, we adopt the convention that the first subscript denotes source, and the second destination). Additionally, there may be gross ad-valorem tariffs t_{mnj}. The lower nest (sector j bundle) is an Armington aggregate of goods coming from all source countries:

$$\mathcal{F}_{nj} = \left[\sum_m \mu_{mnj}^{\frac{1}{\gamma}} \mathcal{F}_{mnj}^{\frac{\gamma-1}{\gamma}}\right]^{\frac{\gamma}{\gamma-1}}$$

with the associated price index:

$$P_{nj}^f = \left[\sum_m \mu_{mnj} (\tau_{mnj} t_{mnj} P_{mj})^{1-\gamma}\right]^{\frac{1}{1-\gamma}},$$

where P_{mj} is the factory-gate price of sector j output in country m. The final expenditure shares are:

$$\pi_{nj}^f = \frac{\zeta_{nj}\left(P_{nj}^f\right)^{1-\rho}}{\sum_k \zeta_{nk}\left(P_{nk}^f\right)^{1-\rho}} \quad \text{and} \quad \pi_{mnj}^f = \frac{\mu_{mnj}\left(\tau_{mnj} t_{mnj} P_{mj}\right)^{1-\gamma}}{\sum_\ell \mu_{\ell nj}\left(\tau_{\ell nj} t_{\ell nj} P_{\ell j}\right)^{1-\gamma}}.$$

2.2 Production

A representative firm in sector j in country n operates a CRS production function

$$Y_{nj} = Z_{nj} H_{nj}^{\eta_j} X_{nj}^{1-\eta_j}$$

where X_{nj} is the intermediate input bundle:

$$X_{nj} \equiv \left(\sum_i \vartheta_{i,nj}^{\frac{1}{\varepsilon}} X_{i,nj}^{\frac{\varepsilon-1}{\varepsilon}}\right)^{\frac{\varepsilon}{\varepsilon-1}}$$

and the use of sector i intermediate inputs is also an Armington aggregate from different source countries:

$$X_{i,nj} \equiv \left(\sum_m \mu_{mi,nj}^{\frac{1}{\nu}} X_{mi,nj}^{\frac{\nu-1}{\nu}} \right)^{\frac{\nu}{\nu-1}}$$

with the associated price index:

$$P_{i,nj}^X = \left[\sum_m \mu_{mi,nj} (\tau_{mni} t_{mni} P_{mi})^{1-\nu} \right]^{\frac{1}{1-\nu}}.$$

Let $\pi_{i,nj}^x$ be the share of sector i in total intermediate expenditure by (n,j), and $\pi_{mi,nj}^x$ be the share of intermediates from country m sector i in total intermediate spending by (n,j), on sector i:

$$\pi_{i,nj}^x = \frac{\vartheta_{i,nj} \left(P_{i,nj}^X \right)^{1-\varepsilon}}{\sum_k \vartheta_{k,nj} \left(P_{k,nj}^X \right)^{1-\varepsilon}} \qquad \text{and} \qquad \pi_{mi,nj}^x = \frac{\mu_{mi,nj} \left(\tau_{mni} t_{mni} P_{mi} \right)^{1-\nu}}{\sum_\ell \mu_{\ell i,nj} \left(\tau_{\ell mi} t_{\ell ni} P_{\ell i} \right)^{1-\nu}}$$

From firms' cost minimization problem, the first-order conditions yield:

$$W_{nj} H_{nj} = \eta_j P_{nj} Y_{nj} \tag{2.3}$$

$$\tau_{mni} t_{mni} P_{mi} X_{mi,nj} = \pi_{i,nj}^x \pi_{mi,nj}^x \left(1 - \eta_j \right) P_{nj} Y_{nj}. \tag{2.4}$$

2.3 Equilibrium and Market Clearing

An equilibrium in this economy is a set of goods and factor prices $\{P_{nj}, W_{nj}\}$, labor allocations $\{H_{nj}\}$, and goods allocations $\{Y_{nj}\}$, $\{\mathcal{F}_{mnj}, X_{mi,nj}\}$ for all countries and sectors such that (i) households maximize utility; (ii) firms maximize profits; and (iii) all markets clear.

At the sectoral level, the following market clearing condition has to hold for each n and j:

$$P_{nj} Y_{nj} = \sum_m \frac{1}{t_{mnj}} \left(\sum_i \eta_i P_{mi} Y_{mi} + R_m \right) \pi_{mj}^f \pi_{nmj}^f + \sum_m \frac{1}{t_{mnj}} \sum_i \left(1 - \eta_i \right) P_{mi} Y_{mi} \pi_{j,mi}^x \pi_{nj,mi}^x.$$

Tariff revenue:

$$R_n = \frac{\sum_m \sum_j \frac{t_{mnj}-1}{t_{mnj}} \pi_{nj}^f \pi_{mnj}^f \left(\sum_i \eta_i P_{ni} Y_{ni} \right) + \sum_m \sum_j \frac{t_{mnj}-1}{t_{mnj}} \sum_i \left(1 - \eta_i \right) P_{ni} Y_{ni} \pi_{j,ni}^x \pi_{mj,ni}^x}{1 - \sum_m \sum_j \frac{t_{mnj}-1}{t_{mnj}} \pi_{nj}^f \pi_{mnj}^f}.$$

Labor market clearing:

$$W_{nj} \xi_{nj} \left(\frac{W_n}{P_n} \right)^{\psi} \left(\frac{W_{nj}}{W_n} \right)^{\mu-1} \Gamma \left(1 - \frac{\psi+1}{\mu} \right) L_n = \eta_j P_{nj} Y_{nj}.$$

2.4 Optimal Tariffs and Welfare

We now derive analytical results in a simpler model to provide intuition before turning to the quantitative results. In particular, we assume there is only one sector ($J = 1$) and there are no intermediate inputs ($\eta = 1$). This setting with inelastic labor supply ($\psi = 0$) has been studied by Lashkaripour (2021) and Ignatenko et al. (2025). With flexible labor supply, foreign hours worked react endogenously to tariffs as foreign real wages change, which will impact the expression for the optimal tariff. All derivations for this section are contained in Appendix A.1.

Optimal tariffs. Aggregate welfare in country m is given by:

$$U_m = \frac{R_m}{P_m} + \frac{1}{1+\psi}\frac{W_m H_m}{P_m}. \tag{2.5}$$

To maximize welfare, the government sets tariffs to maximize (2.5) subject to the equilibrium conditions in Section 2.3.

Under the approximation that a country cannot impact the relative wages of other countries to each other, the optimal tariff can be shown to be uniform across all partners and equal to:[8]

$$t_m^* - 1 = \frac{1}{(\gamma - 1) - \left[(\gamma - 1) - \psi\right] \sum_{n \neq m} \omega_{nm} \pi_{mn}}. \tag{2.6}$$

where π_{mn} is the expenditure share of n on goods from m, $\omega_{mn} = \frac{\tilde{X}_{mn}}{\sum_{j \neq m} \tilde{X}_{mj}}$, and $\tilde{X}_{mn}$ is the ex-tariff trade flow from m to n in the equilibrium. The summation term $\sum_{n \neq m} \omega_{mn} \pi_{mn}$ thus represents the export-weighted average expenditure share of partner countries on m's output. When labor supply is fixed, $\psi = 0$, we are back to the Ignatenko et al. (2025) formula. Note that this formula is a generalization of Gros (1987), who stated it for a 2-country case. The small open economy limit of this formula ($\pi_{mn} \to 0$) is the same as the small-country limit of Gros (1987), $t_m^* - 1 = 1/(\gamma - 1)$.

The intuition for why flexible labor supply modifies the optimal tariff formula is as follows. All else equal, an import tariff by country m improves its terms of trade, and by implication worsens the trading partners' terms of trade. That means that the real wage of trading partners falls. That reduces the foreign labor supply and makes foreign goods more expensive at the margin, partly un-doing the terms-of-trade improvement for the tariff-imposing country. This is why the optimal tariff is strictly lower under flexible than fixed labor supply, and it scales with the size of the tariff-imposing country in the export markets $\sum_{n \neq m} \omega_{nm} \pi_{mn}$.[9] This is also why the labor supply elasticity ceases to matter in

[8] That is, the assumption is that the relative wages of foreign countries to each other do not change; the tariff-imposing country's relative wage to the rest of the world is changing. Appendix Figure C4 compares welfare changes from unilaterally optimal tariffs according to the formula to welfare changes under the fully numerically computed optimal tariffs when all wages are flexible relative to each other. The two are almost indistinguishable under various elasticity values, suggesting that this approximation is not restrictive.

[9] Note that this result is obtained under GHH preferences that mute the wealth effects on the labor supply. Under these preferences, the aggregate labor supply is simply isoelastic in the real wage (see eq. 2.2). Wealth effects would mitigate the decline in foreign labor supply in response to the real wage decline. If wealth effects are stronger than the real wage

the small open economy limit, which recovers the Gros (1987) formula.

The optimal tariff in equation (2.6) clarifies that, qualitatively, the US exit from free trade will affect all countries' optimal tariffs. The tariff is a function of all bilateral trade flows of m and of the expenditure shares of all n on m, which are all endogenous objects in the global general equilibrium. When a large player like the US changes its trade policy drastically, the optimal tariff for all $m \neq US$ will change.

Welfare. Appendix A.1 shows that welfare in country m in this simplified model can be expressed as:

$$U_m \propto \left[\bar{t}_m + \psi\left(\bar{t}_m - 1\right)\right] \pi_{mm}^{\frac{1+\psi}{1-\gamma}}, \tag{2.7}$$

where

$$\bar{t}_m \equiv \underbrace{\left(\sum_n \frac{1}{t_{nm}} \pi_{nm}\right)^{-1}}_{\text{harmonic mean gross tariff rate}} .$$

Since the optimal tariff is uniform across partners, $\bar{t}_m$ simplifies to $\bar{t}_m = \left(\frac{1}{t_m^*}(1 - \pi_{mm}) + \pi_{mm}\right)^{-1}$ at the optimum, where π_{mm} is the domestic absorption share. This formula modifies the well-known ACR welfare expression as well as its extension to tariffs by Felbermayr, Jung, and Larch (2015).

Equation (2.7) clarifies the two proximate drivers of welfare changes following any outcome of a tariff game between countries. The first (in brackets) is the tariff revenue effect. All else equal, welfare is higher when import tariffs are higher, due to the usual terms-of-trade effect. Moreover, when labor supply is endogenous, this term is increasing in the disutility of labor (ψ), because tariff revenue is acquired without labor. For a given (uniform) tariff level t_m^*, the tariff effect is larger when the own expenditure share is smaller, as the tariff revenue is higher.

The second part of the decomposition is the real wage effect and its intuition similar to the standard ACR formula, extended for endogenous labor supply. The elasticity of labor supply magnifies the traditional gains from trade, because hours worked also increase in reaction to the change in real wage.

3. Trade Policy Game

We next examine the sustainability of a repeated game cooperative equilibrium. For expositional purposes, we describe the game as the interaction of two large countries (EU and China), but note that the insights apply in a multi-player game as implemented in our quantification in Section 4. In a multi-player context, we can think of each country playing a 2-player game vs. the rest of the world.

effects and labor supply is decreasing in the real wage, the terms-of-trade improvement for the tariff-imposing country will actually raise the labor supply in the trading partners, reinforcing the terms-of-trade effect and increasing the optimal tariff above the fixed labor supply benchmark.

In the background, there is another large country – the US – whose trade policy is exogenous but whose presence affects the global trade equilibrium.

Two trade partners, the EU and China, play a tariff-setting game. Payoffs are given by the following table:

		EU	
		Cooperate	Defect
CHN	Cooperate	$\left(U_{CHN}^{c,c}, U_{EU}^{c,c}\right)$	$\left(U_{CHN}^{c,d}, U_{EU}^{c,d}\right)$
	Defect	$\left(U_{CHN}^{d,c}, U_{EU}^{d,c}\right)$	$\left(U_{CHN}^{d,d}, U_{EU}^{d,d}\right)$

The first superscript denotes China's cooperate/defect strategy, second superscript the EU's. Cooperate in this case means free trade, defect means set the unilaterally optimal tariff on the partner. Following the discussion above, the payoffs respect the following constraints:

$$\begin{aligned} U_n^{c,c} &> U_n^{d,d} \quad n = CHN, EU \\ U_{EU}^{c,d} &> U_{EU}^{c,c} \\ U_{CHN}^{d,c} &> U_{CHN}^{c,c} \\ U_{CHN}^{c,d} &< U_{CHN}^{c,c} \\ U_{EU}^{d,c} &< U_{EU}^{c,c}. \end{aligned}$$

The first constraint simply states that both countries are better off under cooperation than under mutual defection. The second and third constraints are a direct result of equation (2.6), as welfare under the unilaterally optimal tariff is highest regardless of the choice of the other country. The fourth and fifth constraints just state that deviating from the cooperative equilibrium decreases the welfare of the other player.

This configuration of payoffs makes it a prisoner's dilemma game. The above properties of the payoff matrix hold for any US trade policy, but the actual values of the payoffs will differ depending on what the US does. Unilaterally optimal tariffs, as in equation (2.6), are positive and high, and both countries placing optimal tariffs on each other – (Defect, Defect) – is a Nash equilibrium. However, since import tariffs lower world welfare, both the EU and China are better off with mutual free trade. In a one-shot game mutual free trade is not an equilibrium. That outcome can only occur as an equilibrium of an infinitely repeated game.

Sustainability of cooperation. Taking the EU without loss of generality, in the repeated game the NPV of welfare under cooperation is:

$$\mathcal{U}_{EU}^{c,c} = \sum_{t=0}^{\infty} \beta^t U_{EU}^{c,c} = \frac{U_{EU}^{c,c}}{1-\beta},$$

where β is the discount factor. The NPV of welfare from deviating at $t = 0$, assuming a grim trigger strategy of the other player is:

$$\mathcal{U}_{EU}^{c,d_{t=0}} = U_{EU}^{c,d} + \sum_{t=1}^{\infty} \beta^t U_{EU}^{d,d} = U_{EU}^{c,d} + \frac{\beta}{1-\beta} U_{EU}^{d,d}.$$

Cooperation is sustainable when:

$$\begin{aligned}
\mathcal{U}_{EU}^{c,c} &\geq \mathcal{U}_{EU}^{c,d_{t=0}} \\
1 &\geq (1-\beta)\frac{U_{EU}^{c,d}}{U_{EU}^{c,c}} + \beta\frac{U_{EU}^{d,d}}{U_{EU}^{c,c}}.
\end{aligned}$$

Alternatively, this inequality defines the minimum β for which cooperation is sustainable:

$$\frac{\frac{U_{EU}^{c,d}}{U_{EU}^{c,c}} - 1}{\frac{U_{EU}^{c,d}}{U_{EU}^{c,c}} - \frac{U_{EU}^{d,d}}{U_{EU}^{c,c}}} \leq \beta, \tag{3.1}$$

with the similar counterpart expression for China.

The expressions above assume that the country enjoys one period of the unilateral defection payoff, followed by a lifetime of Nash payoffs. Hence the β should be interpreted as the discount factor over the amount of time needed for the other country to react. For example, if the other player takes a year to react, then the β can be interpreted as a yearly discount factor. If the other player is faster to react, the yearly discount factor required to sustain cooperation can be computed from an annual discount factor β_y as $\beta_y = \beta^{1/t}$ where t is the fraction of months in the year before the reaction occurs.[10] Mitchener, O'Rourke, and Wandschneider (2022) document that retaliation in the Smoot-Hawley Trade War was very fast for the countries who retaliated to US tariffs. On the other hand, widespread retaliation to US Liberation Day tariffs of April 2025 had not materialized as of early 2026. More broadly, Horn, Johannesson, and Mavroidis (2011) report that the WTO dispute resolution process lasted on average 15 months.

