Tariffs as Bargaining Chips: A Quantitative Analysis of the U.S.–China Trade War*

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Abstract

U.S. President Joe Biden has maintained Trump tariffs on Chinese imports, despite campaign promises to remove them before the 2020 presidential election. We investigate the hypothesis that these tariffs can serve as leverage in future tariff negotiations with China, using a quantitative model incorporating U.S. regions and international trade linkages. After estimating the bargaining power of the U.S. and China, we compute their cooperative tariffs starting from the 2017 baseline and 2019 trade-war equilibrium separately. Simulation results show that, regardless of the relative bargaining power of the U.S., the trade war always improves U.S. welfare in the post-negotiation cooperative equilibrium. With an estimated Nash bargaining weight between 0.47 and 0.70, the trade war with China yields an additional post-negotiation welfare improvement of 0.04%–0.05% for the U.S.

Keywords: tariff bargaining, U.S.–China trade war, quantitative trade policy

JEL codes: F13, F51, R13

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I Introduction

During the 2016 U.S. presidential campaign, Donald Trump denounced the U.S.–China trade relationship and repeatedly vowed to increase tariffs on Chinese imports. After winning the 2016 election, he kept his promise by imposing a series of wide-ranging increases in tariffs from 2018 through 2019. As documented in Bown (2021), the average U.S. tariff on China had risen to more than 19% by January 2021, up from 3% before the trade war. At the same time, China retaliated by increasing its average tariff on U.S. goods from 8% to more than 20%. During the next presidential campaign, Joe Biden attacked the trade war as reckless and irresponsible, and stated that he would remove the Trump tariffs.[1] However, Joe Biden has not kept his word since winning the 2020 election, and the existing Trump tariffs remain in place as of 2023.

Several explanations for the Biden administration's reluctance to remove the Trump tariffs have emerged since 2021, including lobbying pressure from firms that have benefited from the Trump tariffs, concern about appearing weak on China, and campaign considerations for the 2024 presidential election. While acknowledging the merits of these theories, we do not seek to determine which one is the most probable. Instead, we focus on an argument that has been substantiated by U.S. government officials: these tariffs can be used as bargaining chips in future trade negotiations with China. In testimony before a U.S. Senate Appropriations subcommittee in June 2022, U.S. Trade Representative Katherine Tai stated, "The China tariffs are, in my view, a significant piece of leverage – and a trade negotiator never walks away from leverage". In this paper, we investigate this claim by quantitatively examining whether the trade war has improved the post-negotiation welfare outcomes of the U.S.

We start by developing a general equilibrium quantitative model that features both international trade and the U.S. economy disaggregated into eight regions and thirteen sectors. Firms in each U.S. region demand labor, local factors, and materials from all other markets in the economy, as in Caliendo, Parro, Rossi-Hansberg and Sarte (2017). By incorporating intermediate goods, sec-

[1]For example, on August 3, 2019, Joe Biden wrote on Twitter that "...Trump doesn't care about the farmers, workers, and consumers that are being crushed by his irresponsible trade war with China... I will reverse his senseless policies."

toral heterogeneity, and input-output linkages, our model features intersectoral trade, interregional trade, and international trade. The U.S. and China can engage in bilateral tariff negotiations, and the bargaining outcome depends on both the tariff levels before the negotiation and the relative bargaining power of the two countries.

We use the method of mathematical programming with equilibrium constraints (MPEC), popularized by Su and Judd (2012), to compute the outcomes of potential tariff negotiations between the U.S. and China in two scenarios. In the first scenario, the U.S. and China engage in Nash bargaining starting from the baseline equilibrium calibrated to the 2017 fundamentals before the trade war. In the second scenario, we first apply tariff changes observed during the trade war, and then compute the cooperative tariffs starting from the trade-war equilibrium. If the combined U.S. welfare change relative to the 2017 baseline in the second scenario is larger than the U.S. welfare improvement in the first scenario, we consider this result as supporting evidence of Katherine Tai's claim.

As analyzed in previous theoretical works on trade policy cooperation, bilateral tariff negotiations usually result in mutual tariff reductions. For example, Bagwell and Staiger (1999) show that, in a two-country, neo-classical trade model where non-cooperative tariffs can be imposed to improve terms of trade, both countries can benefit from a mutual reduction in tariffs. In addition, if political incentives are absent and governments simply use tariffs to maximize national income, the tariff negotiation will lead to an efficient equilibrium in which at least one country imposes zero tariffs. Ossa (2011) derives the same result in a Krugman (1980)-style environment in which tariffs can be used to improve welfare through production relocation. The results of our simulation, which uses the reasonably comprehensive general equilibrium model, are consistent with these theoretical predictions: the resulting cooperative equilibrium in both scenarios always involves one country imposing zero tariffs. However, since the total welfare change in the second scenario also incorporates the welfare change due to trade-war tariffs, existing theories cannot predict which scenario will lead to the greater welfare improvement for the U.S.

One key result from our quantitative analysis is that, regardless of the relative bargaining power between the U.S. and China, the U.S. always experiences a larger welfare increase relative to the 2017 baseline in the second scenario. In other words, compared to moving directly to the cooperative equilibrium from low tariffs, imposing trade-war tariffs before negotiating with China consistently results in greater U.S. post-negotiation welfare gains. This finding can be explained by the theoretical analysis of tariff bargaining in Bagwell and Staiger (1999) and Ossa (2011): the bilateral tariff negotiation between the U.S. and China involves reciprocal tariff reductions, and the U.S. welfare gain from the tariff negotiation starting from the 2017 baseline equilibrium is limited due to low U.S. tariff rates. For the same reason, tariff negotiation starting from high tariffs in the trade war equilibrium can substantially improve the U.S. welfare. Our simulation shows that, even after taking the welfare effects of the trade war into consideration, the negotiation starting from trade-war tariffs leads to a larger U.S. welfare improvement than the the negotiation starting from low tariffs before the trade war. This result is robust to extending the analysis to a multi-period framework, incorporating political weights into the objective function of the U.S., allowing negative tariffs (import subsidies), fixing trade deficits between countries, and using alternative estimates of trade elasticities.

Whereas the U.S. experiences a larger welfare increase when the tariff negotiation starts from the trade-war equilibrium, China is always worse off than negotiating directly from the 2017 low-tariff baseline. To better understand the underlying cause of this outcome, we also consider a counter-factual analysis in which, instead of imposing the factual retaliatory tariffs, China imposes welfare-maximizing tariffs in the trade war equilibrium. Our analysis reveals that China's optimal retaliatory tariffs are generally higher than those it actually imposed. The sub-optimal factual retaliatory tariffs not only fail to maximize China's welfare in the trade war equilibrium, but also leave the U.S. greater room for tariff reductions in future tariff negotiation. If China had retaliated optimally, U.S. welfare gains could have been smaller than those achieved by negotiating directly from the 2017 baseline when the U.S. bargaining weight is small.

We estimate the bilateral bargaining power between the U.S. and China by examining China's accession to the World Trade Organization (WTO) in 2001. Our approach closely follows the method of moments estimation introduced in Bagwell, Staiger and Yurukoglu (2021). In particular, given the estimated parameters of the trade model and the outside options, we can predict cooperative tariffs between the U.S. and China with any bargaining power parameter. We then numerically search over the bargaining power parameter to minimize the distance between factual Chinese tariffs after China's accession to the WTO and the predicted bargaining tariff outcomes. The estimated Nash bargaining weight of the U.S. in the bilateral tariff negotiation with China ranges from 0.47 to 0.70.[2] We obtain a range of the U.S. bargaining power because of the U.S. trade policy uncertainty before China's accession to the WTO. As documented in Handley and Limão (2017) and Alessandria, Khan and Khederlarian (2024), although the U.S. had already imposed low most-favored-nation (MFN) tariffs on Chinese imports before 2001, the U.S. Congress could vote to revoke China's MFN status and impose the non-cooperative "column 2" tariffs instead. These two possible outside options enable us to compute the two bounds of the U.S. bargaining power relative to China. Given this range of bargaining power, the trade war leads to an additional U.S. post-negotiation welfare gain of 0.04%–0.05% relative to its pre-trade-war welfare level. Meanwhile, China's post-negotiation welfare change decreases by 0.09%–0.10%.

By quantifying how the U.S.–China trade war affects potential negotiation outcomes, this paper contributes to the growing body of literature on quantitative trade policy. Ossa (2014) and Ossa (2016) initiated the study of non-cooperative and cooperative tariffs in multi-region quantitative trade models. Other papers in this strand of literature have analyzed the welfare effects of cooperative and non-cooperative trade policies either through numerical optimization (Mei, 2020; Bagwell et al., 2021; Beshkar, Chang and Song, 2024; Ritel, 2022; de Souza, Hu, Li and Mei, 2024; Mei, 2024) or through analytical characterization of optimal trade policy (Bartelme, Costinot, Donaldson and Rodríguez-Clare, 2019; Beshkar and Lashkaripour, 2020; Lashkaripour, 2021; Lashkaripour and Lugovskyy, 2023). Most closely related to our work are Bown et al. (2023) and Beshkar et al. (2024), both of which focus on the reciprocal tariff reductions among

[2]This estimated range of Nash bargaining weight indicates that the U.S. had more bilateral bargaining power in the negotiation with China, which is consistent with the finding in Bown, Caliendo, Parro, Staiger and Sykes (2023) that China's tariff reductions after its accession to the WTO exceeded the norm of reciprocity.

WTO member countries. Our analysis not only corroborates Katherine Tai's claim that the Trump tariffs can be used as bargaining chips, but also quantitatively illustrates how applied tariffs can influence the outcome of tariff negotiation in broader settings.

Our work also complements the theoretical literature that analyzes the welfare outcomes of trade negotiations. In addition to Bagwell and Staiger (1999) and Ossa (2011), Bagwell and Staiger (2004), Bagwell and Staiger (2018), Bagwell, Staiger and Yurukoglu (2020), and Beshkar and Lee (2022) also study the implications of different institutional features for tariff bargaining outcomes. By contrast, we estimate the relative bargaining power between the U.S. and China, and quantify the potential welfare effects of the U.S.–China trade war on tariff bargaining. The numerical results computed from the comprehensive general equilibrium model also substantiate previous results derived theoretically from simpler trade models.

Finally, this paper contributes to a burgeoning body of literature that studies the impact of the trade war initiated by the Trump administration. Previous works have mainly focus on the impact on U.S. prices and welfare (Amiti, Redding and Weinstein, 2019; Waugh, 2019; Fajgelbaum, Goldberg, Kennedy and Khandelwal, 2020; Amiti, Redding and Weinstein, 2020; Handley, Kamal and Monarch, 2020; Bown, 2021; Cavallo, Gopinath, Neiman and Tang, 2021), responses from China (He, Mau and Xu, 2021; Ma, Ning and Xu, 2021; Benguria, Choi, Swenson and Xu, 2022; Jiao, Liu, Tian and Wang, 2022; Jiang, Lu, Song and Zhang, 2023; Chor and Li, 2024), and U.S. election outcomes (Che, Lu, Pierce, Schott and Tao, 2022; Choi and Lim, 2023; Blanchard, Bown and Chor, 2024).[3] Our paper is distinct from these works by considering the Trump tariffs as bargaining chips, thereby providing the first quantitative study of the potential negotiation outcomes between the U.S. and China.

The rest of the paper is structured as follows: we start by developing a general equilibrium quantitative model that features both international trade and spatial features within the U.S. in Section II. After presenting data and calibrations in Section III, we present simulation results of tariff negotiations in Section IV. Section V presents some extensions and robustness checks, and

[3] See Fajgelbaum and Khandelwal (2022) for a comprehensive review of the literature on the impact of the U.S.–China trade war on aggregate welfare and distributional consequences for the U.S., China, and other countries.

the last section concludes.

II Model

To guide our analysis of cooperative tariffs, we follow Caliendo et al. (2017) and develop a quantitative model that features both international trade and the U.S. economy disaggregated by region and sector. The model incorporates intermediate goods, sectoral heterogeneity, and input-output linkages. We consider a total of $N + M$ locations, in which N is the number of regions in the U.S. and M is the number of other countries. The locations are indexed by i or $n \in \{1, \ldots, N, N+1, \ldots N+M\}$. The sectors are indexed by j or $k \in \{1, \ldots, J\}$. The U.S. economy has two factors: labor and a composite of land and structures. Labor can move freely across the regions and sectors in the U.S., but there is no international migration. The land and structures, H_n, are immobile and can be used by any sector. The total population of the U.S. is denoted by L_{US}, and the population in sector j, region n is denoted by L_n^j. For locations outside of the U.S., we abstract from the fixed factors and assume that labor is the only factor of production.

II.1 Consumers

Agents in location $n \in \{1, \ldots, N, N+1, \ldots, N+M\}$ have Cobb-Douglas preferences

$$U(C_n) = \prod_{j=1}^{J} \left(c_n^j\right)^{\alpha_n^j}, \quad \text{where } \sum_{j=1}^{J} \alpha_n^j = 1,$$

with consumption share α_n^j for each sector $j \in \{1, \ldots, J\}$, over local final goods c_n^j from sector j bought at price index P_n^j. Income in each location, denoted by I_n, is derived from two sources: households supply labor L_n inelastically at wage w_n and receive transfers on a lump-sum basis (including both tariff revenues and transfers accounting for trade imbalances, which will be discussed in more detail later).

II.2 Technology

The production technology closely follows Eaton and Kortum (2002) and Caliendo and Parro (2015). Final goods can be used for consumption or as inputs for the production of intermediate goods. In each sector, the final goods are produced using a continuum of intermediate goods in that sector. Intermediate goods are produced using labor and a fixed factor of land and structures in locations within the U.S., along with the final goods from all the sectors, while the production of intermediate goods from other countries uses only labor and final goods. The final goods used to produce intermediate goods are referred to as "materials".

The representative firms of sector j produce a continuum of varieties $\mu^j \in [0,1]$ in each region n. In each location n, sector j, each firm draws its productivity level z_n^j independently from a Fréchet distribution with shape parameter θ^j and location parameter T_n^j. The production of a variety within the U.S. associated with idiosyncratic productivity level z_n^j is given by

$$q_n^j(z_n^j) = z_n^j \left[\left[h_n^j(z_n^j)\right]^{\beta_n} \left[l_n^j(z_n^j)\right]^{(1-\beta_n)}\right]^{\gamma_n^j} \prod_{k=1}^{J} \left[M_n^{jk}(z_n^j)\right]^{\gamma_n^{jk}}, \text{ for } n \in \{1,\ldots,N\},\ j \in \{1,..,J\},$$

where $h_n(\cdot)$ and $l_n(\cdot)$ denote demand for structures and labor, respectively. $M_n^{jk}(\cdot)$ denotes the demand for materials from sector k for the production of intermediate good in sector j in location n. $\gamma_n^{jk} \geq 0$ is the share of input from sector k in the production of goods in sector j in location n, and γ_n^j is the share of value added. The production function is constant return to scale; therefore $1-\gamma_n^j = \sum_{k=1}^{J} \gamma_n^{jk}$. Since the production of intermediate goods outside of the U.S. does not require a fixed factor, $\beta_n = 0$ for $n \in \{N+1,\ldots,N+M\}$, and the corresponding production function becomes

$$q_n^j(z_n^j) = z_n^j \left[l_n^j(z_n^j)\right]^{\gamma_n^j} \prod_{k=1}^{J} \left[M_n^{jk}(z_n^j)\right]^{\gamma_n^{jk}}, \text{ for } n \in \{N+1,\ldots,N+M\},\ j \in \{1,\ldots,J\}.$$

Markets are competitive, so sector j firms in country n set the price at x_n^j/z_n^j. Taking x_n^j as the cost of the input bundle for intermediate goods in location n, sector j, we have

$$\begin{aligned} x_n^j =& B_n \left[r_n^{\beta_n} w_n^{1-\beta_n} \right]^{\gamma_n^j} \prod_{k=1}^{J} \left[P_n^k \right]^{\gamma_n^{jk}}, \text{ for } n \in \{1, \ldots, N\} \\ x_n^j =& B_n' w_n^{\gamma_n^j} \prod_{k=1}^{J} \left[P_n^k \right]^{\gamma_n^{jk}}, \text{ for } n \in \{N+1, \ldots, N+M\}, \end{aligned} \tag{1}$$

where $B_n = [\gamma_n^j (1-\beta_n)^{(1-\beta_n)} \beta_n^{\beta_n}]^{-\gamma_n^j} \prod_{k=1}^{J} [\gamma_n^{jk}]^{-\gamma_n^{jk}}$ and $B_n' = [\gamma_n^j]^{-\gamma_n^j} \prod_{k=1}^{J} [\gamma_n^{jk}]^{-\gamma_n^{jk}}$.

Final goods in each location are produced using intermediate goods from the lowest cost suppliers around the world. The production technology of Q_n^j is a constant elasticity of substitution (CES) aggregator given by

$$Q_n^j = \left[\int_{\mathcal{R}_+^{N+M}} \tilde{q}_n^j (z^j)^{1-1/\eta_n^j} \phi^j(z^j) dz^j \right]^{\eta_n^j/(\eta_n^j - 1)},$$

where $\tilde{q}_n(z^j)$ is the demand for an intermediate good of a given variety such that the vector of productivity drawn from each location for that variety is $z^j = (z_1^j, z_2^j, \ldots, z_{N+M}^j)$. The joint density function for the vector z^j is denoted by $\phi^j(z^j) = \exp\{-\sum_{n=1}^{N+M} T_n^j (z_n^j)^{-\theta^j}\}$, with marginal densities given by $\phi_n^j(z_n^j) = \exp\{-T_n^j (z_n^j)^{-\theta^j}\}$, and the integral is over $\mathcal{R}_+^{N+M}$. For non-tradable sectors, the producers only use locally produced intermediates.

II.3 International trade costs and prices

We assume that trade in intermediate goods is costly due to iceberg trade costs and an ad valorem tariff. In particular, $d_{ni}^j \geq 1$ units of tradable intermediate goods in sector j need to be shipped from location i to location n with $d_{nn}^j = 1$. Sector j goods imported by country n from country i incur tariff t_{ni}^j. Combining both the iceberg trade costs and the ad valorem tariff, we define $\kappa_{ni}^j = \tau_{ni}^j d_{ni}^j$, where $\tau_{ni}^j = 1 + t_{ni}^j$. For goods circulated within the U.S., only iceberg trade costs are applicable, so $\tau_{ni}^j = 1$ for $i, n \in \{1, \ldots, N\}$. Non-tradable sectors have infinite trade costs, so $\kappa_{ni}^j = \infty$. After considering trade costs, the price of intermediate good μ^j in location n is given by

$$p_n^j(\mu^j) = \min_i \left\{ \frac{x_i^j \kappa_{ni}^j}{z_i^j(\mu^j)} \right\}.$$

Following the probabilistic representation of technologies in Eaton and Kortum (2002), we can derive the price index for the composite of intermediate goods j in region n:

$$P_n^j = \Gamma\left(\frac{1-\eta_n^j}{\theta^j}+1\right)^{1/(1-\eta_n^j)} \left[\sum_{i=1}^{N} T_i^j \left(x_i^j \kappa_{ni}^j\right)^{-\theta^j}\right]^{-1/\theta^j}, \tag{2}$$

where $\Gamma(.)$ is the Gamma function. When j denotes a non-tradable sector, the price index becomes

$$P_n^j = \Gamma\left(\frac{1-\eta_n^j}{\theta^j}+1\right)^{1/(1-\eta_n^j)} \left[T_n^j \left(x_n^j\right)^{-\theta^j}\right]^{-1/\theta^j}.$$

As consumers have Cobb-Douglas preferences, the aggregate consumption price index P_n is given by

$$P_n = \prod_{j=1}^{J} \left(\frac{P_n^j}{\alpha_n^j}\right)^{\alpha_n^j}.$$

We can also derive location n's expenditure on the intermediate goods of sector j purchased from location i. We use $X_n^j = P_n^j Q_n^j$ as the total expenditure on sector j goods in location n and X_{ni}^j as the expenditure of location n on sector j goods from location i. The expenditure share $\pi_{ni}^j = X_{ni}^j / X_n^j$ is given by

$$\pi_{ni}^j = \frac{T_i^j \left[x_i^j \kappa_{ni}^j\right]^{-\theta^j}}{\sum_{h=1}^{N+M} T_h^j \left[x_h^j \kappa_{nh}^j\right]^{-\theta^j}}. \tag{3}$$

II.4 Income

To address the regional trade imbalances within the U.S., we assume that the local factors are partly owned by local governments and the rents are redistributed to local residents. The rest of the rents are collected by central government, forming a national portfolio that is redistributed to all the agents within the U.S. However, trade imbalances still exist between countries and will be handled of through transfers.