Using (2.7), the ratio of welfare between defection and cooperation can be written as:

$$\frac{U_m^{c,d}}{U_m^{c,c}} = \left[(1+\psi)\left(\frac{1}{t_m^{c,d}}(1-\pi_{mm}^{c,d}) + \pi_{mm}^{c,d}\right)^{-1} - \psi\right] \times \left(\frac{\pi_{mm}^{c,d}}{\pi_{mm}^{c,c}}\right)^{\frac{1+\psi}{1-\gamma}}. \tag{3.2}$$

where $t_m^{c,d}$ is given by the optimal tariff formula (2.6) evaluated at the defection trade flows. The ratio

[10] Note that in this dynamic infinitely repeated game, a folk theorem applies and almost any payoffs are subgame perfect equilibria. We restrict the equilibrium to a game where the assumption is a one period defection results in a lifetime of Nash payoffs, with no further changes. Naturally, one could compute the discount factor necessary to sustain cooperation with other restrictions, such as punishment for 10 periods followed by a return to cooperation, and so on.

of welfare between Nash and cooperation can also be written in this form. To further gain intuition, approximate equation (3.2) around free-trade ($t_m = 1$) to get

$$\ln \frac{U_m^{c,d}}{U_m^{c,c}} \approx (1+\psi)\left[\left(1-\pi_{mm}^{c,d}\right)\left(t_m^{c,d}-1\right)-\frac{1}{\gamma-1}\ln\left(\frac{\pi_{mm}^{c,d}}{\pi_{mm}^{c,c}}\right)\right].$$

For a small open economy, the optimal tariff equation (2.6) gives $\left(t_m^{c,d}-1\right) = 1/(\gamma-1)$, so that (3.2) further simplifies to

$$\ln \frac{U_m^{c,d}}{U_m^{c,c}} = \frac{1+\psi}{\gamma-1}\left[\left(1-\pi_{mm}^{c,d}\right)-\ln\left(\frac{\pi_{mm}^{c,d}}{\pi_{mm}^{c,c}}\right)\right]. \tag{3.3}$$

The change in welfare from cooperation to unilateral defection depends on the two elasticities, on the defection own-expenditure share and on the change in own-expenditure share. The first term in the bracket captures the tariff revenue, while the log term captures the traditional ACR gains from trade channel. When considering unilateral defection, the tariff channel dominates so that $\frac{U_m^{c,d}}{U_m^{c,c}} > 0$. However, when considering the change to the Nash equilibrium, the own-expenditure trade share channel dominates, so that we get $\frac{U_m^{d,d}}{U_m^{c,c}} < 0$.

All the payoffs in (3.1) will change between the pre-2025 trade equilibrium and the equilibrium in which the US exits global free trade. In particular, the unilaterally optimal tariff for the EU and for China will change when the US moves to autarky. As equation (3.2) makes clear, changes in the payoff matrix when the US exits the free trade equilibrium will depend on changes in the domestic absorption shares and changes in optimal tariffs, which are themselves a function of trade-weighted foreign absorption shares that will change for all countries. Computing the elements of the payoff matrix and the discount factor necessary to sustain a cooperative equilibrium therefore necessitates solving the quantitative model. Section 4 quantifies the changes in the unilaterally optimal tariffs, and relates these changes to model primitives. We compute the minimum country-specific β that can sustain cooperation, and assess how it is affected by the US exit from free trade.

Myopic policymaker. We so far assumed that the country receives one period of unilateral defection, followed by Nash payoffs forever (grim trigger). Suppose that policymakers are myopic and only care about the welfare until T periods after the deviation. Then the minimum β is defined implicitly by the following equation:

$$\frac{1-\beta^T}{1-\beta} = \frac{U_{EU}^{c,d}}{U_{EU}^{c,c}} + \beta\frac{1-\beta^{T-1}}{1-\beta}\frac{U_{EU}^{d,d}}{U_{EU}^{c,c}} \tag{3.4}$$

The same formula applies if the punishment period is only between period 2 and T, and reverts back to cooperation from $T+1$ onwards.[11] We will apply equation (3.4) in the quantitative section to investigate the potential role of myopic preferences driven by short-term political considerations.

[11]In that case, the equation becomes $\frac{1}{1-\beta} = \frac{U_{EU}^{c,d}}{U_{EU}^{c,c}} + \beta\frac{1-\beta^{T-1}}{1-\beta}\frac{U_{EU}^{d,d}}{U_{EU}^{c,c}} + \beta^T\frac{1}{1-\beta}$ which is equivalent.

More generally, the infinitely repeated tariff game is a prisoner's dilemma game, which is known to have potentially many equilibria (the Folk Theorem, Fudenberg and Maskin, 1986).[12]

4. Quantitative Results

The quantitative results compare the welfare of the EU, China and 40 other countries under the current cooperative trade regime to the non-cooperative Nash equilibrium in which all countries set unilateral optimal tariffs derived in Section 2.4 on each other. We perform this exercise for both the pre-2025 world trade regime and the alternative trade regime in which the US exits free trade. We begin with a single sector model, and in extensions consider alternative values of the key elasticities and a multi-sector model with production networks.

4.1 Calibration

Table 1 shows the parameters and expenditure shares required for the numerical implementation. The parsimonious model only requires 4 objects: the trade elasticity, the labor supply elasticity, the bilateral trade shares, and the current ad valorem tariff rates. We set the trade elasticity to 2 following Boehm, Levchenko, and Pandalai-Nayar (2023), and the Frisch elasticity to 0.75 following Chetty et al. (2011), but extensively probe sensitivity to the values of these 2 parameters. The sources for the tariff and trade shares are standard. We aggregate all EU countries to a single country in the model. The baseline quantification uses 42 countries (including an aggregate EU and a composite rest of the world).

Solution method. The model is converted to changes following the approach of Dekle, Eaton, and Kortum (2008), and spelled out in Appendix A.2. Given initial trade shares and tariffs, the algorithm computes the change in equilibrium quantities (trade shares, output, prices, etc.) for any arbitrary vector of tariff changes t_{mn}. In our model, trade is balanced, which is not the case in the data. Thus, we first recover a version of the initial equilibrium that fully satisfies the equilibrium conditions by solving the model with no changes in tariffs, as is standard in the literature (e.g. Costinot and Rodríguez-Clare, 2014; Ossa, 2014). The resulting trade shares are consistent with equilibrium conditions and remain very close to the data.

To solve for optimal trade policy of country n, we numerically find the values of t_{mn} that maximize n's welfare, keeping all other countries' tariffs constant. As shown in Section 2.4, the optimal tariff is uniform across partners for a given country. Hence, we only need to find one tariff per country $t^*_{mn} = t^*_m$, so that the optimal tariff for an importer given other countries' tariffs can be solved using

[12] Conditional on a set of tariffs, the simple one-sector trade model we work with for much of the paper satisfies the conditions for existence of a unique within-period production and trade equilibrium (Allen, Arkolakis, and Takahashi, 2020). Similar theoretical results are not available for the more general multi-sector economy with input-output linkages, but numerically we have not come across multiple within-period production equilibria.

Table 1: Parameter values

Param.	Value	Source	Related to
Parsimonious model			
γ	2	Boehm, Levchenko, and Pandalai-Nayar (2023)	trade elasticity
ψ	0.75	Chetty et al. (2011)	Frisch elasticity of labor supply
π_{mn}		ICIO	bilateral trade shares
t_{mn}		UN-TRAINS	average ad-valorem tariff
Multisector extension			
ρ	1		final cross-sector subst. elasticity
ε	1		interm. cross-sector subst. elasticity
ν	2	Boehm, Levchenko, and Pandalai-Nayar (2023)	trade elasticity in interm. inputs
μ	1.5	Galle, Rodríguez-Clare, and Yi (2023)	Sectoral labor supply elasticity
η_j		ICIO	value added share in gross output
π^f_{nj}		ICIO	sectoral final shares
$\pi^x_{i,nj}$		ICIO	sectoral intermediate shares
π^f_{mnj}		ICIO	final trade shares
$\pi^x_{mi,nj}$		ICIO	intermediate trade shares

Notes: This table summarizes the parameters and data targets used in the quantitative model and their sources.

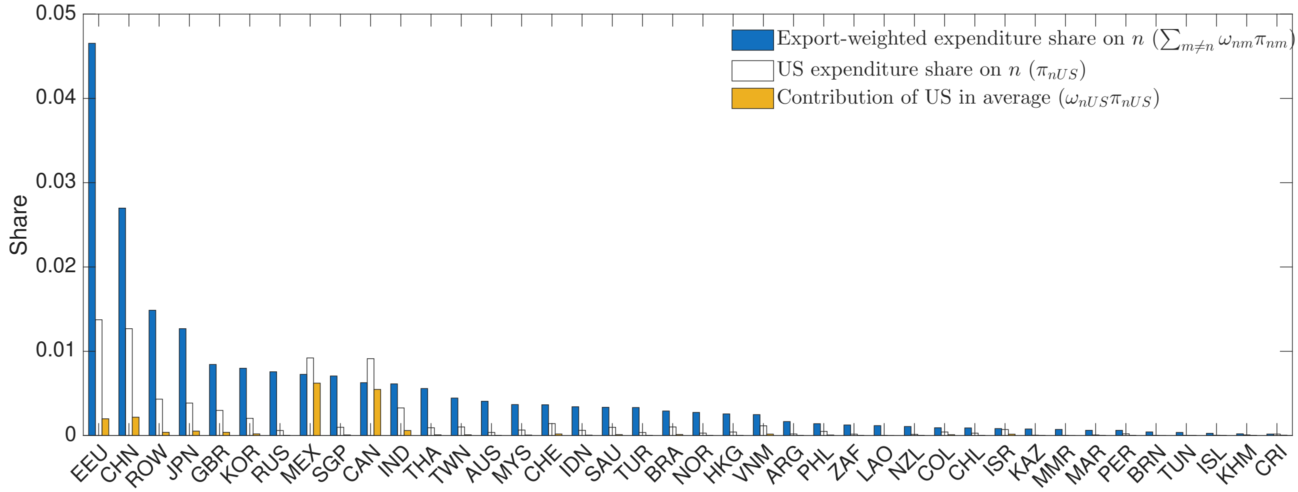
common numerical methods.[13] To solve the Nash equilibrium, we find the country-level optimal tariff sequentially over countries and iterate until convergence. We first solve for the unilateral tariff of every country, keeping other countries' tariffs fixed. We then solve for best-response tariffs country by country given other countries unilateral tariffs, and iterate until each country best-responds to the other countries' tariffs.

4.2 Parsimonious Model

Baseline description. In light of the optimal tariff formula (2.6), the relevant quantities to determine the impact of a US withdrawal on n's tariff are the expenditure share of the US on n (π_{nUS}) and the export-weighted average expenditure of the world on n ($\sum_{m\neq n}\omega_{nm}\pi_{nm}$). Figure 1 displays those quantities in the baseline model calibrated to 2018. Of course, since 2018 tariffs are not at the unilaterally optimal level, those would change under optimal trade policy. Nevertheless, these shares are informative about the likely changes in tariffs when removing the US. The white bars show the export-weighted average expenditure on n ($\sum_{m\neq n}\omega_{nm}\pi_{nm}$), the blue bars show the US expenditure share on n. In all cases except for Canada and Mexico, the blue bar is lower than the white bar. When removing the US, the average should thus increase slightly for all countries except for Canada

[13] Since equation (2.6) only holds for tariff-equilibrium shares ω_{mn} and π_{mn}, we cannot simply plug in data shares to compute the optimal tariff.

Figure 1: Baseline expenditure shares



Notes: The figure displays the expenditure share of the US on other countries, as well as the export-weighted average expenditure shares on all countries, in the baseline model calibrated to 2018 flows. EEU refers to the European Union.

and Mexico, which would imply an increase in optimal tariffs. However, the magnitude is likely to be small, as the contribution of the US to the weighted average (in orange) is very small for most countries. As a consequence, we should not expect a large change in optimal tariffs in most countries when removing the US.

Of course, all these quantities will in principle change in the new trade equilibrium, so we now turn to the quantification.

Optimal tariffs scenarios. We first solve for optimal tariffs in the parsimonious model in which the optimal tariff formula applies, so that the quantitative results are easily interpretable through the lens of theory. Figure 2 shows export-share-weighted average foreign expenditure shares on each country's exports ($\sum_{m \neq n} \omega_{nm}\pi_{nm}$) in the baseline and Nash equilibria. The left-most, blue bar shows these expenditure shares in the 2018 observed equilibrium, that is, with the US participating in free trade. As the world moves to Nash equilibrium from there, foreign absorption shares go down for all countries (red bars). When the US is removed from world trade but the world continues to cooperate in trade, the foreign absorption share increases slightly for most countries relative to the observed level. All in all, however, across all of these scenarios, the differences between equilibria with and without the US are minor quantitatively, suggesting that other countries' unilaterally optimal tariffs will remain mostly unchanged with or without the US according to formula (2.6).

Table 2 displays the optimal unilateral and Nash tariffs, as well as the own expenditure shares (π_{nn}), for China the EU and the average of the other 40 countries, both in the baseline economy and after the US exits world trade. It is immediately apparent that both China and the EU are relatively closed economies, with high domestic absorption ratios of 0.900-0.931. For the other countries in the world the π_{nn}'s are on the order of 0.8. The optimal unilateral defection tariffs are around 100%, and slightly higher for the largest economic blocs in the world, the EU and China. The Nash equilibrium tariffs are quite similar to the unilateral defection tariffs. Evidently, a country's optimal tariffs depend very little on other countries' tariffs, a quantitative outcome also observed by Ossa (2014). It is not surprising as most countries are small relative to the world economy, and for small countries the optimal tariff converges simply to $1/(\gamma - 1)$ regardless of the configurations of its export shares. Indeed, outside of China and the EU, unilateral defection and Nash optimal tariffs are essentially indistinguishable. But even for China and the EU the optimal tariff difference is barely notable.

The middle panel illustrates the equilibrium after the US moves to autarky.[14] At noted above the export-weighted foreign absorption shares of both China and the EU rise slightly (Figure 2), implying that China and the EU become more important sources of other countries' imports. As a result, the optimal tariffs increase relative to the 2018 baseline, but the increase is very modest, less than 0.5 percentage points. Table 2 reports the welfare changes relative to the baseline under the unilateral defection and Nash tariffs with and without the US participating in free trade, computed using equations (2.7) and (3.2). The domestic absorption shares of all countries rise following the US exit. As countries become less open overall, both the welfare increase following a unilateral defection, and the welfare decrease in the Nash equilibrium are smaller in absolute terms relative to the 2018 baseline. Appendix Figure C6 plots the welfare losses from going to the Nash equilibrium for each country and scenario. The variation across countries is very similar across US trade regimes.

The last column uses (3.1) to compute the minimum discount factor at which cooperation is sustainable. On net, the smaller welfare losses of moving to Nash tariffs and the smaller welfare gains from a unilateral defection translate into a very small increase in the discount factor necessary to sustain cooperation, from 0.425 (0.433) for China (EU) to around 0.429 (0.438). All in all, these results suggest that whether or not the US participates in free trade has a minimal impact on the sustainability of trade cooperation elsewhere in the world.