We assume that a fraction of $\iota_n, n \in \{1, \ldots, N\}$ of the local factor rents is collected by the central government, forming the national portfolio. All residents within the U.S. hold an equal share of the national portfolio. The $(1 - \iota_n)$ fraction of the return is redistributed to local residents equally. The difference between the remittances to the central government and the local factor income generates imbalances across regions within the U.S.:

$$\Upsilon_n \equiv \iota_n r_n H_n - \chi L_n, \text{ for } n \in \{1, \ldots, N\}, \tag{4}$$

where r_n is the rental rate for the fixed factor, and $\chi = \sum_{i=1}^N \iota_i r_i H_i / \sum_{i=1}^N L_i$ is the share of national portfolio received by each resident in the U.S.

The excess income generated by these imbalances in region n is spent by agents on local final goods. The magnitude of these across-region imbalances will change in the model with the change of tariff, as it will affect the wages and the rental rates of land and structures. The tariff revenues are distributed as lump-sum payments to all residents in location $n \in \{1, \ldots, N, N+1, \ldots, N+M\}$, along with the unaddressed trade surplus across countries. The income for residents in location n within the U.S. is

$$I_n = w_n + \chi + (1 - \iota_n) r_n H_n / L_n + \lambda_n - s_n, \text{ for } n \in \{1, \ldots, N\},$$

where w_n is the wage, $r_n H_n / L_n$ is per capita income of land and structure rents in location n, λ_n is the per capita tariff revenue received by agents in location n, and s_n is the per capita trade surplus generated from the country-wide trade imbalances. Similarly, the income for residents in other countries is given by $I_n = w_n + \lambda_n - s_n$ for $n \in \{N+1, \ldots, N+M\}$, since we abstract from the fixed factor for locations outside of the U.S.

II.5 Labor mobility and market clearing

We first focus on the U.S. economy. Regional labor market clearing for locations within the U.S. requires that

$$\sum_{j=1}^{J} \int_0^{\infty} l_n^j(z)\phi_n^j(z)dz = \sum_{j=1}^{J} L_n^j = L_n, \text{ for } n \in \{1, \ldots, N\},$$

where L_n^j is the number of workers in sector j in region n. In addition, the labor market clearing at the national level requires that $\sum_{n=1}^{N} L_n = L_{US}$. For any U.S. region, the market clearing condition for land and structures must satisfy

$$\sum_{j=1}^{J} \int_0^{\infty} h_n^j(z)\phi_n^j(z)dz = \sum_{j=1}^{J} H_n^j = H_n, \text{ for } n \in \{1, \ldots, N\},$$

where H_n^j denotes the land and structures used in sector j in region n. We abstract from labor mobility and fixed factor input for locations outside of the U.S.

Intermediate goods producers solve the profit maximization problem, along with the equilibrium condition between rental rates and wages $r_n H_n(1-\beta_n) = \beta_n w_n L_n$ for all $n \in \{1, \ldots, N\}$. Then, by defining $\omega_n \equiv [r_n/\beta_n]^{\beta_n}[w_n/(1-\beta_n)]^{(1-\beta_n)}$, free mobility along with the labor market clearing condition gives us an expression for labor input in region n of the U.S.:

$$L_n = \frac{H_n \left[\frac{\omega_n}{P_n U + u_n - \lambda_n + s_n}\right]^{1/\beta_n}}{\sum_{i=1}^{N} H_i \left[\frac{\omega_i}{P_i U + u_i - \lambda_i + s_n}\right]^{1/\beta_n}} L, \tag{5}$$

where $u_n \equiv \Upsilon_n/L_n = \iota_n r_n H_n/L_n - \chi$ is per capita regional transfer in region n within the U.S. Since labor is perfectly mobile within the U.S., utility $U_n = U_{US}$ is equalized for $n \in \{1, \ldots, N\}$.

Total expenditure on final goods j in location n, X_n^j, is the sum of the expenditure on composite intermediate goods by firms and the expenditure on final consumption by households:

$$X_n^j = \sum_{k=1}^{J} \gamma_n^{j,k} \sum_{i=1}^{N+M} X_i^k \frac{\pi_{in}^k}{\tau_{in}^k} + \alpha_n^j I_n L_n, \tag{6}$$

where

$$I_n L_n = \omega_n (H_n)^{\beta_n} (L_n)^{1-\beta_n} - \Upsilon_n + \Lambda_n - S_n, \text{ for } n \in \{1, \ldots, N\},$$

$$I_n L_n = w_n L_n + \Lambda_n - S_n, \text{ for } n \in \{N+1, \ldots, N+M\}.$$

In particular, $\Lambda_n = \sum_{j=1}^{J} \sum_{i=1}^{N+M} t_{ni}^j X_n^j \frac{\pi_{ni}^j}{\tau_{ni}^j}$ refers to location n's tariff revenue on sector j goods from all locations.

Sectoral trade surplus is defined as $S_n^j = \sum_{i=1}^{N+M} \left(X_i^j \frac{\pi_{in}^j}{\tau_{in}^j} - X_n^j \frac{\pi_{ni}^j}{\tau_{ni}^j} \right)$, and total trade surplus at national level is $\sum_{j=1}^{J} S_n^j = S_n$. Finally, using trade surplus and expenditure, we have the trade balance condition:

$$\sum_{j=1}^{J} \sum_{i=1}^{N+M} X_n^j \frac{\pi_{ni}^j}{\tau_{ni}^j} + \Upsilon_n + S_n = \sum_{j=1}^{J} \sum_{i=1}^{N+M} X_i^j \frac{\pi_{in}^j}{\tau_{in}^j}. \tag{7}$$

This equation suggests that the total expenditure net of tariff expenditure plus trade surpluses is equal to the sum of each country's expenditure.

II.6 Competitive equilibrium

Given factor supplies L and $\{H_n\}_{n=1}^{N}$, a competitive equilibrium under given tariff structure τ for this economy is a set of utility levels $\{U_{US}, U_n\}_{n=N+1}^{N+M}$, a set of factor prices in each region, $\{\omega_n\}_{n=1}^{N+M}$, a set of labor allocation within the U.S. $\{L_n\}_{n=1}^{N}$, regional transfers within the U.S. $\{\Upsilon_n\}_{n=1}^{N}$ and prices $\{P_n^j\}_{n=1,j=1}^{N+M,J}$, which satisfy equilibrium conditions 1, 2, 3, 4, 5, 6, and 7 for all sectors j and locations n. In practice, we solve the model using the exact hat algebra approach, as in Dekle, Eaton and Kortum (2007), to avoid calibrating unchanged underlying parameters. We present the corresponding equilibrium conditions in Appendix Section A.1. In addition, as discussed in Ossa (2014), the presence of aggregate trade imbalances between countries can generate extreme general equilibrium adjustments in response to trade policy changes. Accordingly, we follow the exercise in Dekle et al. (2007) to construct a trade flow matrix of 2017 without trade imbalances. All later simulations of tariff negotiations in the main analysis will treat this purged trade flow data as the

2017 baseline equilibrium.[4] Nevertheless, we also consider an alternative setup that fixes the 2017 factual imbalances in Section V.5 as a robustness check.

II.7 Tariff negotiation

We assume that the U.S. and China can negotiate over their bilateral tariffs. In particular, the two countries select their bilateral tariffs to maximize the Nash product of their welfare:

$$
\begin{aligned}
\max_{\{\boldsymbol{\tau}_{US,chn},\boldsymbol{\tau}_{chn,US}\}} & \left[U_{US}\left(\boldsymbol{\tau}_{US,chn},\boldsymbol{\tau}_{chn,US}\right)-U_{US}\left(\boldsymbol{\tau}^0_{US,chn},\boldsymbol{\tau}^0_{chn,US}\right)\right]^{\psi} \\
& \left[U_{chn}\left(\boldsymbol{\tau}_{chn,US},\boldsymbol{\tau}_{US,chn}\right)-U_{chn}\left(\boldsymbol{\tau}^0_{chn,US},\boldsymbol{\tau}^0_{US,chn}\right)\right]^{1-\psi} \\
& \text{s.t. the competitive equilibrium conditions are satisfied, and} \\
& U_{US}\left(\boldsymbol{\tau}_{US,chn},\boldsymbol{\tau}_{chn,US}\right)\geq U_{US}\left(\boldsymbol{\tau}^0_{US,chn},\boldsymbol{\tau}^0_{chn,US}\right), \\
& U_{chn}\left(\boldsymbol{\tau}_{chn,US},\boldsymbol{\tau}_{US,chn}\right)\geq U_{chn}\left(\boldsymbol{\tau}^0_{chn,US},\boldsymbol{\tau}^0_{US,chn}\right),
\end{aligned}
\tag{8}
$$

where the bargaining power of the U.S. against China is denoted by ψ. When $\psi = 1$, the U.S. maximizes its own welfare while keeping China welfare non-decreasing. Throughout this paper, we refer to the solution to (8) as cooperative tariffs or post-negotiation tariffs. In particular, $\boldsymbol{\tau}_{US,chn}$ refers to the predicted vector of cooperative tariffs imposed by the U.S. on Chinese goods across all sectors and $\boldsymbol{\tau}_{chn,US}$ is the vector of cooperative tariffs imposed by China on U.S. goods. $U_{US}\left(\boldsymbol{\tau}^0_{US,chn},\boldsymbol{\tau}^0_{chn,US}\right)$ and $U_{chn}\left(\boldsymbol{\tau}^0_{chn,US},\boldsymbol{\tau}^0_{US,chn}\right)$ denote the initial welfare levels of the U.S. and China under the pre-negotiation tariff profile $(\boldsymbol{\tau}^0_{US,chn},\boldsymbol{\tau}^0_{chn,US})$ that will prevail if the two countries fail to reach an agreement. In practice, we also adopt the exact hat algebra approach to solve the Nash bargaining problem, and the hat-algebra equilibrium details are presented in Appendix Section A.2.

[4]This approach has been adopted in several existing works on quantitative trade policy, such as Ossa (2014) and Bagwell et al. (2021). Ossa (2016) discusses the implications of various approaches for managing trade deficits in counterfactual analysis.

III Data, calibration, and some empirical facts

In this section, we first present the data and the calibration of parameters used in the quantitative exercise. We then discuss the estimation of two remaining key parameters: the bargaining power between the U.S. and China ψ, and the elasticity of substitution θ^j. In the last part of the section, we present some basic facts of the U.S.–China trade war.

III.1 Data

In our quantitative analysis, we consider two major economies: the U.S. and China. The remaining countries are grouped into one entity known as the Rest of the World (ROW). Following the classification in the Regional Economics Information System (REIS) of the U.S. Bureau of Economic Analysis (BEA), we disaggregate the U.S. into eight regions: *New England*, *Mideast*, *Great Lakes*, *Plains, Southeast*, *Southwest*, *Rocky Mountain*, and *Far West*. Each region represents a grouping of states with similar economic and social conditions. Twelve tradable sectors are organized as shown in the left column of Table 1. We combine non-tradable sectors into a single service sector.

We use the economy in 2017 as the pre-trade-war baseline to analyze the Nash bargaining over tariffs and the economy in 1997 to estimate the relative bargaining power between the U.S and China. Consequently, we need to calibrate two sets of parameters, those in 1997 and those in 2017, to accommodate different economic situations. The detailed data sources and the calibration process are formally stated as follows.

We obtain bilateral international trade flow data from the OECD Inter-Country Input-Output (ICIO) database for the years 1997 and 2017. Regional-sectoral trade flows within the U.S. are computed by using the standard Commodity Flow Survey (CFS). To disaggregate the trade flows between the U.S. and other trading countries to the regional level, we follow Caliendo, Dvorkin and Parro (2019) and allocate the aggregate trade volume proportionally to the sectoral employment share in each region. The labor employment data at the region-sector level are obtained from BEA

Table 1: Elasticity of Substitution and Political Economy Weight Estimates

Sector	θ_j	σ_{US}	σ_{CHN}
Chemical	2.43	0.91	1.12
Computer, electronic and electrical equipment	2.70	**1.32**	1.06
Food, beverages and tobacco	2.30	0.71	**1.28**
Machinery	2.56	**1.20**	1.02
Mineral	1.98	0.91	0.78
Miscellaneous	3.66	1.13	0.78
Petroleum	2.76	0.57	**1.15**
Primary and fabricated metal	2.82	1.03	**1.16**
Rubber	2.72	1.01	0.83
Service	3.31	1.00	1.00
Textiles	2.97	**1.35**	0.80
Transportation	2.98	1.08	1.12
Wood and paper	2.78	0.77	0.92
Mean	2.77	1.00	1.00

Note: The entries under θ_j are the estimates of elasticity of substitution. The entries under σ_{US} and σ_{CHN} are the estimates of political economy weights for the U.S. and China, respectively, which are scaled to have a mean of one. The bold entries highlight the sectors with the three highest values of political weights for each country. Parameter estimates are reported by sector in alphabetical order.

for the matching year or the nearest year available. In this way, we obtain a complete trade flow matrix that bilaterally links 8 + 2 locations by 12 tradable sectors.

The OECD ICIO database also provides information regarding intermediate trade flows for any origin sector and destination sector, as well as the trade values used for final goods consumption. We directly back out value-added shares in gross production, γ_n^j, and input-output coefficients, γ_n^{jk}, from the database.

The consumption expenditure share in each location for each sector is computed as

$$\alpha_n^j = \frac{1}{I_n}\left(\sum_{i=1}^{N+M} X_n^j \pi_{ni}^j - \sum_{k=1}^{J}\sum_{i=1}^{N+M} \gamma_i^{kj}\frac{\pi_{in}^k}{\tau_{in}^k} X_i^k\right).$$

Because the implied intermediate good expenditures in some industries exceed gross expenditures, γ_n^{kj} and α_n^j are pinned down simultaneously à la Bagwell et al. (2021) to ensure that the calibrated

α does not have a negative value.[5]

The shares of local rent allocated to the national portfolio, ι_n, are calibrated to eliminate trade imbalances between U.S. regions. Specifically, we compute the regional trade surplus for each location within the baseline model and then conduct a numerical search for a vector of $\boldsymbol{\iota}$ that minimizes the sum of the squared regional surpluses within the U.S.

Lastly, we calibrate β_n, the input share of land and structures in intermediate goods production. We follow Caliendo et al. (2017) and calculate the value-added share of land and structures as

$$\beta_n = \left(\frac{Employment\ Compensation_n}{Value\ added_n} - 0.17 \right) /0.83,$$

where the compensation data of the employees and the disaggregated value-added data are obtained from BEA. This adjustment process first teases out the value-added share of equipment (17%), and then renormalizes the remaining fraction in value added.

III.2 Estimation of bargaining power

We estimate the relative bargaining power between the U.S. and China by examining the episode of China's accession to the WTO in 2001. After joining the WTO, China significantly reduced its MFN tariff rates to other WTO member countries. In the meanwhile, the tariffs on China applied by the U.S. remained largely unchanged.[6] This is because the U.S. had already granted China normal trade relations (NTR) status and significantly reduced tariffs on Chinese products to MFN levels in 1980. The U.S. Congress voted annually throughout the 1990s on a bill to renew China's NTR status. If China's NTR status had been revoked, Chinese exports to the U.S. would have been subject to "column 2 tariffs", the non-cooperative tariffs applied to U.S. imports

[5] Specifically, we adjust the values of γ_n^{kj} slightly to minimize the sum of the squared distance between the imputed input-output coefficients and the input-output coefficients from the OECD ICIO data, while ensuring that the final goods expenditure shares are all non-negative.

[6] As documented in Dorsey (2003), "China will reduce tariffs on nonagricultural products (which account for 95% of its imports) to 8.9% by 2005, and tariffs on agricultural products to 15% by January 2004." In Figure A.1 of the Appendix, we plot the U.S. and China tariff rates at sector level in 1997 and 2005, respectively. The U.S. tariff rates on Chinese imports remained almost the same with only a slight decline. Meanwhile, China significantly lowered its tariffs on U.S. imports after joining the WTO.

from non-WTO member countries (Ossa, 2014). This trade policy uncertainty associated with U.S. tariffs on Chinese goods lasted until 2001 when China gained permanent NTR status after joining the WTO.[7]

We estimate the bargaining power parameter ψ using a method of moments estimation that closely follows the approach introduced in Bagwell et al. (2021). In particular, given the estimated parameters of the trade model, we can predict post-negotiation tariffs with any bargaining weight and outside options by solving the Nash bargaining problem (8). We can then numerically search over ψ to minimize the distance between the post-negotiation tariffs predicted by our model and the factual bargaining outcomes that we discuss in more detail later. We use the world economy in 1997 and 2005 to approximate the equilibrium before and after China's accession to the WTO, respectively.

Given the institutional background of China's accession to the WTO, we introduce three institutional constraints when solving the Nash bargaining problem numerically to estimate the U.S. bargaining power ψ. The first constraint is about the outside option of the U.S.: since the U.S. already reduced tariffs on Chinese imports to MFN levels in 1980, setting $\boldsymbol{\tau}^0_{US,chn}$ as the U.S. applied tariffs in 1997 as in Bagwell et al. (2021) may not accurately reflect the threat point of the U.S in the negotiation with China. In fact, since the U.S. tariffs remained largely unchanged, the computed U.S. bargaining power from this setup should be considered the upper bound of ψ. As noted in Bagwell et al. (2021), a country tends to be assigned a larger bargaining power in a bilateral bargaining pair if tariff reductions of the country are smaller than those of its negotiating partner. The lower bound of ψ, meanwhile, is computed by setting $\boldsymbol{\tau}^0_{US,chn}$ as the "column 2 tariffs" of the U.S, the outside option that would bring the largest tariff reductions on the U.S. side.

Second, because the applied MFN tariff rates imposed by the U.S. on most WTO members remained relatively stable between 1997 and 2005, we assume that China was fully aware of the U.S. post-negotiation tariff rates throughout the negotiation process. In other words, $\boldsymbol{\tau}_{US,chn}$ in (8)

[7] As discussed in Handley and Limão (2017), China never lost its NRT status, but it came close: "In the 1990s, after the Tiananmen Square protests, Congress voted on a bill to revoke MFN status every year and the House passed it three times."

is pinned down by the U.S. applied MFN tariff rates in 2005, and we only need to compute $\boldsymbol{\tau}_{chn,US}$ to solve the Nash bargaining problem. We believe that this setup more accurately reflects the tariff bargaining environment during China's accession to the WTO. Nevertheless, we also consider the alternative setup in which $\boldsymbol{\tau}_{US,chn}$ and $\boldsymbol{\tau}_{chn,US}$ are both adjustable during the negotiation. The computed results are presented in Section V.5 as a robustness check.

Third, we treat the applied MFN tariffs in 2005 on ROW as given when estimating the relative bargaining power between the U.S. and China. Unlike the Uruguay Round, which involved a collection of inter-connected bilateral bargains (Bagwell et al., 2021), the U.S.–China bilateral agreement is generally regarded as the core of the negotiation on China's accession to the WTO (Dorsey, 2003). Therefore, by focusing on the negotiation between the U.S. and China only, we do not need to consider the complications from the Nash-in-Nash approach adopted in Bagwell et al. (2021), which is substantially more computationally demanding than our current approach.