An interesting question is what to make of the overall levels of these implied discount rates. The textbook calibration of annual β is 0.96, much higher than the minimum β's we find, implying that trade cooperation for such an agent is very easy to sustain. However, various political and behavioral frictions may render policy makers effectively much less patient. For example, Amador (2003) argues that re-election risk can make the policy maker act as a hyperbolic discounter, effectively raising impatience. Gabaix (2020) introduces the concept of cognitive discounting, such that limited understanding of the future renders agents as-if less patient. Gabaix (2020) advocates an annual cognitive discount rate of 0.5, only slightly above the baseline minimum β's we recover. This view of discounting would imply cooperation is more fragile than appears at first glance.

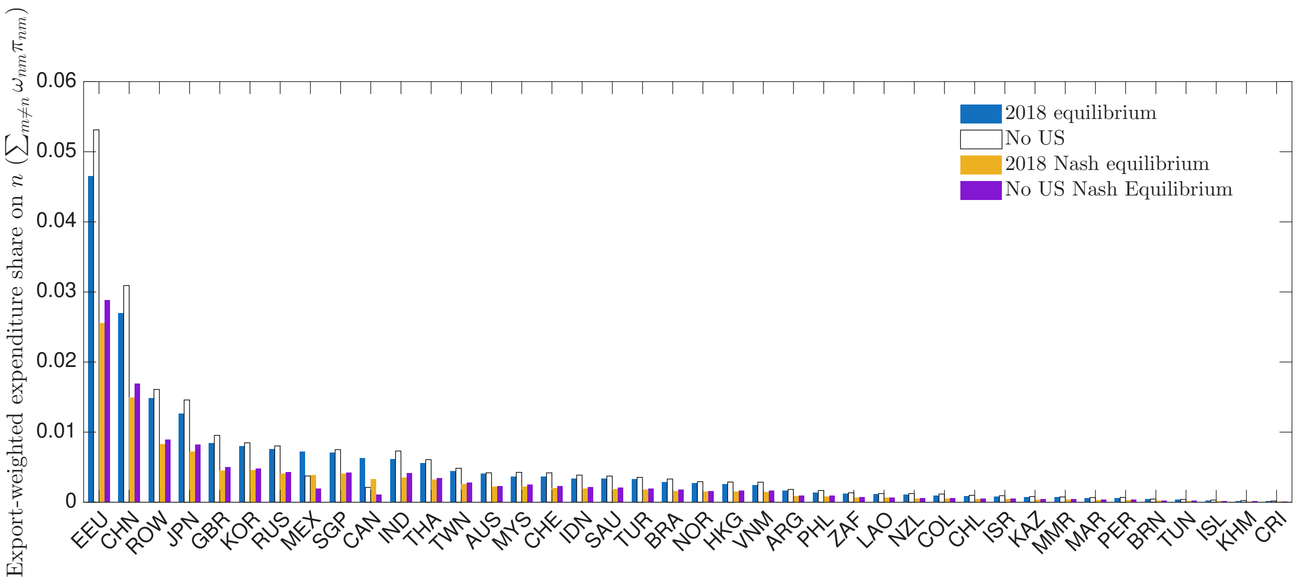
[14] Appendix Figure C5 reports the welfare changes for each country when this happens. All countries in the sample lose from US moving to autarky. The welfare loss for the US from going to autarky is −13.8%.

Table 2: Nash and unilateral defection welfare changes ($\gamma = 2$, $\psi = 0.75$)

	Baseline	Unilateral defection			Nash equilibrium			
Baseline: 2018 tariffs								
	π_{mm}	π_{mm}	Tariff	Δ% U	π_{mm}	Tariff	Δ% U	Min. β
China	0.931	0.945	102.30%	2.09%	0.963	102.05%	-2.91%	0.425
EU	0.900	0.920	101.30%	3.09%	0.946	100.14%	-4.19%	0.433
Average	0.804	0.840	100.38%	5.34%	0.889	100.36%	-9.15%	0.394
Median	0.818	0.852	100.25%	5.11%	0.899	100.21%	-8.57%	0.394
2018 tariffs + US removed from world trade								
	Baseline	Unilateral defection			Nash equilibrium			
	π_{mm}	π_{mm}	Tariff	Δ% U	π_{mm}	Tariff	Δ% U	Min. β
China	0.940	0.952	102.21%	1.85%	0.968	101.78%	-2.51%	0.429
EU	0.915	0.932	101.56%	2.65%	0.954	100.21%	-3.52%	0.438
Average	0.826	0.858	100.44%	4.79%	0.902	100.42%	-8.11%	0.396
Median	0.854	0.881	100.31%	4.34%	0.920	100.29%	-6.82%	0.398
2018 tariffs + "Liberation Day" tariff ($t_{n,US} = 21\%$)								
	Baseline	Unilateral defection			Nash equilibrium			
	π_{mm}	π_{mm}	Tariff	Δ% U	π_{mm}	Tariff	Δ% U	Min. β
China	0.932	0.945	102.32%	2.07%	0.963	102.08%	-2.74%	0.436
EU	0.902	0.921	101.30%	3.04%	0.946	100.14%	-3.88%	0.448
Average	0.807	0.842	100.38%	5.29%	0.889	100.36%	-8.64%	0.405
Median	0.824	0.856	100.25%	5.01%	0.899	100.21%	-7.75%	0.408

Notes: The table displays the percentage changes in welfare relative to the baseline. The "baseline 1" scenario is the current (2018) tariff level equilibrium. The "baseline 2" is the equilibrium that results from shocking baseline 1 with 500% increase in US import and export trade costs, effectively removing the US from the world economy. The "baseline 3" is the equilibrium that results from imposing a uniform tariff of 21% on US imports, with no retaliation. The US still plays Nash tariff. The "Unilateral" columns shows the own trade share, defection tariffs and welfare change when only the row country sets their optimal defection tariff. The "Nash" columns report the own trade shares, tariffs and welfare changes when all countries set their optimal (uniform) tariff given all other countries do the same. The "Minimum β" column computes the minimum discount factor required to sustain the baseline payoff. All payoffs are computed using the model with many countries (while pooling the EU countries into a single one), a single sector, no intermediate inputs, $\gamma = 2$ and $\psi = 0.75$.

Figure 2: Expenditure shares in the baseline and when the US leaves



Notes: The figure displays the export-weighted expenditure share on a country's goods in the 2018 observed equilibrium and simulated 2018 Nash equilibrium, as well as for the scenario where the US is removed from world trade and the resulting Nash equilibrium.

Partial exit of the US. Our baseline exercise removes the US entirely from the world economy. While this scenario is useful as a benchmark, it is extreme. In an alternative exercise, we assume that the US sets a uniform tariff of 21%, corresponding to the import-weighted average of the "Liberation Day" tariffs announced on April 2nd, 2025.[15] In this scenario, the US is still a trade partner of all countries, and in the Nash equilibrium should a country deviate, the US imposes its optimal tariffs in the global Nash equilibrium. In contrast to the baseline in the top panel, all country trade shares with the US are slightly changed in the cooperative equilibrium, as the US is now imposing tariffs even in the setting where the rest of the world cooperates. The bottom panel of Table 2 reports the implied baseline π_{mm}, optimal tariffs, Nash tariffs and welfare changes from applying optimal tariffs and Nash tariffs, together with the β necessary to sustain cooperation.

Both the welfare gains from unilateral defection, and the welfare losses under Nash are in-between the 2018 baseline and the full no-US counterfactual. The net effect is to increase the minimum β slightly, e.g. from 0.425 in the baseline to 0.436 in the "Liberation Day" scenario. The minimum β rises slightly because in this exercise, the US is part of the tariff game. Thus, when placing optimal tariffs, countries also gain from the terms-of-trade improvement vis-a-vis the US. At the same time, the initial US tariff is 21% to start with. Thus, the decline in welfare when the US retaliates with Nash tariffs is smaller than in the baseline in which the US moves to Nash tariffs from negligible initial tariffs. Note that the US experiences a welfare improvement of 1.19% under Liberation Day tariffs when all countries

[15] See the list here: `https://www.whitehouse.gov/wp-content/uploads/2025/04/Annex-I.pdf`.

cooperate, and a welfare decline of −4.34% under the Nash equilibrium in this setting.

In Figure 3 we extend this exercise further to consider the minimum β under alternative possible "Liberation day" tariffs placed by the US. Interestingly, the figure reveals an inverse "U" shaped pattern, as the US tariffs increase towards the US Nash tariffs. For US tariffs less than Nash tariffs, the reasoning above applies, and the minimum β increases. However, once the US tariff reaches the Nash tariff, the minimum β sustaining cooperation declines again. At this point, the US no longer retaliates to deviations, as the Nash tariffs are less than the tariffs the US is putting into place. Therefore, any equilibrium trade shares with the US under these tariffs are protected from retaliation. As the US tariff increases however, equilibrium trade shares with the US decline. Therefore, for the remaining countries, the share of trade subject to retaliation increases, lowering the β necessary to sustain cooperation.

Alternative scenario: no retaliation vis-a-vis the US. In response to the 2025 tariffs, retaliation against the US was largely limited to China. Table 3 reports the results of a scenario where the US imposes "Liberation Day" tariffs and keeps them unchanged. Other countries, when they play unilateral deviation or Nash only change their tariffs on other countries, keeping their tariffs on the US at their current levels. Thus, when placing optimal tariffs, countries make an exception for the US, eliminating terms-of-trade gains with respect to the US. The US is no longer part of the Nash tariff game, and maintains "Liberation Day" tariffs throughout. This scenario captures possible geopolitical motivations, such as defense considerations, that might prevent countries from placing high tariffs on the US. Overall, in this setting, the unilateral deviation tariffs are substantially smaller than the other cases considered, with somewhat smaller welfare gains from deviation. The Nash equilibrium tariffs are slightly larger than the other scenarios, and the Nash welfare losses are smaller, as even in the global-ex US Nash equilibrium, countries trade with the US with "Liberation Day" tariffs. Correspondingly, the minimum β to sustain global cooperation without retaliation against the US rises from an average of 0.405 to an average of 0.433. The one exception is China, whose minimum discount rate rises to 0.579 in this scenario.

Length of punishment and the discount factor. As discussed in Section 3, the discount factor needed to sustain cooperation depends on the duration of the punishment, or equivalently, the time horizon of the policymaker. Our baseline exercises assumed that the punishment lasts for all periods after the initial one-period defection. Figure 4 shows the average minimum discount factor implied by equation (3.4), for varied punishment durations. Unsurprisingly, for punishment that lasts only one or two periods, the implied discount factor to sustain cooperation is substantially higher (at around 0.75 in the fully cooperative baseline, in contrast to 0.397 in Table 2). However, cooperation rapidly becomes sustainable even for moderate duration of punishment, and in about 4 periods of punishment, cooperation is nearly as sustainable as the infinite punishment case. Note that for all durations of punishment, the discount factor required to sustain cooperation is nearly unchanged by the assumptions on the US presence in the global trade equilibrium. It is also notable how valuable

Table 3: No retaliation against "Liberation Day"

	Baseline	Unilateral defection			Nash equilibrium			
	π_{mm}	π_{mm}	Tariff	Δ% U	π_{mm}	Tariff	Δ% U	Min. β
China	0.932	0.942	74.15%	1.61%	0.953	75.98%	-1.18%	0.579
EU	0.902	0.914	63.37%	1.94%	0.932	64.56%	-2.39%	0.454
Average	0.807	0.831	67.59%	3.71%	0.863	68.20%	-5.23%	0.433
Median	0.824	0.841	67.72%	3.32%	0.876	68.31%	-4.70%	0.425

Notes: The table displays the percentage changes in welfare relative to the "Liberation Day" baseline in Table 2. The baseline is the equilibrium that results from imposing a uniform tariff of 21% on US imports, with no retaliation. The US no longer plays Nash tariff, and countries do not retaliate against the US when imposing Nash tariffs. The "Unilateral" columns shows the own trade share, defection tariffs and welfare change when only the row country sets their optimal defection tariff, where the tariff is not imposed on the US. The "Nash" columns report the own trade shares, tariffs and welfare changes when all countries set their optimal (uniform) tariff given all other countries do the same, excluding the US. The "Minimum β" column computes the minimum discount factor required to sustain the baseline payoff. All payoffs are computed using the model with many countries (while pooling the EU countries into a single one), a single sector, no intermediate inputs, $\gamma = 2$ and $\psi = 0.75$. Averages and medians are computed excluding the US.

is free trade. Even under the mildest, 1-period punishment for deviation the required discount factor is around 0.75, far lower than the typically assumed annual discount factors above 0.9.

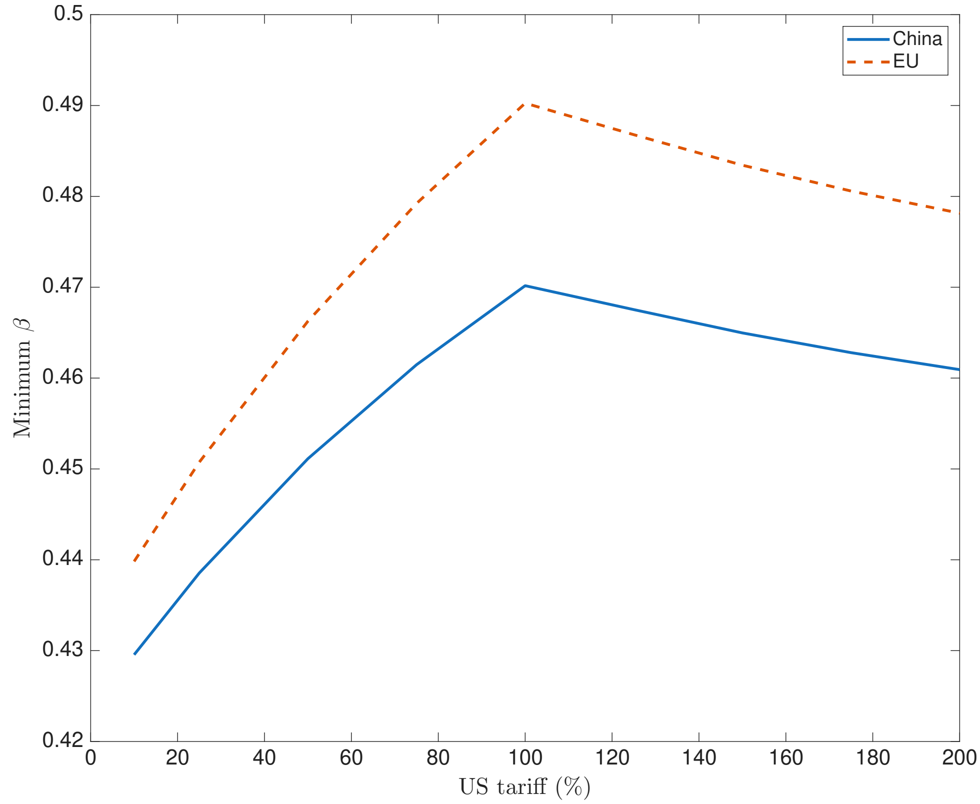
4.3 Alternative Elasticities

We next consider the sensitivity of our results to assumptions on parameters. Table 4 shows the results with a higher trade elasticity ($\gamma = 5$), while Table 5 repeats our exercise with inelastic labor supply, setting $\psi = 0$. Both these alternative elasticities are common in the trade literature.

Trade elasticity. Unilateral and Nash equilibrium optimal tariffs are substantially lower with a higher trade elasticity. This is expected, since the tariff is largely determined by the inverse of the trade elasticity in the formula (2.6). Unsurprisingly, the welfare gains from optimal tariffs, and the welfare losses from a Nash equilibrium, are also smaller, as a higher trade elasticity implies smaller welfare gains from trade (equation 2.7). This implies that the discount factor necessary for cooperation is very similar to the baseline parameters, and again, barely changes when the US trade policy changes to autarky or Liberation day tariffs.