Given these assumptions, we estimate the bargaining power by searching for a value of ψ that minimizes the distance between the factual level of China's tariffs after joining the WTO and the solutions to China's cooperative tariffs given this ψ. Formally, the bargaining power of the U.S. relative to China is backed out by solving

$$\min_{\psi}\left(\boldsymbol{\tau}_{chn,US}(\psi)-\boldsymbol{\tau}^{2005}_{chn,US}\right)'\left(\boldsymbol{\tau}_{chn,US}(\psi)-\boldsymbol{\tau}^{2005}_{chn,US}\right),$$

where $\boldsymbol{\tau}_{chn,US}(\psi)$ is the vector of the predicted cooperative tariff of China on the U.S. exports given the bargaining power ψ from solving (8) and $\boldsymbol{\tau}^{2005}_{chn,US}$ is the unilateral vector of the applied MFN tariff rates of China against the U.S. in the year 2005. Using the grid search method, we obtain the upper and lower bounds of the U.S. bargaining power relative to China: $\hat{\psi}=0.47$ when setting $\boldsymbol{\tau}^{0}_{US,chn}$ as "column 2 tariffs" and $\hat{\psi}=0.70$ when setting $\boldsymbol{\tau}^{0}_{US,chn}$ as the U.S. applied tariffs in 1997.

Our estimates of $\psi\in[0.47,0.70]$ indicate that the U.S. had more bilateral bargaining power in the negotiation with China. Bown et al. (2023) also study the same event but focus on reciprocal tariff reductions that keep the terms of trade between the two countries unchanged (Bagwell and

Staiger, 1999). Bown et al. (2023) find that, contrary to recent accusations against China, the tariff reductions by China after its accession to the WTO actually exceeded the norm of reciprocity. This finding is consistent with our estimated value of the U.S. bargaining power: as noted in Bagwell et al. (2021), a country tends to be assigned a smaller bargaining power in bilateral bargaining if its tariff reductions will be larger than those of its negotiating partner.

III.3 Elasticity of substitution

The elasticity of substitution, θ^j, is estimated using the well-known method first described by Feenstra (1994) and documented in Feenstra (2010). Data used for bilateral trade flow and quantity are from the CEPII's BACI database, covering the time period from 1996 to 2016. The estimated elasticities are reported in Table 1. The average of estimated elasticities of substitution is 2.77, which is similar to the estimated average of 2.80 in Mei (2024) and falls within the range of previous findings in the literature.[8] In Section V.5, we also use estimates of elasticity of substitution from Caliendo and Parro (2015) as a robustness check.

III.4 Trade war tariffs

We obtain the tariff data from the World Integrated Trade Solution (WITS) at the country-product (HS 6-digit) level and aggregate it into sectors based on trade volume weight. As in Jiao et al. (2022), the bilateral trade war tariff data are calculated as the pre-trade war applied MFN tariff rates plus the changes in tariff rates caused by each round of the U.S–China tariff war until the end of 2019. Tariff changes in each round are obtained from the Peterson Institute for International Economics (PIIE). Following the approach in Fajgelbaum, Goldberg, Kennedy, Khandelwal and Taglioni (2021), the tariff changes are scaled by the total time in effect over the two-year window.

In Figure 1, we show the factual tariff rates before and after the trade war by sector. As can be seen from the left panel, the average U.S. tariffs on Chinese goods increased from 2.99% to

[8] Ossa (2014) uses the GTAP database with trade data from 1994 to 2008, and the average of estimated elasticities is 3.42 with a range from 1.19 to 10.07. This is because the sectors in Ossa (2014) are more granular, and agricultural sectors such as wheat and rice exhibit greater elasticity of substitution.

13.30%. At the same time, Chinese tariffs on U.S. goods increased from 6.79% to 14.76%.[9] The U.S. raised tariffs on Chinese goods in all sectors, whereas China did the same, with the exception of transportation. This is because China reduced the MFN tariffs on motor vehicles in July 2018. China later retaliated against the U.S. Section 301 Investigations by raising tariffs on the transportation industry, but the retaliation tariffs were suspended on January 1, 2019. The reduction in MFN tariffs on motor vehicles also led to a slight decrease in Chinese tariffs on goods from ROW. Meanwhile, the U.S. tariffs applied to goods from other countries remained stable during the trade war.

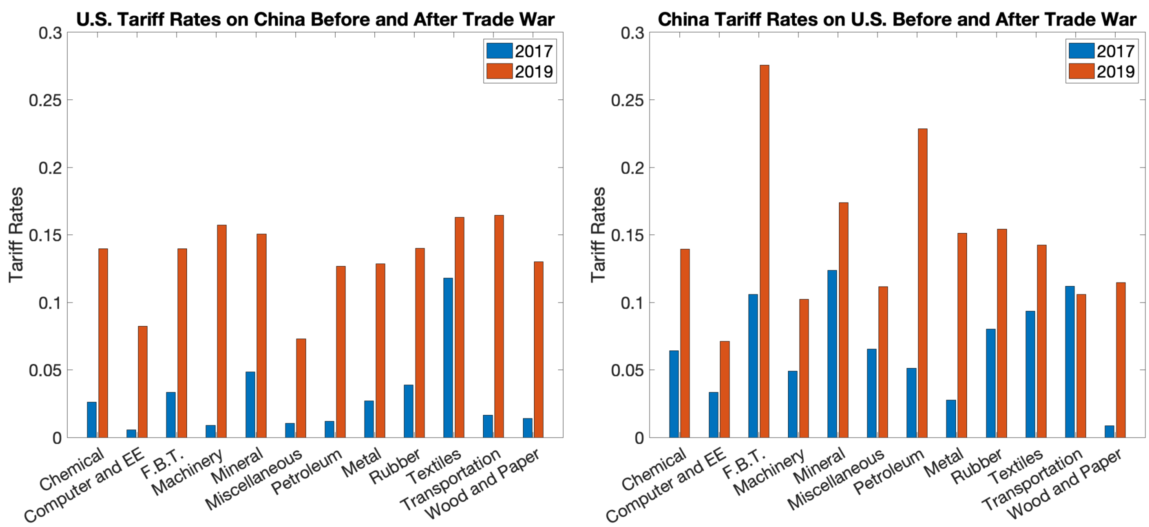


Figure 1: Tariff Rates Applied During the U.S.—China Trade War

Note: The figure plots the factual bilateral tariff rates between the U.S. and China in 2017 (before the trade war) and at the end of 2019 (after the trade war). Tariff data are aggregated into sectors based on trade volume. Sectors are arranged in alphabetical order.

IV Main results

In this section, we first describe the procedure used to examine the U.S. Trade Representative Katherine Tai's claim that the Trump-era tariffs can be used as a leverage in future tariff negotiations with China. Next, we present the computed cooperative tariffs as a result of negotiations and

[9]Despite using the same data source, the average tariff changes we calculate differ from those in Bown (2021) because we first aggregate tariffs at sector level before taking the simple average.

the corresponding welfare changes.

IV.1 Procedure

We want to quantitatively analyze whether the trade war improves the U.S. post-negotiation welfare. To do so, we first calibrate the model constructed in Section II with the 2017 data. Next, we compute the cooperative tariffs between the U.S. and China given bargaining power ψ by solving (8) with the MPEC approach. $\boldsymbol{\tau}^0_{US,chn}$ and $\boldsymbol{\tau}^0_{chn,US}$ in the Nash bargaining problem are set to be the pre-trade-war tariffs of the two countries in 2017. We use $\hat{\boldsymbol{U}}^{co-17}(\psi)$ to denote the corresponding the vector of welfare change from the 2017 baseline equilibrium when the computed cooperative tariffs were imposed, which incorporates each country's respective welfare change, $\hat{U}^{co-17}_{US}(\psi)$, $\hat{U}^{co-17}_{chn}(\psi)$, and $\hat{U}^{co-17}_{ROW}(\psi)$.

We then apply the trade-war tariffs rates observed in 2019 to the 2017 baseline equilibrium. Given the tariff changes, the resulting vector of welfare change of the trade war equilibrium relative to the 2017 baseline equilibrium is denoted by $\hat{\boldsymbol{U}}^{war}$. Note that $\hat{\boldsymbol{U}}^{war}$ does not depend on ψ as the computation of welfare changes does not involve tariff bargaining.

Starting from the equilibrium with trade-war tariffs, we can again use the MPEC approach to compute cooperative tariffs given ψ. In this scenario, $\boldsymbol{\tau}^0_{US,chn}$ and $\boldsymbol{\tau}^0_{chn,US}$ are set to be the trade-war tariffs of the two countries observed in 2019. The corresponding vector of welfare change from imposing cooperative tariffs relative to the trade-war equilibrium is denoted by $\hat{\boldsymbol{U}}^{co-war}(\psi)$. Using $\hat{\boldsymbol{U}}^{co-19}(\psi) \equiv \hat{\boldsymbol{U}}^{war} \times \hat{\boldsymbol{U}}^{co-war}(\psi)$ to denote the vector of welfare change relative to the 2017 baseline, we define $\hat{U}^{co-19}_{US}(\psi)$ as the corresponding relative welfare change of the U.S. By comparing $\hat{U}^{co-19}_{US}(\psi)$ with $\hat{U}^{co-17}_{US}(\psi)$, we can quantitatively evaluate Katherine Tai's claim about using the Trump tariffs as bargaining chips: if $\hat{U}^{co-19}_{US}(\psi) > \hat{U}^{co-17}_{US}(\psi)$, then the trade war improves the U.S. welfare from the tariff negotiation with China relative to the negotiation outcome using 2017 as the starting point.

IV.2 Post-negotiation equilibrium

Figure 2 displays the average cooperative tariff rates of the U.S. and China in both pre- and post-war tariff negotiations given different bargaining powers. The two lines on the left panel represent the simple average of bilateral cooperative tariff rates between the U.S. and China if the tariff negotiation starts from the 2017 equilibrium. It can be observed that, irrespective of the U.S. bargaining power, the average cooperative tariff of the U.S. is always zero if the negotiation starts from the 2017 equilibrium. At the same time, the computed cooperative tariff for China is always positive, although the level of tariffs decreases as the bargaining power of the U.S. increases. At our estimated range of $\psi = [0.47, 0.70]$, the average cooperative tariff of China ranges from 5.60% to 3.91%. Even when we set $\psi = 1$ and the U.S. gains all of the bargaining power against China, the average of China's predicted cooperative tariff rates is still 1.76%.

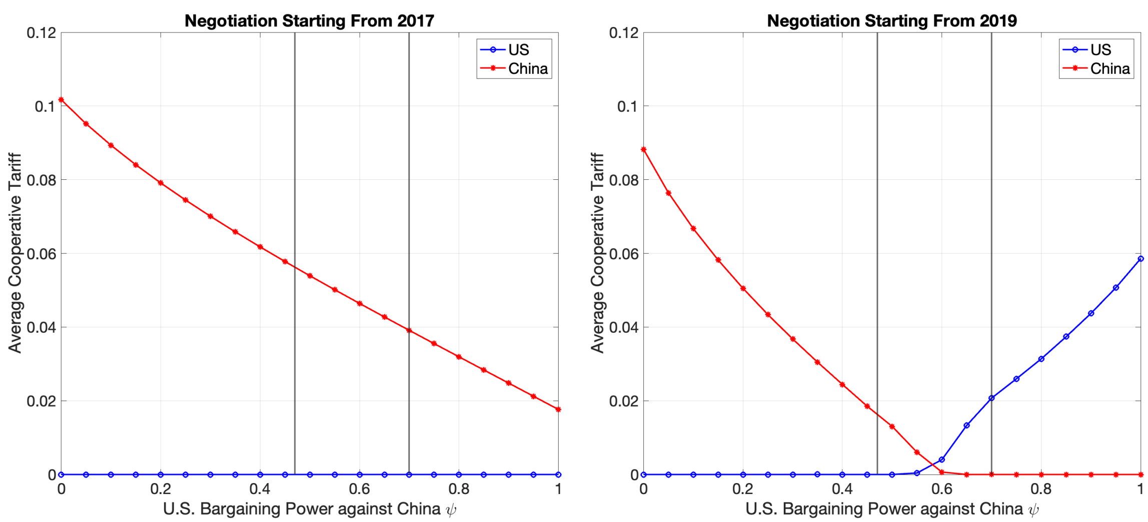


Figure 2: Average Post-Negotiation Tariffs for the U.S. and China

Note: This figure plots the simple average of post-negotiation tariffs across sectors for the U.S. and China. The left panel shows predicted tariffs when the negotiation starts from the 2017 baseline equilibrium, whereas the right panel shows predicted tariffs when the negotiation starts from the trade-war equilibrium. The two vertical lines indicate the lower bound (0.47) and upper bound (0.70) of the estimated bargaining power of the U.S. relative to China.

The solid lines on the right panel of Figure 2 refer to the average of bilateral cooperative tariff rates for both countries if the tariff negotiation starts from the 2019 trade-war equilibrium. When $\psi < 0.6$, the U.S. cooperative tariff is zero and China's cooperative tariff is positive, just as with the negotiated tariffs starting from the 2017 equilibrium. However, when $\psi \geq 0.6$, the U.S. cooperative tariff becomes positive and that of China reaches zero. When $\psi = 0.47$, China's post-negotiation tariff rate is 1.61%, lower than 5.60% in the other scenario indicated by the red solid line. When $\psi = 0.70$, the average tariff rate for the U.S. is 2.07%.

Previous works on cooperative tariffs (Bagwell and Staiger, 1999; Ossa, 2011) have theorized that if political incentives are absent and governments simply use tariffs to maximize their own welfare, tariff negotiations will lead to an efficient equilibrium in which at least one country imposes zero tariffs.[10] The post-negotiation tariffs illustrated in Figure 2 are consistent with this theoretical prediction: the post-negotiation equilibrium always involves one country having zero tariffs, regardless of which tariff profile the negotiation starts from. However, previous theoretical studies cannot predict which of the two countries will impose zero tariffs. In fact, we can see from Figure 2 that the level of resulting cooperative tariffs depends on both the bargaining power ψ and the pre-negotiation tariff profile $(\boldsymbol{\tau}^0_{US,chn}, \boldsymbol{\tau}^0_{chn,US})$.[11]

Comparing the cooperative tariffs in the two scenarios shown in Figure 2 also reflects the change in the U.S. bargaining position. Relative to the post-negotiation tariff starting from the 2017 equilibrium, the average U.S. post-negotiation tariff starting from the 2019 trade-war equilibrium is always equal or higher for any given ψ. Meanwhile, the average Chinese post-negotiation tariff starting from the 2019 trade-war equilibrium is always lower. This pattern can be explained by the improved bargaining position of the U.S. after the trade war. Prior to the trade war, the U.S. applied tariff rates are on average lower than the Chinese rates, as shown in Figure 1. Starting from this equilibrium, the U.S. does not have much room for mutual tariff reductions, and China is always able to impose positive tariffs in the post-negotiation equilibrium. However, the difference in pre-negotiation tariffs shrinks after the two countries raise tariffs amidst the trade war. Starting from the trade-war equilibrium, the U.S. has more room to reduce tariffs. China has to provide more

[10] In Section V.5, we consider a setup that allows for negative tariffs or import subsidies. In this case, zero tariffs are no longer guaranteed in the cooperative equilibrium. However, the welfare outcomes discussed in the main text later still hold.

[11] The role of initial tariff profile in trade policy cooperation has been emphasized by Ossa (2014) in the computation of world cooperative tariffs.

tariff concessions in this case, which results in lower cooperative tariffs in the post-negotiation equilibrium.

IV.3 Examining Katherine Tai's claim

It is worth noting that the improved bargaining position of the U.S. after the trade war does not automatically support Katherine Tai's claim about using the trade-war tariffs as bargaining chips. This is because in the second scenario, the U.S. needs to move from the 2017 equilibrium to the 2019 equilibrium in order to enjoy the improved bargaining position. If we simply compare $\hat{U}_{US}^{co-war}$ with $\hat{U}_{US}^{co-17}$, the U.S. welfare change in the trade war is excluded. In other words, the U.S. may enjoy a better bargaining position if the tariff negotiation starts from the trade-war equilibrium, but the cost of the trade war could be too large relative to the additional gain from the tariff negotiation. Therefore, we should compare $\hat{U}_{US}^{co-19}(\psi) \equiv \hat{U}_{US}^{war} \times \hat{U}_{US}^{co-war}(\psi)$ with $\hat{U}_{US}^{co-17}(\psi)$ when examining Katherine Tai's claim. In this way, the welfare change in both scenarios is relative to the 2017 baseline equilibrium.

Figure 3 illustrates the post-negotiation welfare change (relative to the 2017 baseline) of the two scenarios for the U.S. and China.[12] In both panels, the blue lines represent $\hat{U}_{US}^{co-17}(\psi)$ and $\hat{U}_{chn}^{co-17}(\psi)$, the welfare change of the tariff negotiation starting from the 2017 equilibrium. The red lines represent $\hat{U}_{US}^{co-19}(\psi)$ and $\hat{U}_{chn}^{co-19}(\psi)$, the combined welfare change of the tariff negotiation starting from the trade-war equilibrium in 2019 and the welfare change from the 2017 baseline to the trade-war equilibrium. As expected, the U.S. post-negotiation welfare change is always increasing with the U.S. bargaining power ψ, and the opposite pattern is observed for China's post-negotiation welfare change.

One important result observed in Figure 3 is that, for any given ψ, it is always the case that $\hat{U}_{US}^{co-19}(\psi) > \hat{U}_{US}^{co-17}(\psi)$ and $\hat{U}_{chn}^{co-19}(\psi) < \hat{U}_{chn}^{co-17}(\psi)$. In other words, regardless of the relative bargaining power between the U.S. and China, the U.S. always enjoys greater welfare improvement

[12]Exact levels of percentage welfare changes are reported in Table A.1 of the Appendix. For welfare changes computed from tariff negotiation, only the values based on $\psi = 0.47$ and $\psi = 0.70$ are reported.

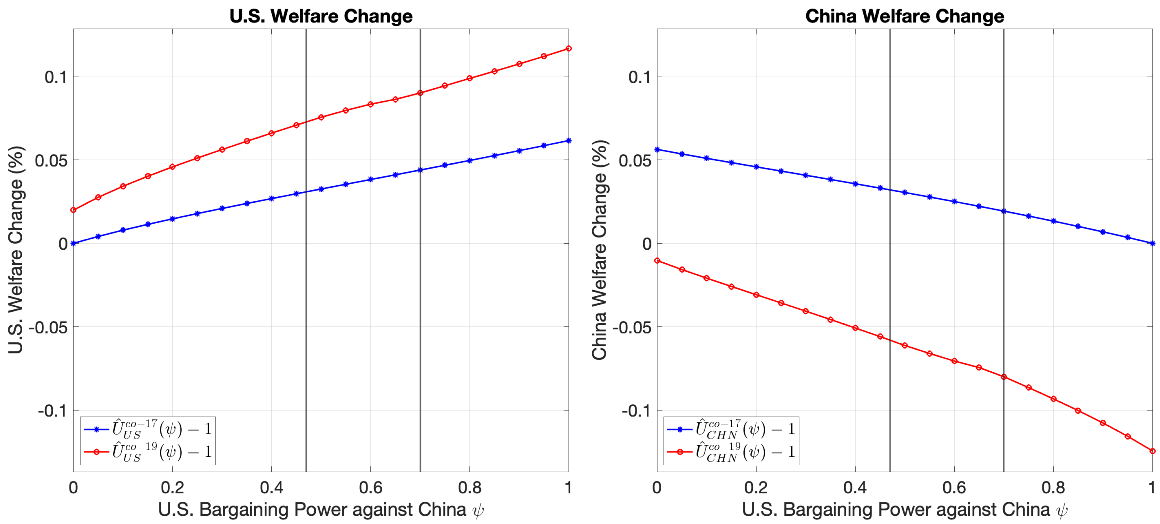


Figure 3: Post-Negotiation Welfare Change

Note: The blue lines refer to the welfare change of the tariff negotiation starting from the 2017 tariff profile. The red lines refer to the welfare change of the tariff negotiation starting from the 2019 tariff profile. The two vertical solid lines indicate the lower bound (0.47) and upper bound (0.70) of the estimated bargaining power of the U.S. relative to China.