Panel (a) of Figure 5 plots the minimum β for the EU as a function of the trade elasticity. Panel (a) of Appendix Figure C7 does the same for China. As the trade elasticity increases, the minimum discount factor required to sustain cooperation increases, though the changes are modest. For our baseline calibration of $\gamma = 2$, the minimum β for cooperation to be sustainable for the EU ranges between around 0.44-0.47 across scenarios. For an extremely high trade elasticity of $\gamma - 1 = 7$ or 8, the range is around 0.455-0.595.

Figure 3: Discount factor under partial exit of the US

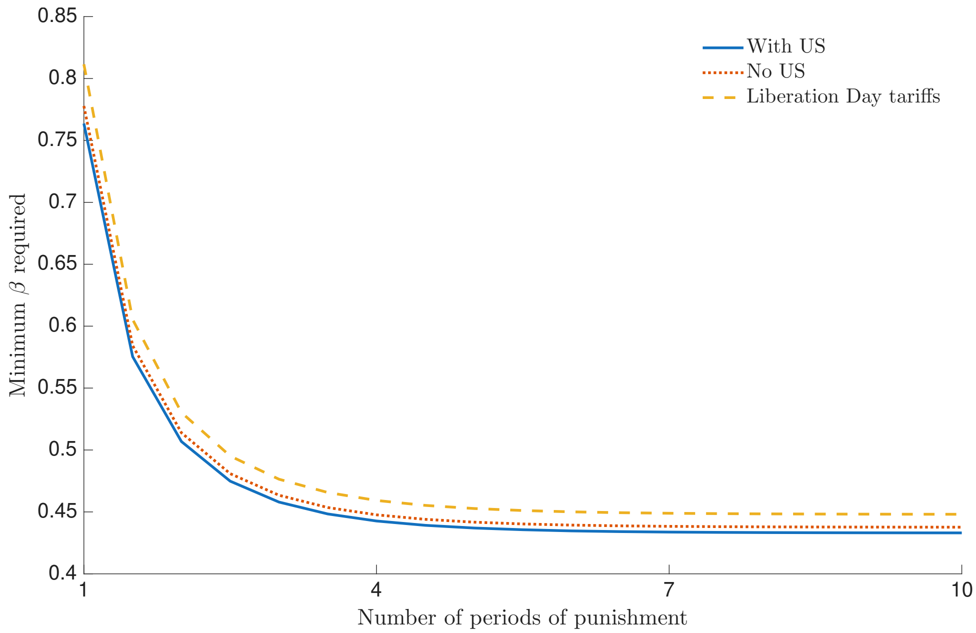


Notes: The figure displays the minimum β under different US tariffs.

Labor supply elasticity. With inelastic labor supply, optimal and Nash equilibrium tariffs are slightly higher, by around 2-3 percentage points for China and the EU, and about 0.2 percentage points for the rest of the countries, on average. This is because when foreign hours worked remain unchanged the positive terms-of-trade effect from imposing tariffs is stronger. As equation (2.7) illustrates, in our setting the labor supply elasticity directly impacts the welfare gains from trade. As a result, gains from unilaterally optimal tariffs are smaller with inelastic labor supply, even when the optimal tariffs are higher. The losses from the Nash equilibrium are also closer to zero. The implied discount factors to maintain a cooperative equilibrium remain very similar to the baseline, with and without US participation in the global trading system.

Panel (b) of Figure 5 plots the minimum β as a function of the Frisch elasticity for the EU (Appendix Figure C7 for China). Cooperation becomes more sustainable at higher Frisch elasticities, reflecting larger gains from trade as ψ increases. To gain intuition as to why the minimum β decreases, notice that equation (3.3) implies that welfare is more sensitive both to tariff revenue and to the own trade share when ψ is higher. In the unilateral deviation, the tariff revenue effect dominates resulting in a positive welfare change magnified by the larger ψ, while in the Nash equilibrium, the welfare change

Figure 4: Discount factor and length of punishment



Notes: The figure displays the minimum β required as a function of the number of punishment periods before reverting to the cooperation strategy. In all scenarios, $\gamma = 2$ and $\psi = 0.75$.

is negative and magnified by the larger ψ as well. As a result, the denominator in equation (3.1) increases more than the numerator, resulting in a lower β required for cooperation. The quantitative impact of larger Frisch elasticities is nevertheless modest. For a high Frisch elasticity of 4, cooperation for the EU is sustainable if β is around 0.397-0.417 across scenarios.

Alternative punishment strategy. Our baseline assumption is that when a country deviates, all other countries move to the multilateral Nash equilibrium, imposing tariffs on all partners. Here, we conduct an alternative punishment strategy. We assume that if country m deviates, all other countries set a retaliatory tariff on m, but keep their tariffs on each other unchanged. For example, if China defects, we assume that starting the next period, all countries impose an optimal tariff on China, and China adapts its tariffs on the rest of the world to best respond to this punishment. This implies an alternative punishment payoff $U_m^{d,d}$, and hence a different minimum β required to sustain cooperation. Table 6 reports the welfare changes and minimum β under this punishment scenario. In all cases, the minimum β is higher than when all countries move to Nash. This is expected, since the welfare loss from being isolated is lower than the welfare loss when the world moves to a full trade war. However, comparing across panels, the minimum discount factor remains fairly stable. The only slight increase happens in the Liberation Day scenario, where cooperation requires a marginally higher discount factor.

Table 4: Nash and unilateral defection welfare changes ($\gamma = 5$, $\psi = 0.75$)

	Baseline	Unilateral defection			Nash equilibrium			
Baseline 1: 2018 tariffs								
	π_{mm}	π_{mm}	Tariff	Δ% U	π_{mm}	Tariff	Δ% U	Min. β
China	0.931	0.951	25.7%	0.52%	0.967	25.8%	-0.74%	0.412
EU	0.898	0.929	25.7%	0.84%	0.952	25.5%	-1.03%	0.452
Average	0.804	0.856	25.2%	1.37%	0.901	25.3%	-2.52%	0.346
Median	0.818	0.866	25.1%	1.27%	0.905	25.1%	-2.29%	0.361
2018 tariffs + US removed from world trade								
	Baseline	Unilateral defection			Nash equilibrium			
	π_{mm}	π_{mm}	Tariff	Δ% U	π_{mm}	Tariff	Δ% U	Min. β
China	0.940	0.958	25.8%	0.46%	0.971	25.8%	-0.62%	0.429
EU	0.914	0.940	25.8%	0.73%	0.959	25.6%	-0.84%	0.467
Average	0.827	0.873	25.2%	1.22%	0.913	25.3%	-2.22%	0.351
Median	0.854	0.894	25.1%	1.07%	0.928	25.1%	-1.99%	0.362
2018 tariffs + "Liberation Day" tariff ($t_{n,US} = 21\%$)								
	Baseline	Unilateral deviation			Nash equilibrium			
	π_{mm}	π_{mm}	Tariff	Δ% U	π_{mm}	Tariff	Δ% U	Min. β
China	0.934	0.953	25.7%	0.50%	0.967	25.8%	-0.60%	0.459
EU	0.903	0.933	25.7%	0.81%	0.952	25.5%	-0.78%	0.509
Average	0.811	0.861	25.2%	1.32%	0.901	25.3%	-2.11%	0.387
Median	0.829	0.874	25.1%	1.22%	0.905	25.1%	-1.94%	0.407

Notes: The table displays the percentage changes in welfare relative to each baseline. The "baseline 1" scenario is the current (2018) tariff level equilibrium. The "baseline 2" is the equilibrium that results from shocking baseline 1 with 500% increase in US import and export trade costs, effectively removing the US from the world economy. The "baseline 3" is the equilibrium that results from imposing a uniform tariff of 21% on US imports, with no retaliation. The US still plays Nash tariff. The "Unilateral" columns shows the own trade share, defection tariffs and welfare change when only the row country sets their optimal defection tariff. The "Nash" columns report the own trade shares, tariffs and welfare changes when all countries set their optimal (uniform) tariff given all other countries do the same. The "Minimum β" column computes the minimum discount factor required to sustain the baseline payoff. All payoffs are computed using the model with many countries (while pooling the EU countries into a single one), a single sector, no intermediate inputs and inelastic labor supply, $\gamma = 5$ and $\psi = 0.75$.

Table 5: Nash and unilateral defection welfare changes with fixed labor supply (γ = 2, ψ = 0)

	Baseline	Unilateral defection			Nash equilibrium			
Baseline: 2018 tariffs								
	π_{mm}	π_{mm}	Tariff	Δ% U	π_{mm}	Tariff	Δ% U	Min. β
China	0.931	0.945	103.80%	1.22%	0.963	103.26%	-1.59%	0.437
EU	0.900	0.920	103.63%	1.81%	0.946	101.98%	-2.33%	0.443
Average	0.804	0.842	100.64%	3.02%	0.890	100.57%	-5.35%	0.383
Median	0.818	0.853	100.42%	2.92%	0.900	100.38%	-4.84%	0.382
2018 tariffs + US removed from world trade								
	Baseline	Unilateral defection			Nash equilibrium			
	π_{mm}	π_{mm}	Tariff	Δ% U	π_{mm}	Tariff	Δ% U	Min. β
China	0.940	0.952	103.9%	1.08%	0.968	103.1%	-1.38%	0.442
EU	0.915	0.932	104.2%	1.57%	0.954	102.3%	-1.95%	0.450
Average	0.826	0.860	100.7%	2.71%	0.903	100.6%	-4.72%	0.387
Median	0.854	0.883	100.5%	2.45%	0.921	100.5%	-3.92%	0.388
2018 tariffs + "Liberation Day" tariff ($t_{n,US}$ = 21%)								
	Baseline	Unilateral defection			Nash equilibrium			
	π_{mm}	π_{mm}	Tariff	Δ% U	π_{mm}	Tariff	Δ% U	Min. β
China	0.932	0.946	103.8%	1.21%	0.963	103.3%	-1.50%	0.449
EU	0.901	0.921	103.7%	1.79%	0.946	102.0%	-2.15%	0.458
Average	0.807	0.844	100.6%	2.99%	0.890	100.6%	-5.06%	0.394
Median	0.824	0.858	100.4%	2.86%	0.900	100.4%	-4.46%	0.393

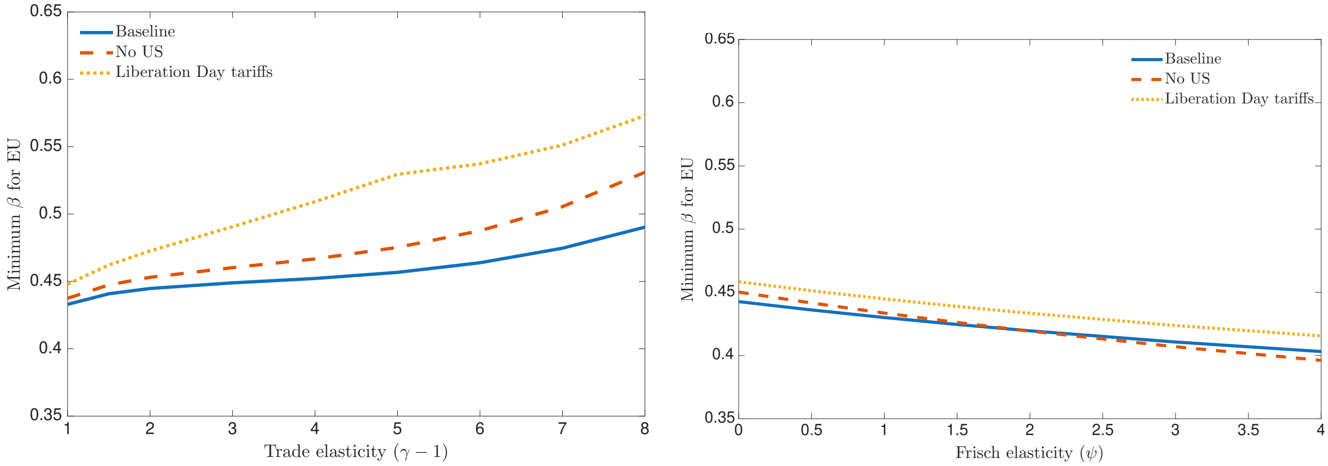
Notes: The table displays the percentage changes in welfare relative to each baseline. The "baseline 1" scenario is the current (2018) tariff level equilibrium. The "baseline 2" is the equilibrium that results from shocking baseline 1 with 500% increase in US import and export trade costs, effectively removing the US from the world economy. The "baseline 3" is the equilibrium that results from imposing a uniform tariff of 21% on US imports, with no retaliation. The US still plays Nash tariff. The "Unilateral" columns shows the own trade share, defection tariffs and welfare change when only the row country sets their optimal defection tariff. The "Nash" columns report the own trade shares, tariffs and welfare changes when all countries set their optimal (uniform) tariff given all other countries do the same. The "Minimum β" column computes the minimum discount factor required to sustain the baseline payoff. All payoffs are computed using the model with many countries (while pooling the EU countries into a single one), a single sector, no intermediate inputs, inelastic labor supply (ψ = 0), and γ = 2.

Table 6: Targeted punishment and unilateral defection welfare changes ($\gamma = 2$, $\psi = 0.75$)

	Baseline	Unilateral defection			Punishment equilibrium			
Baseline: 2018 tariffs								
	π_{mm}	π_{mm}	Tariff	Δ% U	π_{mm}	Tariff	Δ% U	Min. β
China	0.931	0.945	102.30%	2.09%	0.963	101.47%	-0.30%	0.874
EU	0.900	0.920	101.30%	3.09%	0.946	100.39%	-0.56%	0.848
Average	0.804	0.840	100.38%	5.34%	0.889	100.20%	-1.98%	0.764
Median	0.818	0.852	100.25%	5.11%	0.899	100.14%	-1.79%	0.768
2018 tariffs + US removed from world trade								
	Baseline	Unilateral defection			Punishment equilibrium			
	π_{mm}	π_{mm}	Tariff	Δ% U	π_{mm}	Tariff	Δ% U	Min. β
China	0.940	0.952	102.21%	1.85%	0.968	101.34%	-0.27%	0.875
EU	0.915	0.932	101.56%	2.65%	0.954	100.44%	-0.52%	0.837
Average	0.826	0.858	100.44%	4.79%	0.902	100.24%	-1.77%	0.767
Median	0.854	0.881	100.31%	4.31%	0.920	100.17%	-1.49%	0.768
2018 tariffs + "Liberation Day" tariff ($t_{n,US} = 21\%$)								
	Baseline	Unilateral defection			Punishment equilibrium			
	π_{mm}	π_{mm}	Tariff	Δ% U	π_{mm}	Tariff	Δ% U	Min. β
China	0.932	0.945	102.32%	2.07%	0.963	101.59%	-0.21%	0.910
EU	0.902	0.921	101.30%	3.04%	0.946	100.36%	-0.42%	0.881
Average	0.807	0.842	100.38%	5.29%	0.889	100.21%	-1.70%	0.791
Median	0.824	0.856	100.25%	5.01%	0.899	100.15%	-1.51%	0.797

Notes: The table displays the percentage changes in welfare relative to the baseline. The first panel is the current (2018) tariff level equilibrium. The second panel is the equilibrium that results from shocking baseline 1 with 500% increase in US import and export trade costs, effectively removing the US from the world economy. The third panel is the equilibrium that results from imposing a uniform tariff of 21% on US imports, with no retaliation. The US still plays Nash tariff. The "Unilateral" columns shows the own trade share, defection tariffs and welfare change when only the row country sets their optimal defection tariff. The "Punishment" columns report the own trade shares, tariffs and welfare changes when the country deviates and all other countries set an optimal bilateral tariff against that country. The "Minimum β" column computes the minimum discount factor required to sustain the baseline payoff. All payoffs are computed using the model with many countries (while pooling the EU countries into a single one), a single sector, no intermediate inputs, $\gamma = 2$ and $\psi = 0.75$.

Figure 5: Labor supply elasticity and free trade cooperation sustainability (EU)



(a) Varying trade elasticity

(b) Varying labor supply elasticity

Notes: The figure displays the minimum β required for the EU to sustain the free trade equilibrium, for different values of γ (left panel, keeping $\psi = 0.75$) or ψ (right panel, keeping $\gamma = 2$). In the first panel, we the US moves to its Nash tariffs in the punishment phase, unless the Nash tariff is lower than the Liberation Day tariff. In that case, we force it to keep the LD tariff and solve for other countries' Nash tariffs taking the LD tariff as given. Appendix Figure C7 repeats the same exercise for China.

4.4 Multi-Sector Model with the Global Production Network

The results presented so far use a simple one-sector model with a labor-only production function. Here, we extend the analysis to the full multi-country multi-sector model with input-output linkages laid out in Section 2. The multi-sector model requires several additional elasticities, that we enumerate in the bottom panel of Table 1. The expenditure shares data by sector and final/intermediate use are sourced from the OECD ICIO database. We calibrate the model to 17 sectors listed in Appendix Table B2 (16 tradable sectors and one service sector for which we don't impose any change in trade costs or tariff). We maintain the assumption that each country sets a single tariff over all partners and all sectors.[16]

Table 7 displays the results. Unilaterally optimal tariffs are substantially lower with multiple sectors, averaging around 58.5% for the full sample of countries in the baseline including the US. The result that, relative to a value added-only production structure, introducing input trade lowers the optimal tariffs is known (Caliendo et al., 2023; Blanchard, Bown, and Johnson, 2025). The welfare gains from optimal tariffs and the losses from the Nash equilibrium are slightly larger, but quantitatively

[16]While this is a result in the one-sector case, it is an assumption in the multi-sector case with IO linkages. Solving for bilateral, sector specific optimal tariffs is computationally challenging given the number of sectors and countries considered here. Quantitative trade models featuring bilateral or sector specific optimal tariffs typically solve for such tariffs with fewer sectors or countries (e.g. Blanchard, Bown, and Johnson, 2025; Bai et al., 2025b) We have solved for bilateral optimal tariffs in a single sector model, and they are very similar to the single uniform optimal tariff (Appendix Figure C2). We also used MPEC (Su and Judd, 2012) to solve to the optimal partner-sector specific tariff in the multi-sector model. Appendix Figure C3 shows that the welfare change is similar to that of our restricted single tariff over all partners and sectors.

similar to the single sector baseline. The minimum β to sustain cooperation is higher than in the simple model, at 0.477 for the full sample. Again, while the minimum β's increase when the US exits the trading system or when the US places Liberation Day tariffs, the increase is modest and the sustainability of the cooperative equilibrium is similar regardless of US policy.

5. Conclusion

The second Trump administration delivered a shock to the world trading system. Almost immediately a debate started on whether free trade among country pairs not involving the US can survive this shock. This paper addresses this question using both analytical and quantitative tools. We find that other countries' optimal tariffs do not change much following the US exit, and that the minimum discount factor required to sustain trade cooperation among the other countries – our metric for cooperation sustainability – changes very little. The analytical results help us understand why this is the case. While the US is a large player, and its exit from free trade rearranges the full world trade matrix, the implied change is not large enough to have a material impact on the prospects of free trade elsewhere on the globe.

Table 7: Nash and defection welfare changes in the multi-sector model with IO linkages

	Baseline	Unilateral defection			Nash equilibrium			
Baseline: 2018 tariffs								
	π_{mm}	π_{mm}	Tariff	Δ% U	π_{mm}	Tariff	Δ% U	Min. β
China	0.930	0.940	58.3%	2.03%	0.949	58.8%	-2.25%	0.480
EU	0.836	0.860	54.2%	2.17%	0.872	54.1%	-2.23%	0.498
Average	0.664	0.694	58.5%	4.74%	0.713	58.4%	-6.08%	0.526
Median	0.672	0.714	59.1%	4.01%	0.732	58.3%	-5.87%	0.477
2018 tariffs + US non-services removed from world trade								
	Baseline	Unilateral defection			Nash equilibrium			
	π_{mm}	π_{mm}	Tariff	Δ% U	π_{mm}	Tariff	Δ% U	Min. β
China	0.937	0.946	57.7%	1.83%	0.954	58.3%	-1.74%	0.517
EU	0.848	0.870	54.6%	2.02%	0.880	54.8%	-1.55%	0.571
Average	0.683	0.711	57.4%	4.32%	0.728	57.2%	-5.02%	0.567
Median	0.702	0.735	57.6%	3.85%	0.759	57.3%	-4.48%	0.489
2018 tariffs + Liberation Day tariff ($t_{n,US,j}$ = 21%)								
	Baseline	Unilateral defection			Nash equilibrium			
	π_{mm}	π_{mm}	Tariff	Δ% U	π_{mm}	Tariff	Δ% U	Min. β
China	0.931	0.941	58.4%	2.02%	0.950	58.9%	-2.09%	0.497
EU	0.837	0.861	54.3%	2.15%	0.873	54.2%	-2.04%	0.519
Average	0.666	0.696	58.8%	4.68%	0.714	58.7%	-5.78%	0.528
Median	0.673	0.715	59.2%	4.00%	0.733	58.3%	-5.46%	0.479

Notes: The table displays the percentage changes in welfare relative to each baseline. The "baseline 1" scenario is the current (2018) tariff level equilibrium. The "baseline 2" is the equilibrium that results from shocking baseline 1 with 500% increase in US import and export trade costs for non-service sectors. The "baseline 3" is the equilibrium that results from imposing a uniform tariff of 21% on US imports to non-service sectors, with no retaliation. The US still plays Nash tariff in the Nash equilibrium. The "Unilateral" columns shows the own trade share, defection tariffs and welfare change when only the row country sets their optimal defection tariff. The "Nash" columns report the own trade shares, tariffs and welfare changes when all countries set their optimal (uniform) tariff given all other countries do the same. The "Minimum β" column computes the minimum discount factor required to sustain the baseline payoff. All payoffs are computed using the model with many countries (while pooling the EU countries into a single one), many sectors, intermediate inputs, and elastic labor supply. The parameter values are $\gamma = \nu = 2$, $\psi = 0.75$, $\rho = \varepsilon = 1$ and η_j calibrated from intermediate input shares in the data.

References

Alessandria, George, Jiaxiaomei Ding, and Shafaat Yar Khan. 2025. "The Tariff Tax Cut: Tariffs as Revenue." Mimeo, Rochester, Syracuse, and the Federal Reserve Board.

Allen, Treb, Costas Arkolakis, and Yuta Takahashi. 2020. "Universal Gravity." *Journal of Political Economy* 128 (2):393–433.

Alvarez, Fernando and Robert E., Jr. Lucas. 2007. "General Equilibrium Analysis of the Eaton-Kortum Model of International Trade." *Journal of Monetary Economics* 54 (6):1726–1768.

Amador, Manuel. 2003. "A Political Economy Model of Sovereign Debt Repayment." Mimeo, Stanford.

Arkolakis, Costas, Arnaud Costinot, and Andrés Rodríguez-Clare. 2012. "New Trade Models, Same Old Gains?" *American Economic Review* 102 (1):94–130.

Bagwell, Kyle, Chad P. Bown, and Robert W. Staiger. 2016. "Is the WTO Passé?" *Journal of Economic Literature* 54 (4):1125–1231.

Bagwell, Kyle and Robert W. Staiger. 1990. "A Theory of Managed Trade." *American Economic Review* 80 (4):779–795.

———. 2002. *The Economics of the World Trading System*. The MIT Press.

Bai, Yan, Keyu Jin, Dan Lu, and Hanxi Wang. 2025a. "Optimal trade policy with international technology diffusion." *Journal of International Economics* 153:104038.

———. 2025b. "Technological Rivalry and Optimal Dynamic Policy in an Open Economy." Forthcoming, *Journal of Political Economy: Macroeconomics*.

Bai, Yan, Dan Lu, and Hanxi Wang. 2025. "Optimal Trade Policies and Market Power in General Equilibrium Trade Models." Mimeo, Rochester and CUHK.

Becko, John Sturm, Gene M. Grossman, and Elhanan Helpman. 2025. "Optimal Tari§s with Geopolitical Alignment." Mimeo, Princeton and Harvard.

Blanchard, Emily J, Chad P Bown, and Robert C Johnson. 2025. "Global Value Chains and Trade Policy." *The Review of Economic Studies* :rdaf017.

Boehm, Christoph, Andrei A. Levchenko, and Nitya Pandalai-Nayar. 2023. "The Long and Short (Run) of Trade Elasticities." *American Economic Review* 113 (4):861–905.

Bonadio, Barthélémy, Zhen Huo, Andrei A Levchenko, and Nitya Pandalai-Nayar. 2021. "Global Supply Chains in the Pandemic." *Journal of International Economics* 133:103534.

Bonadio, Barthélémy, Zhen Huo, Andrei A. Levchenko, and Nitya Pandalai-Nayar. 2025. "Globalization, structural change and international comovement." *Journal of Monetary Economics* 151:103745.

Caliendo, Lorenzo and Robert C. Feenstra. 2024. "Foundation of the small open economy model with product differentiation." *Journal of International Economics* 150:103820.

Caliendo, Lorenzo, Robert C. Feenstra, John Romalis, and Alan M. Taylor. 2023. "A second-best argument for low optimal tariffs on intermediate inputs." *Journal of International Economics* 145:103824.

Chetty, Raj, Adam Guren, Day Manoli, and Andrea Weber. 2011. "Are Micro and Macro Labor Supply Elasticities Consistent? A Review of Evidence on the Intensive and Extensive Margins." *American Economic Review* 101 (3):471–75.

Costinot, Arnaud and Andrés Rodríguez-Clare. 2014. "Trade Theory with Numbers: Quantifying the Consequences of Globalization." In *Handbook of International Economics*, vol. 4. 197–261.

Dávila, Eduardo, Andrés Rodríguez-Clare, Andreas Schaab, and Stacy Yingqi Tan. 2025. "A Dynamic Theory of Optimal Tariffs." Mimeo, Yale and Berkeley.

Dekle, Robert, Jonathan Eaton, and Samuel Kortum. 2008. "Global Rebalancing with Gravity: Measuring the Burden of Adjustment." *IMF Staff Papers* 55 (3):511–540.

Dixit, Avinash. 1987. *Strategic aspects of trade policy*. Econometric Society Monographs. Cambridge University Press, 329–362.

Felbermayr, Gabriel, Benjamin Jung, and Mario Larch. 2015. "The welfare consequences of import tariffs: A quantitative perspective." *Journal of International Economics* 97 (2):295–309.

Fudenberg, Drew and Eric Maskin. 1986. "The Folk Theorem in Repeated Games with Discounting or with Incomplete Information." *Econometrica* 54 (3):533–554.

Gabaix, Xavier. 2020. "A Behavioral New Keynesian Model." *American Economic Review* 110 (8):2271–2327.

Galle, Simon, Andrés Rodríguez-Clare, and Moises Yi. 2023. "Slicing the Pie: Quantifying the Aggregate and Distributional Effects of Trade." *Review of Economic Studies* 90 (1):331–375.

Gros, Daniel. 1987. "A note on the optimal tariff, retaliation and the welfare loss from tariff wars in a framework with intra-industry trade." *Journal of International Economics* 23 (3-4):357–367.

Grossman, Gene. 2016. "The Purpose of Trade Agreements." chap. 7. North-Holland, 379–434.

Horn, Henrik, Louise Johannesson, and Petros C. Mavroidis. 2011. "The WTO Dispute Settlement System 1995–2010: Some Descriptive Statistics." *Journal of World Trade* 45 (6):1107 – 1138.

Hsieh, Chang-Tai, Erik Hurst, Charles I. Jones, and Peter J. Klenow. 2019. "The Allocation of Talent and U.S. Economic Growth." *Econometrica* 87 (5):1439–1474.

Hu, Naiyuan, Yuan Mei, and Tong Ni. 2025. "Tariffs as Bargaining Chips: A Quantitative Analysis of the U.S.–China Trade War." Mimeo.

Huo, Zhen, Andrei Levchenko, and Nitya Pandalai-Nayar. 2025. "International Comovement in the Global Production Network." *Review of Economic Studies* 92 (1):365–403.

Ignatenko, Anna, Ahmad Lashkaripour, Luca Macedoni, and Ina Simonovska. 2025. "Making America great again? The economic impacts of Liberation Day tariffs." *Journal of International Economics* 157:104138.

Itskhoki, Oleg and Dmitry Mukhin. 2025. "The Optimal Macro Tariff." NBER Working Paper 33839.

Johnson, Harry G. 1951. "Optimum Welfare and Maximum Revenue Tariffs." *Review of Economic Studies* 19 (1):28–35.

Kahn, R. F. 1947. "Tariffs and the Terms of Trade." *Review of Economic Studies* 15 (1):14–19.

Lagakos, David and Michael E. Waugh. 2013. "Selection, Agriculture, and Cross-Country Productivity Differences." *American Economic Review* 103 (2):948–80.

Lashkaripour, Ahmad. 2021. "The cost of a global tariff war: A sufficient statistics approach." *Journal of International Economics* 131:103419.

Maggi, Giovanni. 1999. "The Role of Multilateral Institutions in International Trade Cooperation." *American Economic Review* 89 (1):190–214.

McMillan, J. 1986. *Game Theory in International Economics*. Fundamentals of pure and applied economics. Harwood Academic Publishers.

Mei, Yuan. 2020. "Sustainable cooperation in international trade: A quantitative analysis." *Journal of International Economics* 123:103305.

Mitchener, Kris James, Kevin Hjortshøj O'Rourke, and Kirsten Wandschneider. 2022. "The Smoot-Hawley Trade War." *The Economic Journal* 132 (647):2500–2533.

Ossa, Ralph. 2014. "Trade Wars and Trade Talks with Data." *American Economic Review* 104 (12):4104–46.

Pujolas, Pau and Jack Rossbach. 2024. "Trade Wars with Trade Deficits." Mimeo, McMaster University.

Su, Che-Lin and Kenneth L Judd. 2012. "Constrained optimization approaches to estimation of structural models." *Econometrica* 80 (5):2213–2230.

World Trade Organization. 2024. "World Trade Statistics." URL https://www.wto.org/english/res_e/statis_e/world_trade_statistics_e.htm. Accessed: 2025-12-19.

A. Theory and Quantification Appendix

A.1 Optimal Tariff and Welfare in the One-Sector Model

To derive the optimal tariff formula in the one-sector model with labor-only production function, we follow similar steps as Ignatenko et al. (2025) but keep aggregate labor flexible. When computing country n's optimal tariff, we assume that for $n \neq m$ (foreign destinations), we have $\frac{\partial \ln W_n}{\partial \ln t_{om}} = 0$ and assume $t_{nd} = 1$ for all $d \neq m$ (that is, the rest of the world in free trade).