by starting the tariff negotiation from the trade-war equilibrium. Given our estimated range of ψ, the difference in U.S. post-negotiation welfare improvement relative to the 2017 baseline is from 0.04% (when $\psi = 0.47$) to 0.05% (when $\psi = 0.70$). Meanwhile, China always experiences a smaller welfare improvement or even welfare loss when starting the negotiation from the trade-war equilibrium. For example, when $\psi = 0.70$, China enjoys a welfare improvement of 0.02% if the tariff negotiation starts from the 2017 baseline, but suffers a welfare loss of 0.08% by negotiating after engaging in the trade war. In the second scenario, China incurs an overall welfare loss because the welfare improvement from the tariff negotiation $\hat{U}_{chn}^{co-war}(\psi)$ is not sufficient to cover the welfare loss from the trade war $\hat{U}_{chn}^{war}$.

We also observe the increasing welfare difference in the two scenarios for both the U.S. and China with larger U.S. bargaining power. Note that since $\hat{U}_{US}^{war}$ and $\hat{U}_{chn}^{war}$ do not depend on ψ, this pattern must be driven by the negotiation outcomes of the two scenarios. This is because the tariff negotiation starting from the 2017 baseline always results in zero U.S. cooperative tariffs due to the low U.S. tariff level prior to the negotiation. In this way, the potential welfare improvement from the tariff negotiation is constrained when ψ increases. By contrast, the room for mutual tariff reductions is greater when the tariff negotiation starts from the trade-war equilibrium. Consequently, the U.S. is able to reap more welfare improvement as ψ increases.

The different negotiation outcomes between the U.S. and China also lead to different welfare impacts to other countries. In Figure A.8 of the Appendix, we plot the post-negotiation welfare change for ROW in the two scenarios. We can see that, when the U.S. and China engage in tariff negotiation directly from the 2017 equilibrium, other countries suffer a small welfare loss in the post-negotiation equilibrium. This is can be explained by the trade diversion arisen from bilateral tariff reductions between the U.S. and China. In the second scenario, however, the negative effect of trade diversion from tariff negotiation is outweighed by the "positive" trade diversion caused by the trade-war tariffs. As a result, other countries enjoy a welfare improvement in the post-negotiation equilibrium.

In sum, we compute the outcomes of potential tariff negotiations between the U.S. and China in two scenarios using the model constructed in Section II. In the first scenario, the U.S. and China engage in Nash bargaining starting from the 2017 baseline equilibrium. In the second scenario, we first apply tariff changes observed during the trade war and then compute the cooperative tariffs starting from the trade-war equilibrium. Our simulation indicates that, regardless of the relative bargaining power between the U.S. and China, the U.S. always enjoys a larger welfare increase relative to the 2017 baseline in the second scenario. This result is consistent with Katherine Tai's claim that the tariffs on Chinese goods are a "significant piece of leverage".

V Extensions

In this section, we complement the analysis in Section IV with a few extensions. We first incorporate the dynamic consideration of tariff negotiation by studying a two-period setup. We then discuss whether China can improve its post-negotiation outcomes by imposing a different set of retaliatory tariffs during the trade war. Next, political incentives are incorporated into the government's objective function in the tariff negotiation. We also show substantial heterogeneity in the changes to post-negotiation outcomes across U.S. states before performing a series of checks to establish the robustness of our findings discussed in Section IV.

V.1 Multi-Period Setup

The main analysis in Section IV is based on a static framework. We now consider a simple extension that incorporate the time dimension. In particular, we consider a two-period model with the 2017 equilibrium considered as "period 0".[13] When $t = 1$, the U.S. and China either impose cooperative tariffs with welfare changes $\hat{U}^{co-17}$ (scenario one) or enter the trade war equilibrium with welfare changes $\hat{U}^{war}$ (scenario two). In the next period, the cooperative tariffs are maintained in scenario 1. In scenario two, the two countries engage in tariff negotiation with welfare changes $\hat{U}^{co-war}$ relative to the trade war equilibrium. For both scenarios, the welfare levels are discounted by a common discount factor β^t.

Using $\hat{U}_n^{total-17}(\psi)$ to denote the total welfare change of country n in the first scenario when the U.S. and China engage in tariff negotiation from the 2017 equilibrium, we have:

$$\hat{U}_n^{total-17}(\psi) = \hat{U}_n^{co-17}(\psi) + \beta^t \hat{U}_n^{co-17}(\psi). \tag{9}$$

Similarly, we can define $\hat{U}_n^{total-19}(\psi)$ to be country n's total welfare change in scenario two when the two countries impose trade war tariffs first and then engage in tariff negotiation in period 2:

$$\hat{U}_n^{total-19}(\psi) = \hat{U}_n^{war} + \beta^t \hat{U}_j^{war} \hat{n}_n^{co-war}(\psi). \tag{10}$$

We can further define $\Delta\hat{U}_n^{total}(\psi) \equiv \hat{U}_n^{total-19}(\psi) - \hat{U}_n^{total-17}(\psi)$ to be the difference in total welfare change of country j between the two scenarios. A positive $\Delta\hat{U}_{US}^{total}(\psi)$ indicates that the U.S. enjoys greater total welfare improvement in scenario two in this two-period setting.

[13] In Appendix A.3, we also consider an extension with infinite periods, and the main results in the two-period setup still hold qualitatively.

Figure 4 presents $\Delta\hat{U}^{total}_{US}(\psi)$ and $\Delta\hat{U}^{total}_{chn}(\psi)$ for various values of discount factor β^t. The two lines on the left panel represent $\Delta\hat{U}^{total}_{US}(0.47)$ and $\Delta\hat{U}^{total}_{US}(0.70)$, respectively. We can see that, for a wide range of discount factor ($\beta^t > 0.51$), both $\Delta\hat{U}^{total}_{US}(0.47)$ and $\Delta\hat{U}^{total}_{US}(0.70)$ are positive.[14] In other words, consistent with the main analysis in Section IV, the total U.S. welfare improvement is larger when the U.S. starts a trade war with China first and then engages in tariff negotiation in the next period. Meanwhile, the two lines representing $\Delta\hat{U}^{total}_{chn}(0.47)$ and $\Delta\hat{U}^{total}_{chn}(0.70)$ are always below zero on the right panel.

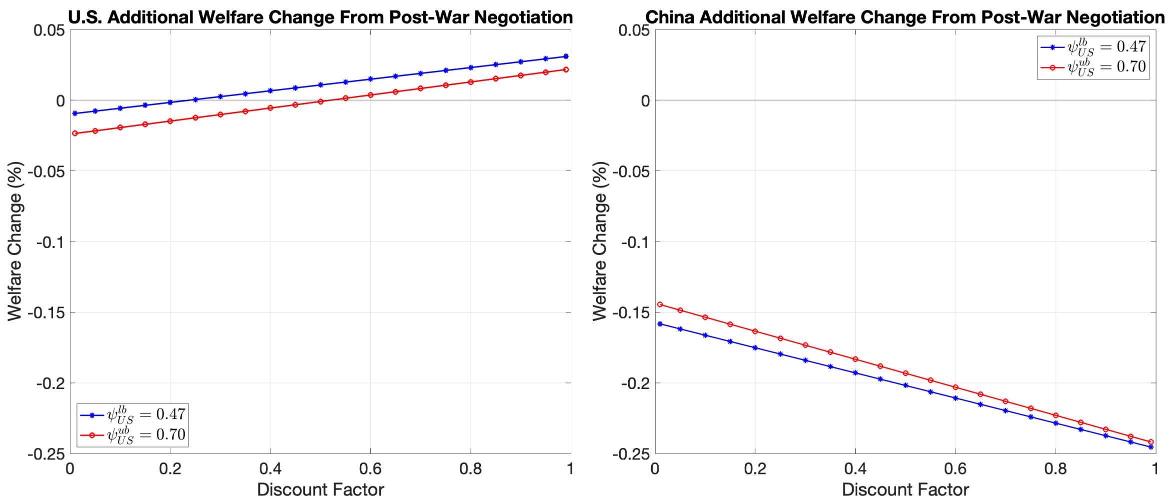


Figure 4: Dynamic Welfare Change in a Two-Period Setup

Note: This figure plots $\Delta\hat{U}^{total}_{n}(\psi)$ for the U.S. and China in the two-period setup. For each country, we consider the lower and upper bound of our estimated U.S. bargaining power ψ (0.47 and 0.70, respectively).

Another feature revealed in Figure 4 is that, on the right panel, the blue line representing $\Delta\hat{U}^{total}_{US}(0.47)$ is always above the red line representing $\Delta\hat{U}^{total}_{US}(0.70)$. In other words, when the bargaining weight for the U.S. is larger, the country's additional welfare improvement in scenario two by negotiating from the trade war equilibrium is smaller. Note that in the main analysis in Section IV, the welfare difference becomes larger as U.S. bargaining power ψ increases. This is because in the static setting, the welfare difference only captures the difference between the second term in (9) and (10). In the two-period setting, however, $\Delta\hat{U}^{total}_{US}(\psi)$ also depends on the difference in the welfare change in period 1 captured by the first term in the two equations: $\hat{U}^{co-17}_{US}(\psi)$ in the

[14]When $\beta^t > 0.75$, $\Delta\hat{U}^{total}_{US}(\psi) > 0$ for all values of $\psi \in [0, 1]$.

first scenario versus $\hat{U}_{US}^{war}$ in the second scenario. Since $\hat{U}_{US}^{co-17}(\psi)$ is increasing in ψ and $\hat{U}_{US}^{war}$ does not depend on ψ, the period 1 welfare difference $(\hat{U}_{US}^{war} - \hat{U}_{US}^{co-17}(\psi))$ is actually decreasing in ψ. Such difference in period 1 welfare changes outweighs the difference in period 2 welfare changes, leading to the result that $\Delta\hat{U}_{US}^{total}(0.47) > \Delta\hat{U}_{US}^{total}(0.70)$ in this two-period setting. Nevertheless, this new pattern about the role of ψ in the two-period setting is consistent with our main finding that the U.S. enjoys a larger welfare improvement by going to the trade war equilibrium first before negotiating with China.