Welfare. The aggregate welfare in country m is given by:

$$U_m = \frac{R_m + D_m + \frac{W_m H_m}{1+\psi}}{P_m}.$$

Taking first order condition with respect to $\ln t_{om}$ yields

$$\frac{\partial \ln U_m}{\partial \ln t_{om}} = \frac{W_m H_m}{\frac{W_m H_m}{1+\psi} + R_m} \frac{\partial \ln W_m}{\partial \ln t_{om}} + \frac{R_m}{\frac{W_m H_m}{1+\psi} + R_m} \frac{\partial \ln R_m}{\partial \ln t_{om}} - \left(\frac{W_m H_m}{\frac{W_m H_m}{1+\psi} + R_m} \frac{\psi}{1+\psi} + 1 \right) \frac{\partial \ln P_m}{\partial \ln t_{om}} \tag{A.1}$$

where we used the fact that $\frac{\partial \ln H_m}{\partial \ln t_{om}} = \psi \left(\frac{\partial \ln W_m}{\partial \ln t_{om}} - \frac{\partial \ln P_m}{\partial \ln t_{om}} \right)$.

Balanced trade equation and wage elasticity. Define $\tilde{X}_{mn} = \frac{X_{nm}}{t_{nm}}$ the ex-tariff exports from n to m. From the balanced trade equation, one gets:

$$\sum_{n \neq m} \tilde{X}_{mn} = \sum_{n \neq m} \tilde{X}_{nm}$$

Taking derivatives gives

$$\sum_{n \neq m} \tilde{X}_{mn} \frac{\partial \ln \tilde{X}_{mn}}{\partial \ln t_{om}} = \sum_{n \neq m} \tilde{X}_{nm} \frac{\partial \ln \tilde{X}_{nm}}{\partial \ln t_{om}}. \tag{A.2}$$

To solve for $\frac{\partial \ln \tilde{X}_{mn}}{\partial \ln t_{om}}$, assuming that $\frac{\partial \ln \tilde{W}_n}{\partial \ln t_{om}} \approx 0 \; \forall \; n \neq m$, start from:

$$\tilde{X}_{mn} = \frac{1}{t_{mn}} \frac{(w_m t_{mn})^{1-\gamma}}{\sum_k (w_k t_{kn})^{1-\gamma}} (W_n H_n + R_n)$$

So for $n \neq m$:

$$\frac{\partial \ln \tilde{X}_{mn}}{\partial \ln t_{om}} = (1-\gamma)(1-\pi_{mn}) \frac{\partial \ln W_m}{\partial \ln t_{om}} + \frac{\partial \ln H_n}{\partial \ln t_{om}}$$

Since $\frac{\partial \ln \tilde{W}_n}{\partial \ln t_{om}} \approx 0 \; \forall \; n \neq m$, we have $\frac{\partial \ln H_n}{\partial \ln t_{om}} = -\psi \pi_{mn} \frac{\partial \ln W_m}{\partial \ln t_{om}}$, so that

$$\frac{\partial \ln \tilde{X}_{mn}}{\partial \ln t_{om}} = \left[(1-\gamma)(1-\pi_{mn}) - \psi \pi_{mn} \right] \frac{\partial \ln W_m}{\partial \ln t_{om}}$$

Plugging back into (A.2) and rearranging gives

$$\frac{\partial \ln W_m}{\partial \ln t_{om}} = \frac{1}{\sum_{n \neq m} \tilde{X}_{mn} \left[(1-\gamma)(1-\pi_{mn}) - \psi \pi_{mn} \right]} \sum_{n \neq m} \tilde{X}_{nm} \frac{\partial \ln \tilde{X}_{nm}}{\partial \ln t_{om}} \tag{A.3}$$

Tariff revenue elasticity. Tariff revenue is given by $R_m = \sum_{n \neq m} (t_{nm} - 1) \tilde{X}_{nm}$. Taking derivatives gives:

$$\frac{\partial \ln R_m}{\partial \ln t_{om}} = \frac{1}{R_m} \sum_n (t_{nm} - 1) \tilde{X}_{nm} \frac{\partial \ln \tilde{X}_{nm}}{\partial \ln t_{om}} + \frac{(W_m H_m + R_m) \pi_{om}}{R_m} \tag{A.4}$$

Optimal tariff. Plugging (A.3) and (A.4) back into (A.1) gives:

$$\frac{\partial \ln U_m}{\partial \ln t_{om}} = \left[\frac{W_m H_m}{\frac{W_m H_m}{1+\psi}+R_m} - \left(\frac{W_m H_m}{\frac{W_m H_m}{1+\psi}+R_m}\frac{\psi}{1+\psi}+1\right)\pi_{mm}\right]\left[\frac{1}{\sum_{n\neq m}\tilde{X}_{mn}\left[(1-\gamma)(1-\pi_{mn})-\psi\pi_{mn}\right]}\sum_{n\neq m}\tilde{X}_{nm}\frac{\partial \ln \tilde{X}_{nm}}{\partial \ln t_{om}}\right]$$
$$+\frac{\sum_n (t_{nm}-1)\tilde{X}_{nm}\frac{\partial \ln \tilde{X}_{nm}}{\partial \ln t_{om}}}{\frac{W_m H_m}{1+\psi}+R_m} - \left(\frac{W_m H_m}{\frac{W_m H_m}{1+\psi}+R_m}\frac{\psi}{1+\psi}+1-\frac{W_m H_m + R_m}{\frac{W_m H_m}{1+\psi}+R_m}\right)\pi_{om} \tag{A.5}$$

Setting the derivative to 0 and rearranging gives

$$0 = \frac{W_m H_m - (W_m H_m + R_m)\pi_{mm}}{\sum_{n\neq m}\tilde{X}_{mn}\left[(1-\gamma)(1-\pi_{mn})-\psi\pi_{mn}\right]}\sum_{n\neq m}\tilde{X}_{nm}\frac{\partial \ln \tilde{X}_{nm}}{\partial \ln t_{om}} + \sum_n (t_{nm}-1)\tilde{X}_{nm}\frac{\partial \ln \tilde{X}_{nm}}{\partial \ln t_{om}}$$

A uniform tariff t_m^* solves this equation:

$$(t_m^*-1) = \frac{W_m H_m - X_{mm}}{\sum_{n\neq m}\tilde{X}_{mn}\left[(\gamma-1)(1-\pi_{mn})+\psi\pi_{mn}\right]}$$

Defining $\omega_{nm} = \frac{\tilde{X}_{mn}}{\sum_{n\neq m}\tilde{X}_{mn}} = \frac{\tilde{X}_{mn}}{W_m H_m - X_{mm}}$ gives:

$$(t_m^*-1) = \frac{1}{(\gamma-1)\sum_{n\neq m}\omega_{nm}(1-\pi_{mn})+\psi\sum_{n\neq m}\omega_{nm}\pi_{mn}}, \tag{A.6}$$

which is equation (2.6) in the main text.

Welfare sufficient statistics. Rearranging the equation for tariff revenue $R_m = \sum_n \frac{(t_{nm}-1)}{t_{nm}}\pi_{nm}(R_m + W_m H_m)$, one gets that

$$R_m = \left(\sum_n \frac{1}{t_{nm}}\pi_{nm}\right)^{-1}\left(1-\sum_n \frac{\pi_{nm}}{t_{nm}}\right)(W_m H_m) = \left(\left(\sum_n \frac{\pi_{nm}}{t_{nm}}\right)^{-1}-1\right)(W_m H_m)$$

Plugging back into the welfare gives

$$U = \frac{\left(\left(\sum_n \frac{\pi_{nm}}{t_{nm}}\right)^{-1}-1\right)(W_m H_m) + \frac{W_m H_m}{1+\psi}}{P_m}$$

which simplifies to

$$U = \frac{\left[\left(\sum_n \frac{\pi_{nm}}{t_{nm}}\right)^{-1}-\frac{\psi}{1+\psi}\right](W_m H_m)}{P_m}$$

Using $\frac{W_m H_m}{P_m^C} = (1+\psi)\left(\frac{W_m}{P_m^C}\right)^{1+\psi}$ and $\pi_{mm} = \frac{(W_m)^{1-\gamma}}{\sum_n (W_n d_{nm} t_{nm})^{1-\gamma}} = \left(\frac{W_m}{P_m}\right)^{1-\gamma}$, we get

$$U = \left[\left(\sum_n \frac{\pi_{nm}}{t_{nm}}\right)^{-1}-\frac{\psi}{1+\psi}\right](1+\psi)(\pi_{mm})^{\frac{1+\psi}{1-\gamma}} \tag{A.7}$$

which is equation (2.7) in the main text.

A.2 Equilibrium in Changes

Denote the proportional change in variable $\hat{X} \equiv \frac{X^{post}}{X^{pre}}$, where X^{pre} is the value before the change in an exogenous parameter, and X^{post} is the value of X after the change. For any arbitrary tariff change $\hat{t}_{mnj}$, The equilibrium in changes is given by a set of output $\hat{Y}_{nj} = \frac{Y^{new}_{nj}}{Y^{old}_{nj}}$, prices$\hat{P}_{nj}$, consumption sectoral shares $\hat{\pi}^f_{mj}$, final trade shares $\hat{\pi}^f_{nmj}$, intermediate sectoral shares $\hat{\pi}^x_{j,mi}$, intermediate trade shares $\hat{\pi}^x_{nj,mi}$, and sectoral wages $\hat{W}_{nj}$ that satisfy:

1. The market clearing condition:

$$\left(\hat{P}_{nj}\hat{Y}_{nj}\right)\left(P_{nj}Y_{nj}\right) = \sum_m \frac{1}{\hat{t}_{mnj}t_{mnj}}\left(\sum_i \eta_i\left(\hat{P}_{mi}\hat{Y}_{mi}\right)\left(P_{mi}Y_{mi}\right) + \hat{D}_m D_m + \hat{R}_m R_m\right)\pi^f_{mj}\hat{\pi}^f_{mj}\pi^f_{nmj}\hat{\pi}^f_{nmj}$$
$$+ \sum_m \frac{1}{\hat{t}_{mnj}t_{mnj}}\sum_i\left(1-\eta_i\right)\left(\hat{P}_{mi}\hat{Y}_{mi}\right)\left(P_{mi}Y_{mi}\right)\pi^x_{j,mi}\hat{\pi}^x_{j,mi}\hat{\pi}^x_{nj,mi}\pi^x_{nj,mi}$$

2. Tariff revenue:

$$\hat{R}_n R_n = \frac{\sum_m\sum_j\left(\hat{t}_{mnj}t_{mnj}-1\right)\hat{\pi}^f_{nj}\pi^f_{nj}\hat{\pi}^f_{mnj}\pi^f_{mnj}\left(\sum_i\eta_i\left(\hat{P}_{ni}\hat{Y}_{ni}\right)\left(P_{ni}Y_{ni}\right)+\hat{D}_n D_n\right)+\sum_m\sum_j\left(\hat{t}_{mnj}t_{mnj}-1\right)\sum_i\left(1-\eta_i\right)\left(\hat{P}_{ni}\hat{Y}_{ni}\right)\left(P_{ni}\right.}{1-\sum_m\sum_j\left(\hat{t}_{mnj}t_{mnj}-1\right)\hat{\pi}^f_{nj}\pi^f_{nj}\hat{\pi}^f_{mnj}\pi^f_{mnj}}$$

3. Trade Shares:

$$\hat{\pi}^f_{nj} = \frac{\hat{\zeta}_{nj}\left(\hat{P}^F_{nj}\right)^{1-\rho}}{\sum_k \pi^f_{nk,t}\hat{\zeta}_{nk}\left(\hat{P}^F_{nk}\right)^{1-\rho}}$$

where

$$\hat{P}^F_{nj} = \left[\sum_m \pi^f_{mnj,t}(\hat{t}_{mnj}\widehat{\tilde{\tau}^f_{mnj}}\hat{P}_{mj})^{1-\gamma}\right]$$

The change in the final consumption shares and intermediate expenditure shares:

$$\hat{\pi}^f_{mnj,t+1} = \frac{\left(\hat{t}_{mnj}\widehat{\tilde{\tau}^f_{mnj}}\hat{P}_{mj}\right)^{1-\gamma}}{\sum_k \pi^f_{knj,t}\left(\hat{t}_{knj}\widehat{\tilde{\tau}^f_{knj}}\hat{P}_{kj}\right)^{1-\gamma}}$$

$$\hat{\pi}^x_{i,nj,t+1} = \frac{\hat{\vartheta}_{i,nj}\left(\hat{P}^X_{i,nj}\right)^{1-\varepsilon}}{\sum_k \pi^x_{k,nj,t}\hat{\vartheta}_{k,nj}\left(\hat{P}^X_{k,nj}\right)^{1-\varepsilon}}$$

where

$$\hat{P}^X_{i,nj} = \left[\sum_i \pi^x_{mi,nj,t}\left(\hat{t}_{mni}\widehat{\tilde{\tau}^x_{mi,nj}}\hat{P}_{mi}\right)^{1-\nu}\right]^{\frac{1}{1-\nu}}$$

$$\hat{\pi}^x_{mi,nj,t+1} = \frac{\left(\hat{t}_{mni}\widehat{\tilde{\tau}^x_{mi,nj}}\hat{P}_{mj}\right)^{1-\nu}}{\sum_k \pi^x_{ki,nj,t}\left(\hat{t}_{mni}\widehat{\tilde{\tau}^x_{ki,nj}}\hat{P}_{kj}\right)^{1-\nu}}$$

4. Prices:

$$\hat{P}_{nj} = \left(\hat{Z}_{nj}\right)^{-1}\hat{W}_{nj}^{(1-\alpha_j)\eta_j}\hat{R}_{nj}^{\alpha_j\eta_j}\left(\hat{P}^X_{nj}\right)^{1-\eta_j}$$

$$\hat{P}_{nj} = \left(\hat{Z}_{nj}\right)^{-1} \hat{W}_{nj}^{(1-\alpha_j)\eta_j} \left(\hat{P}_{nj}\hat{Y}_{nj}\right)^{\alpha_j\eta_j} \left(\hat{K}_{nj}\right)^{-\alpha_j\eta_j} \left(\hat{P}^X_{nj}\right)^{1-\eta_j}$$

where

$$\hat{P}^X_{nj} = \left[\sum_i \pi^x_{i,nj,t}\hat{\vartheta}_{i,nj}\left(\hat{P}^X_{i,nj}\right)^{1-\varepsilon}\right]^{\frac{1}{1-\varepsilon}}$$

5. Labor market condition:

$$\hat{W}_{nj}\hat{\xi}_{nj}\left(\frac{1}{\hat{\chi}_{nt}}\frac{\hat{W}_n}{\hat{P}_n}\right)^{\psi}\left(\frac{\hat{W}_{nj}}{\hat{W}_n}\right)^{\mu-1} = \hat{P}_{nj}\hat{Y}_{nj}$$

where

$$\hat{W}_n = \left(\sum \pi^H_{nj}\hat{\xi}_{nj}\left(\hat{W}_{nj}\right)^{\mu}\right)^{\frac{1}{\mu}}$$

$$\hat{P}_n = \left[\sum_j \pi^f_{nj,t}\hat{\zeta}_{nj}(\hat{P}^F_{nj})^{1-\rho}\right]$$

A.3 Algorithm

1. Guess $\hat{P}_{nj}$
2. Solve for $\hat{\pi}^f_{nj}$, $\hat{\pi}^f_{mnj}$, $\hat{\pi}^x_{i,nj}$, $\hat{\pi}^x_{mi,nj}$ using:

$$\hat{\pi}^f_{nj} = \frac{\hat{\zeta}_{nj}\left(\hat{P}^F_{nj}\right)^{1-\rho}}{\sum_k \pi^f_{nk,t}\hat{\zeta}_{nk}\left(\hat{P}^F_{nk}\right)^{1-\rho}}$$

where $\hat{P}^F_{nj} = \left[\sum_m \pi^f_{mnj,t}(\widehat{\tilde{\tau}^f_{mnj}}\hat{t}_{mnj}\hat{P}_{mj})^{1-\gamma}\right]$

$$\hat{\pi}^f_{mnj} = \frac{\left(\widehat{\tilde{\tau}^f_{mnj}}\hat{t}_{mnj}\hat{P}_{mj}\right)^{1-\gamma}}{\sum_k \pi^f_{knj,t}\left(\widehat{\tilde{\tau}^f_{knj}}\hat{t}_{knj}\hat{P}_{kj}\right)^{1-\gamma}}$$

$$\hat{\pi}^x_{i,nj} = \frac{\hat{\vartheta}_{i,nj}\left(\hat{P}^X_{i,nj}\right)^{1-\varepsilon}}{\sum_k \pi^x_{k,nj,t}\hat{\vartheta}_{k,nj}\left(\hat{P}^X_{k,nj}\right)^{1-\varepsilon}}$$

where $\hat{P}^X_{i,nj} = \left[\sum_i \pi^x_{mi,nj,t}\left(\widehat{\tilde{\tau}^x_{mi,nj}}\hat{t}_{mnj}\hat{P}_{mi}\right)^{1-\nu}\right]^{\frac{1}{1-\nu}}$

$$\hat{\pi}^x_{mi,nj} = \frac{\left(\widehat{\tilde{\tau}^x_{mi,nj}}\hat{t}_{mnj}\hat{P}_{mj}\right)^{1-\nu}}{\sum_k \pi^x_{ki,nj,t}\left(\widehat{\tilde{\tau}^x_{ki,nj}}\hat{t}_{knj}\hat{P}_{kj}\right)^{1-\nu}}$$

3. Solve for $\hat{R}_n R_n$ and $\hat{P}_{nj}\hat{Y}_{nj}$ jointly using the new trade shares (e.g. guess $\left(\hat{P}_{nj}\hat{Y}_{nj}\right)$, solve for $\hat{R}_n R_n$ and update $\left(\hat{P}_{nj}\hat{Y}_{nj}\right)$)

$$\hat{R}_n R_n = \frac{\sum_m \sum_j \left(\hat{t}_{mnj} t_{mnj} - 1\right) \frac{\hat{\pi}^f_{nj} \pi^f_{nj} \hat{\pi}^f_{mnj} \pi^f_{mnj}}{\hat{t}_{mnj} t_{mnj}} \left(\sum_i \eta_i \left(\hat{P}_{ni}\hat{Y}_{ni}\right)(P_{ni}Y_{ni}) + \hat{D}_n D_n\right) + \sum_m \sum_j \left(\hat{t}_{mnj} t_{mnj} - 1\right) \sum_i \left(1 - \eta_i\right) \hat{P}_{ni}\hat{Y}_{ni}P_{ni}}{1 - \sum_m \sum_j \left(\hat{t}_{mnj} t_{mnj} - 1\right) \frac{\hat{\pi}^f_{nj} \pi^f_{nj} \hat{\pi}^f_{mnj} \pi^f_{mnj}}{\hat{t}_{mnj} t_{mnj}}}$$

$$\left(\hat{P}_{nj}\hat{Y}_{nj}\right)\left(P_{nj}Y_{nj}\right) = \sum_m \left(\sum_i \eta_i \left(\hat{P}_{mi}\hat{Y}_{mi}\right)(P_{mi}Y_{mi}) + \hat{D}_m D_m + \hat{R}_m R_m\right) \frac{\hat{\pi}^f_{mj} \pi^f_{mj} \hat{\pi}^f_{nmj} \pi^f_{nmj}}{\hat{t}_{nmj} t_{nmj}}$$
$$+ \sum_m \sum_i \left(1 - \eta_i\right) \left(\hat{P}_{mi}\hat{Y}_{mi}\right)(P_{mi}Y_{mi}) \frac{\pi^x_{j,mi} \hat{\pi}^x_{j,mi} \hat{\pi}^x_{nj,mi} \pi^x_{nj,mi}}{\hat{t}_{nmj} t_{nmj}}$$

4. Solve for the wages $\hat{W}_{nj}$ using

$$\hat{W}_{nj}\hat{\xi}_{nj}\left(\frac{1}{\hat{\chi}_{nt}}\frac{\hat{W}_n}{\hat{P}_n}\right)^{\psi}\left(\frac{\hat{W}_{nj}}{\hat{W}_n}\right)^{\mu-1} = \hat{P}_{nj}\hat{Y}_{nj}$$

5. Solve for the prices $\hat{P}_{nj}$

$$\hat{P}_{nj} = \left(\hat{Z}_{nj}\right)^{-1} \hat{W}_{nj}^{(1-\alpha_j)\eta_j} \left(\hat{P}_{nj}\hat{Y}_{nj}\right)^{\alpha_j \eta_j} \left(\hat{K}_{nj}\right)^{-\alpha_j \eta_j} \left(\hat{P}^X_{nj}\right)^{1-\eta_j}$$

where $\hat{P}^X_{nj} = \left[\sum_i \pi^x_{i,nj,t} \hat{\vartheta}_{i,nj} \left(\hat{P}^X_{i,nj}\right)^{1-\varepsilon}\right]^{\frac{1}{1-\varepsilon}}$

6. Go back to 1

B. Data appendix

Countries and sectors. Table B1 lists the countries used in the calibration. Table B2 lists the sectors. We essentially keep all manufacturing separate, aggregate all agricultural sectors together, all mining and quarrying together, and aggregate the remaining sectors into a service sector.

Tariffs. We extract data on tariffs directly at the ISIC level from the UN-TRAINS dataset.

Table B1: Country List

ISO	Country
ARG	Argentina
AUS	Australia
BRA	Brazil
BRN	Brunei Darussalam
CAN	Canada
CHE	Switzerland
CHL	Chile
CHN	China
COL	Colombia
CRI	Costa Rica
EU	European Union
GBR	United Kingdom
HKG	Hong Kong
IDN	Indonesia
IND	India
ISL	Iceland
ISR	Israel
JPN	Japan
KAZ	Kazakhstan
KHM	Cambodia
KOR	Korea (the Republic of)
LAO	Lao People's Democratic Republic
MAR	Morocco
MEX	Mexico
MMR	Myanmar
MYS	Malaysia
NOR	Norway
NZL	New Zealand
PER	Peru
PHL	Philippines
RUS	Russian Federation
SAU	Saudi Arabia
SGP	Singapore
THA	Thailand
TUN	Tunisia
TUR	Türkiye
TWN	Taiwan
USA	United States of America
VNM	Vietnam
ZAF	South Africa

Notes: The EU is treated as a single country. It is constructed by aggregating Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Germany, Denmark, Spain, Estonia, Finland, France, Greece, Croatia, Hungary, Ireland, Italy, Lithuania, Luxembourg, Latvia, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia and Sweden

Table B2: Sector list

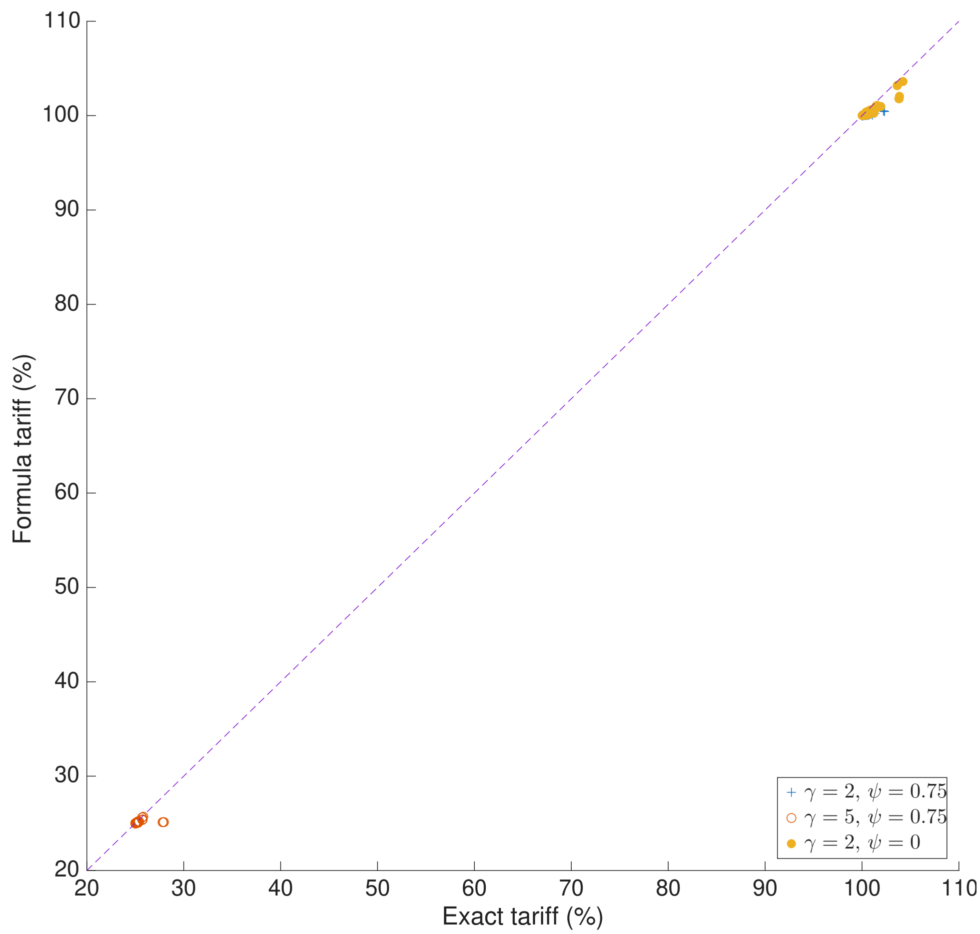
ICIO code	Description	Our aggregation
01T02	Agriculture, hunting, forestry	01T03
03	Fishing and aquaculture	01T03
05T06	Mining and quarrying, energy producing products	05T09
07T08	Mining and quarrying, non-energy producing products	05T09
09	Mining support service activities	05T09
10T12	Food products, beverages and tobacco	10T12
13T15	Textiles, textile products, leather and footwear	13T15
16	Wood an products of wood and cork	16
17T18	Paper products and printing	17T18
19	Coke and refined petroleum products	19
20	Chemical and chemical products	20
21	Pharmaceuticals, medicinal chemical and botanical products	21
22	Rubber and plastics products	22
23	Other non-metallic mineral products	23
24	Basic metals	24T25
25	Fabricates metal products	24T25
26	Computer, electronic and optical equipment	26T27
27	Electrical equipment	26T27
28	Machinery and equipment, nec	28
29	Motor vehicles, trailers and semi-trailers	29T30
30	Other transport equipment	29T30
31T33	Manufacturing nec; repair and installation of M&E	31T33
35	Electricity, gas, steam and air conditioning supply	35T98
36T39	Water supply; sewage, waste management and remediation	35T98
41T43	Construction	35T98
45T47	Wholesale and retail trade; repair of motor vehicles	35T98
49	Land transport and transport via pipelines	35T98
50	Water transport	35T98
51	Air transport	35T98
52	Warehousing and support activities for transportation	35T98
53	Postal and courier activities	35T98
55T56	Accommodation and food service activities	35T98
58T60	Publishing, audiovisual and broadcasting activities	35T98
61	Telecommunications	35T98
62T63	IT and other information services	35T98
64T66	Financial and insurance activities	35T98
68	Real estate activities	35T98
69T75	Professional, scientific and technical activities	35T98
77T82	Administrative and support services	35T98
84	Public administration and defence; compulsory social security	35T98
85	Education	35T98
86T88	Human health and social work activities	35T98
90T93	Arts, entertainment and recreation	35T98
94T96	Other service activities	35T98
97T98	Activities of households as employers	35T98

Notes: The Table details the sectors used in the multi-sector model. The first column lists the sector code in the ICIO database and the third column indicates to which sector aggregate we assign the sector.

C. Robustness results

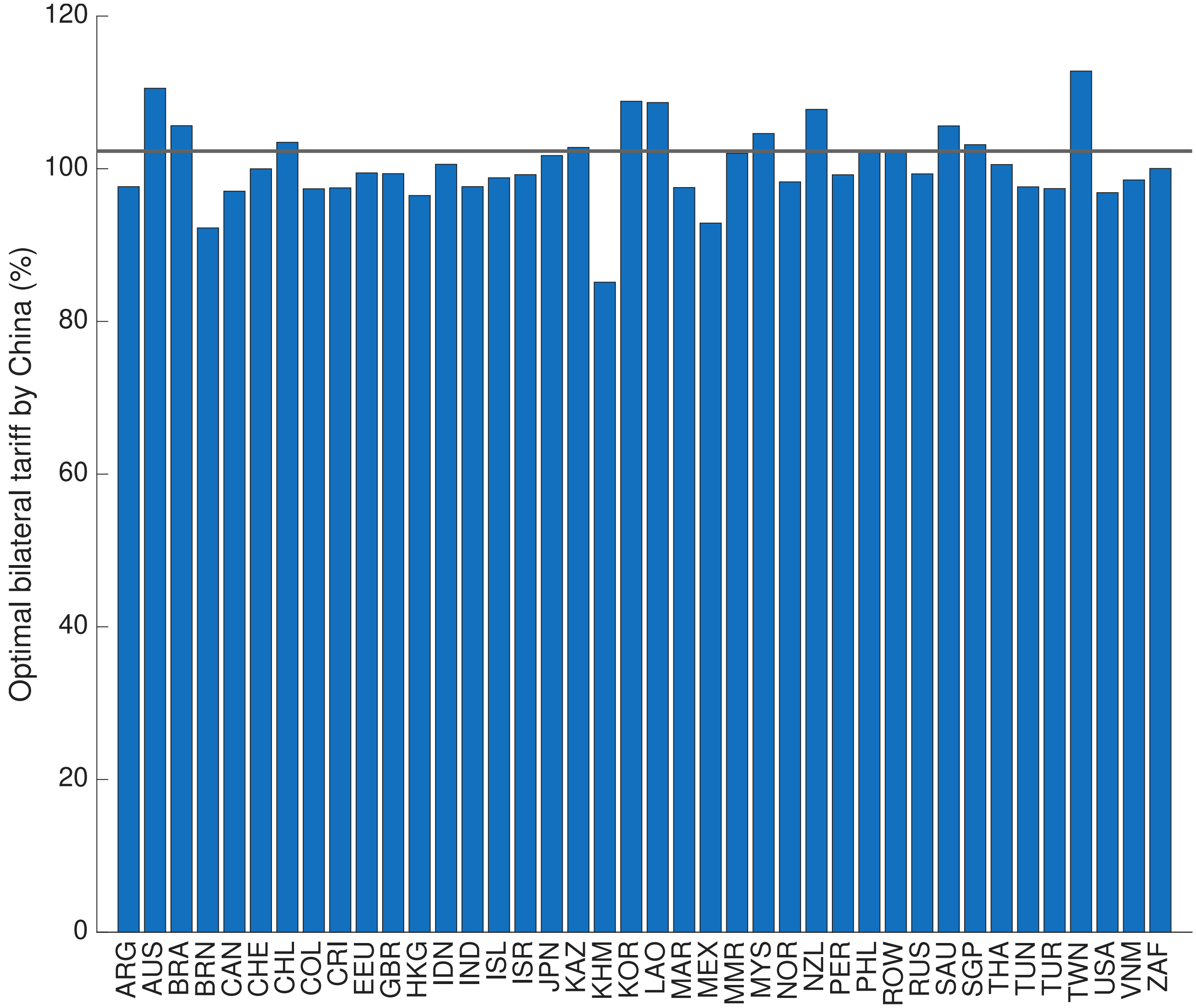
Fit of the analytical optimal tariff formula. The optimal tariff formula derived in Section 2.4 holds under the assumption that relative foreign wages are not affected by the tariff. Figure C4 plots the welfare change from imposing the formula tariff versus the exact numerical optimal unilateral tariff. Dots line up on the 45 degree line, implying that the assumption fits the data well.

Figure C1: Formula tariff and exact tariff



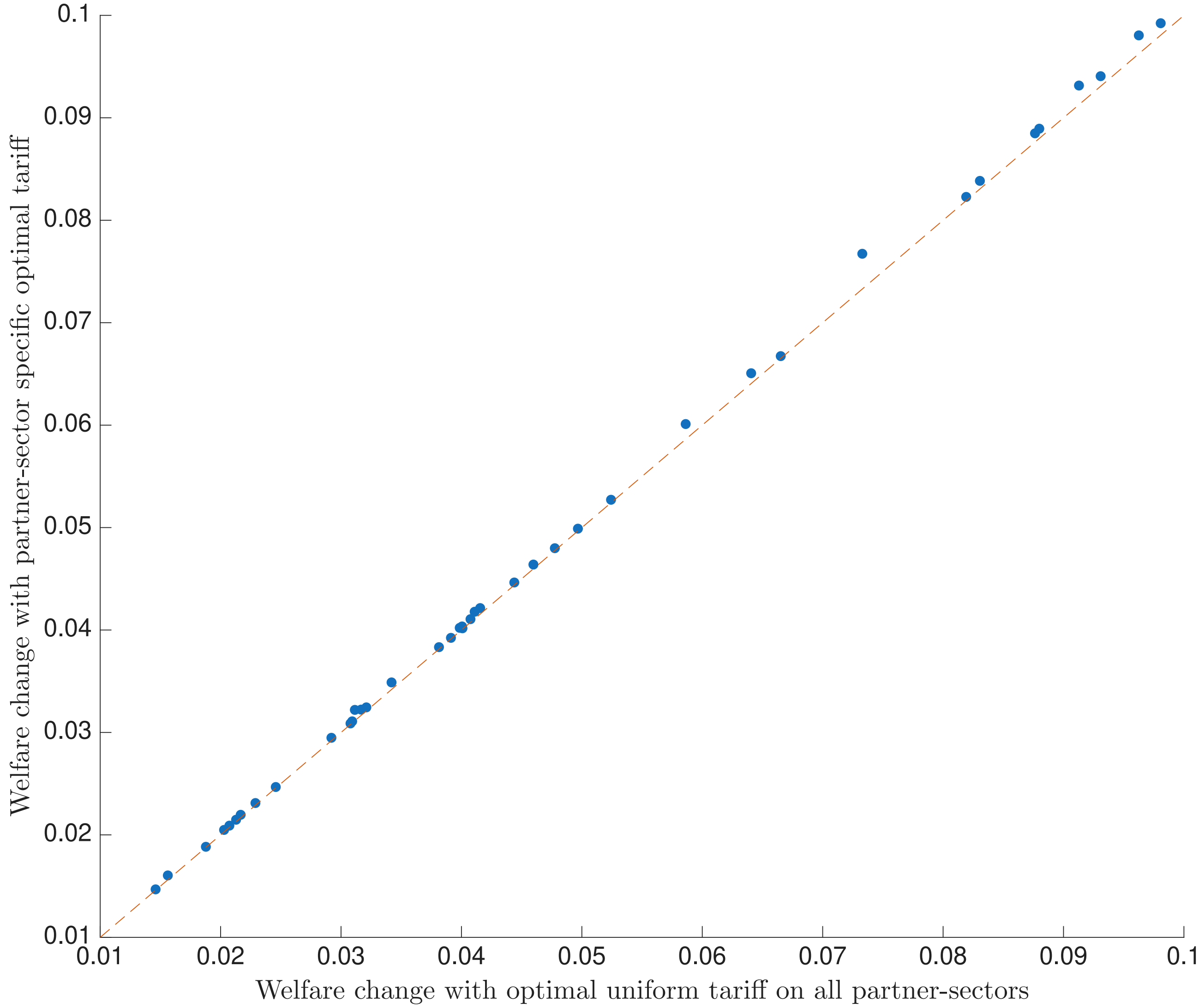
Notes: The figure displays the exact numerical unilateral tariff versus the formula tariff.

Figure C2: Uniform vs bilateral optimal tariffs



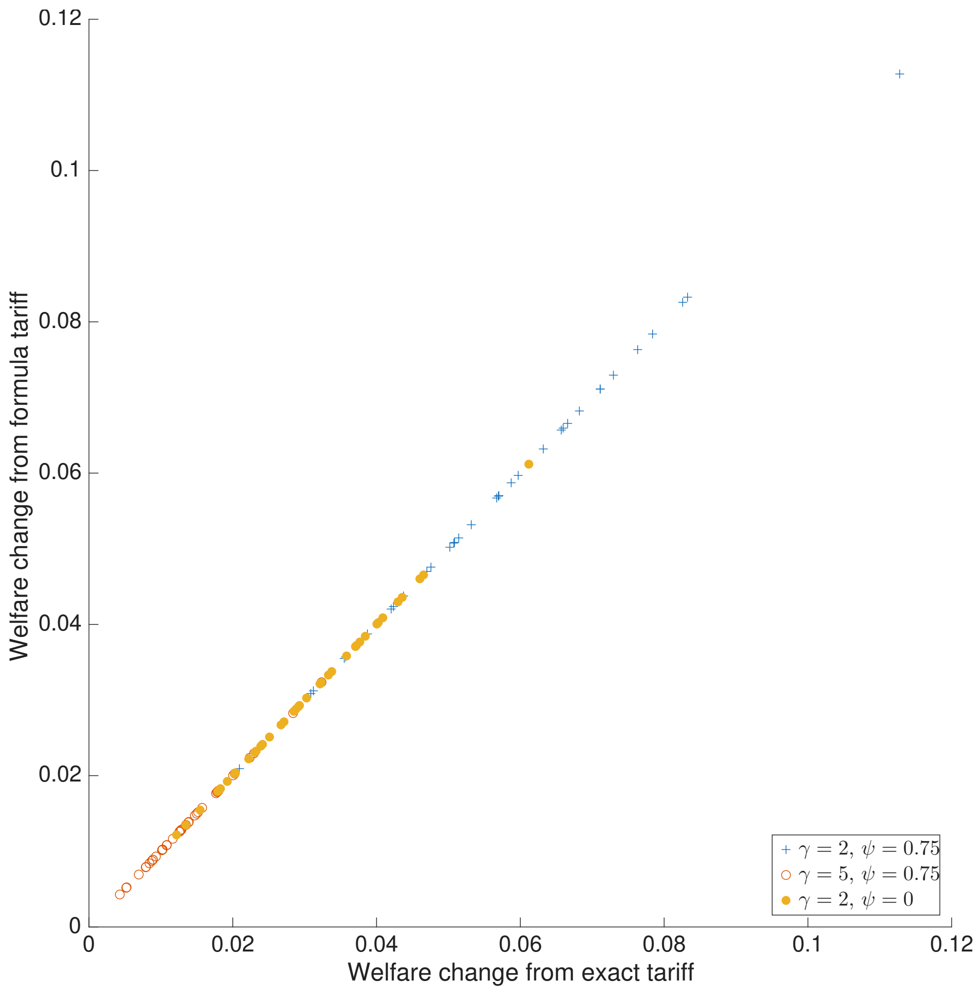
Notes: The figure displays the uniform tariff against the bilateral optimal tariff in the single sector model.

Figure C3: Welfare change with uniform vs bilateral-sectoral optimal tariffs



Notes: The figure plots the welfare change with the optimal (deviation) tariffs when a country can choose a partner-sector specific tariff, against the welfare change when we restrict the choice to a uniform tariff in the multi-sector model.

Figure C4: Welfare changes under formula and exact tariff

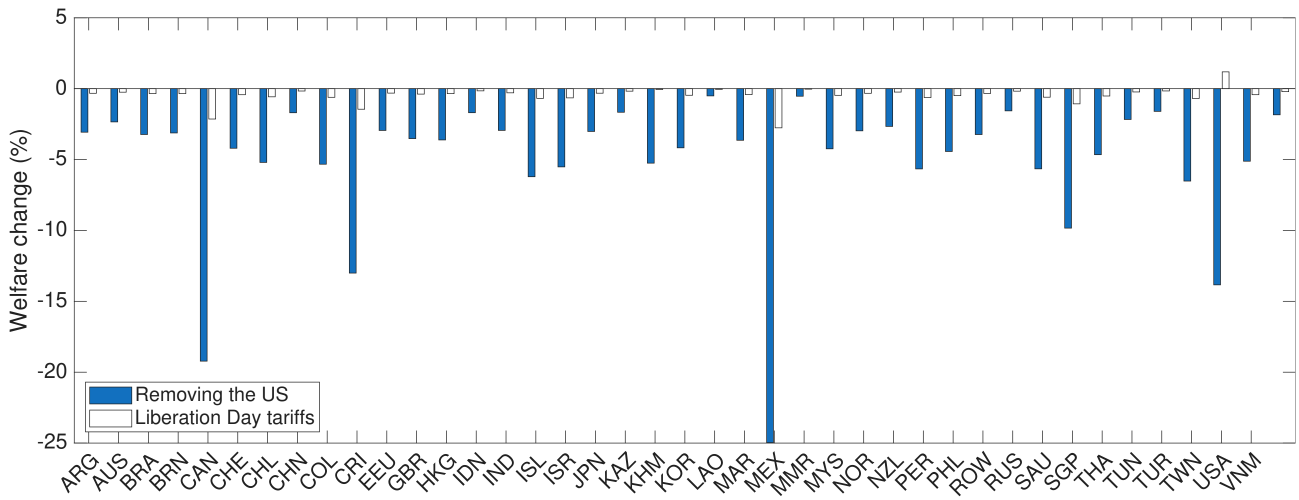


Notes: The figure displays the change in welfare from imposing the exact numerical unilateral tariff versus the formula tariff.

Welfare changes from US removal and from moving to Nash equilibrium. Figure C5 displays the change in welfare when the US withdraws from world trade. Figure C6 displays the welfare change from moving to the Nash Equilibrium.

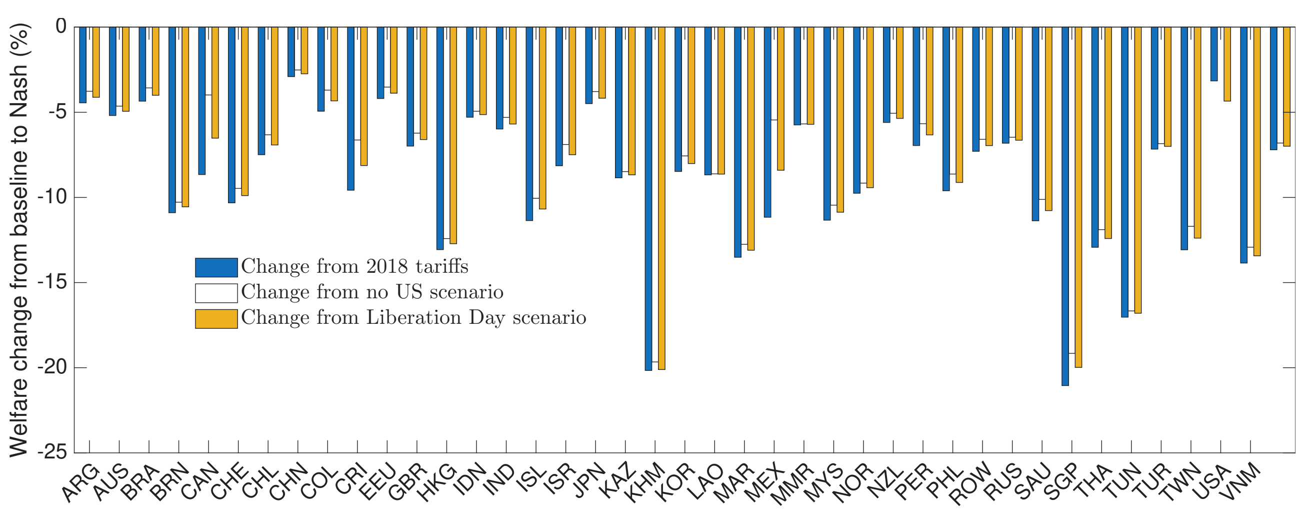
Elasticity sensitivity for China. Figure C7 plots the minimum β for China as a function of the trade elasticity and the Frisch elasticity of labor supply.

Figure C5: Welfare changes when the US leaves



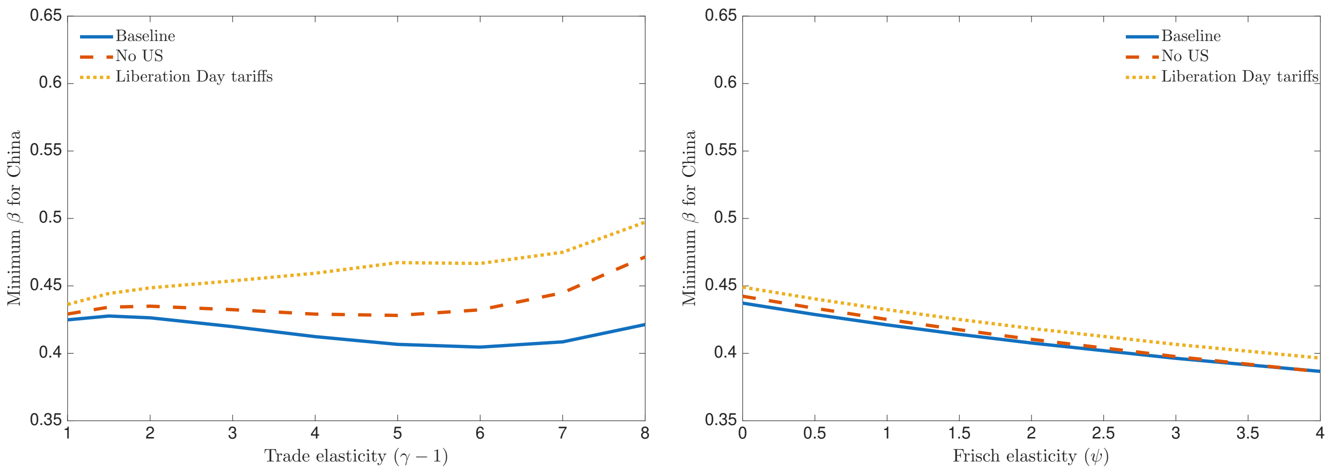
Notes: The figure displays the change in welfare when removing the US entirely (blue bar) or when implementing the average Liberation Day tariff (white bar). In practice, we remove the US entirely by increasing trade costs to and from the US by a factor of 500.

Figure C6: Welfare changes moving to Nash Equilibrium



Notes: The figure displays the welfare changes from moving to the Nash equilibrium, from the baseline 2018 tariffs (blue bar), from the alternative scenario where the US is removed from world trade (white bar) and from the Liberation Day tariffs (orange bar).

Figure C7: Labor supply elasticity and free trade cooperation sustainability (China)



(a) Varying trade elasticity

(b) Varying labor supply elasticity

Notes: The figure displays the minimum β required for China to sustain the free trade equilibrium, for different values of γ (left panel, keeping $\psi = 0.75$) or ψ (right panel, keeping $\gamma = 2$).