V.2 Can China do better?

Our results in Section IV suggest that China's bargaining position deteriorated after the trade war. One natural question that follows is what could China have done to avoid this situation? To answer this question, we consider a counter-factual scenario in which China retaliates optimally during the trade war. In this scenario, we compute the unilateral optimal tariffs by China that maximize its welfare in response to the U.S. trade war tariffs. As shown in Figure 5, China's optimal retaliatory tariffs are in general higher than the observed tariffs with the exception of "Food, beverages and tobacco" and "Petroleum". This pattern is expected, as the higher tariffs on these two sectors probably aim to inflict a greater impact on Republican-leaning counties (Fajgelbaum et al., 2020).

The fact that Chinese optimal retaliatory tariffs are on average higher than the observed trade war tariffs is consistent with our explanation to the quantitative results discussed in Section IV. The sub-optimal factual retaliatory tariffs not only fail to maximize China's welfare in the trade war equilibrium, but also leave the U.S. greater room for tariff reductions. The first effect improves the U.S. trade war welfare change $\hat{U}_{US}^{war}$ whereas the second effect improves the country's gain from tariff negotiation $\hat{U}_{US}^{co-war}(\psi)$.[15] As a result, the U.S. enjoys a greater overall welfare improvement than negotiating from the 2017 baseline.

[15]From Appendix Table A.1, we can see that the trade war actually leads to a U.S. welfare improvement of 0.020%. China, in the meanwhile, suffers a welfare loss of 0.124%.

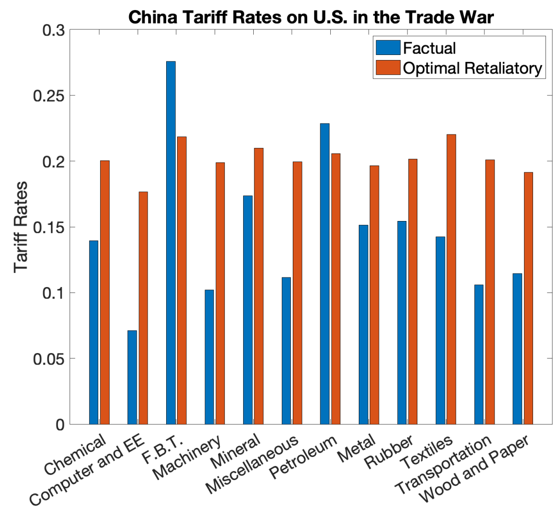


Figure 5: Optimal Retaliatory Tariffs from China

Note: The figure plots China's factual trade-war tariff rates and optimal retaliatory tariffs on the U.S. during the trade war. Sectors are arranged in alphabetical order.

Starting from the counter-factual equilibrium in which China retaliates optimally, we can simulate the tariff negotiation between the U.S. and China as in the main analysis. The green lines in Figure 6 show the welfare outcomes. We can see that engaging a trade war first may not always lead to an improvement in U.S. post-negotiation welfare any more: when China retaliates optimally during the trade war, the U.S. post-negotiation welfare can be worse than negotiating from the 2017 baseline when $\psi \leq 0.10$. However, for the estimated range $\psi \in [0.47, 0.70]$, the main results analyzed in Section IV still hold. At the same time, China's post-negotiation welfare is still worse than negotiating from the 2017 baseline, regardless of the value of the bargaining power parameter ψ.[16]

[16]We also consider another counter-factual scenario in which China does not retaliate but simply maintain the 2017-level tariffs. In this case, the U.S. is in a better bargaining position than the factual trade war equilibrium. When the tariff negotiation starts from this equilibrium, the U.S. cooperative tariff rate becomes positive when $\psi \geq 0.4$. By comparison, the U.S. cooperative tariff starting from the trade war equilibrium becomes positive when $\psi \geq 0.6$, as shown in the right panel of Figure 2. However, the welfare outcomes for both countries are very similar to the patterns shown in Figure 3.

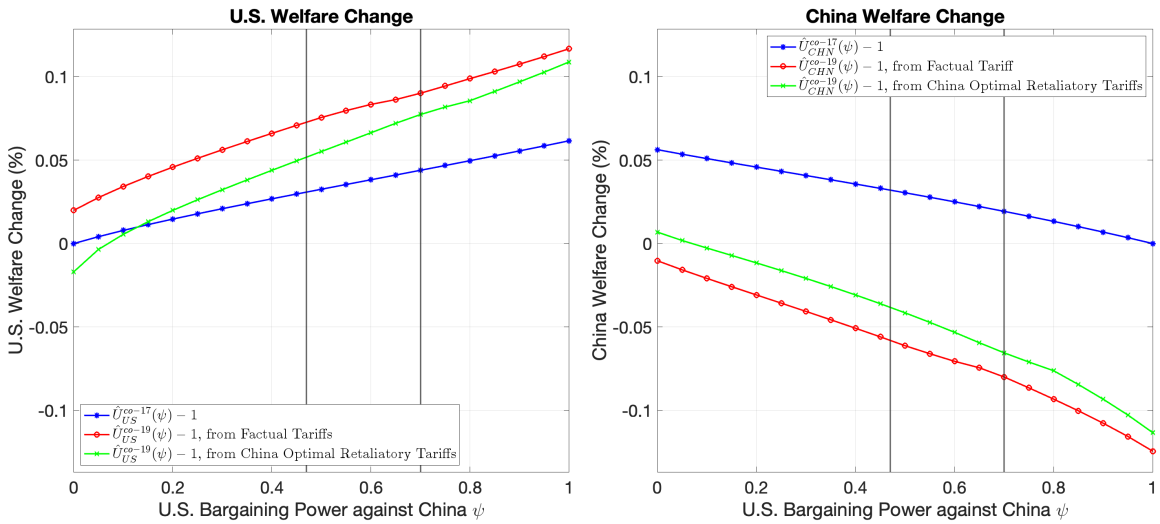


Figure 6: Post-Negotiation Welfare Change with Optimal Retaliatory Tariffs from China

Note: The blue lines refer to the welfare change of the tariff negotiation starting from the 2017 tariff profile. The red lines refer to the welfare change of the tariff negotiation starting from the 2019 factual trade-war tariff profile. The green lines refer to the welfare change of the tariff negotiation starting from China's optimal retaliatory tariffs. The two vertical lines indicate the lower bound (0.47) and upper bound (0.70) of the estimated bargaining power of the U.S. relative to China, respectively.

V.3 Political weights

Throughout the analysis presented in Section IV, we assume that the U.S. and China only care about welfare measured by real income in tariff negotiations. We now consider the possibility that each country's objective function incorporates political economy weights. In particular, the welfare in the Nash bargaining equation (8) now becomes

$$U^{pol} = \sum_{j=1}^{J} \sigma^j W^j, \tag{11}$$

where $W^j \equiv I^j/P$ is the welfare of sector j measured by real income, and $\sigma^j \geq 0$ is the political economy weight of sector j. Following Ossa (2014), we scale σ_j such that $\sum_{j=1}^{J} \sigma^j/J = 1$.[17]

The calibration of σ_j also closely follows the approach introduced in Ossa (2014). Specifically, we rely on a method of simulated moments to minimize the residual sum of squares between the model-predicted unilateral optimal tariffs and observed non-cooperative tariffs after controlling

[17]The equilibrium condition of U^{pol} in changes is reported in Section A.4 of the Appendix.

for their respective means. Since the trade-war tariffs between the U.S. and China are obviously non-cooperative and politically motivated, we use them as the matching targets in the calibration of political weights σ_j. The estimated political weights are reported in the last two columns of Table 1 where the highest three values of each country are highlighted in bold. We believe that these calibrated values are plausible: the three most favored sectors are textiles, machinery, and computer, electronic and electrical equipment in U.S., and food, beverage and tobacco, primary and fabricated metal, and petroleum in China. Similarly, Ossa (2014) also finds that textiles in the U.S. and beverage and tobacco products in China are the most protected sectors.

Figure 7 presents the corresponding welfare changes, and the results are similar to the situation without political weights. We can see that the mean message from Figure 3 still holds: regardless of the relative bargaining power between the U.S. and China, the U.S. always enjoys greater welfare improvement by starting the tariff negotiation from the trade-war equilibrium. We also re-calibrate the U.S. bargaining weight using the politically weighted objective function. The estimated range for ψ is $[0.51, 0.73]$, which is very close to the benchmark estimate. Given the new range of ψ, the difference in U.S. post-negotiation welfare improvement relative to the 2017 baseline is from 0.04% (when $\psi = 0.51$) to 0.05% (when $\psi = 0.73$).

V.4 Heterogeneity across U.S. regions

Since our model incorporates eight regions in the U.S. economy, we can analyze the heterogeneous impact of the U.S.–China tariff negotiation across regions. Because we assume free labor mobility within the U.S., the welfare level across U.S. regions is always equalized in equilibrium. For this reason, we use the population change to measure how the post-negotiation outcomes differ across regions. Figure 8 exhibits the change in population in different regions in the post-negotiation equilibrium when $\psi = 0.47$. Panel a depicts the outcomes of tariff negotiations from the 2017 baseline, whereas Panel b uses the trade-war equilibrium as the starting point. The colors for each region represent its population change relative to the 2017 baseline equilibrium.

From Figure 8, we can see that the spatial distribution of population changes in the two panels

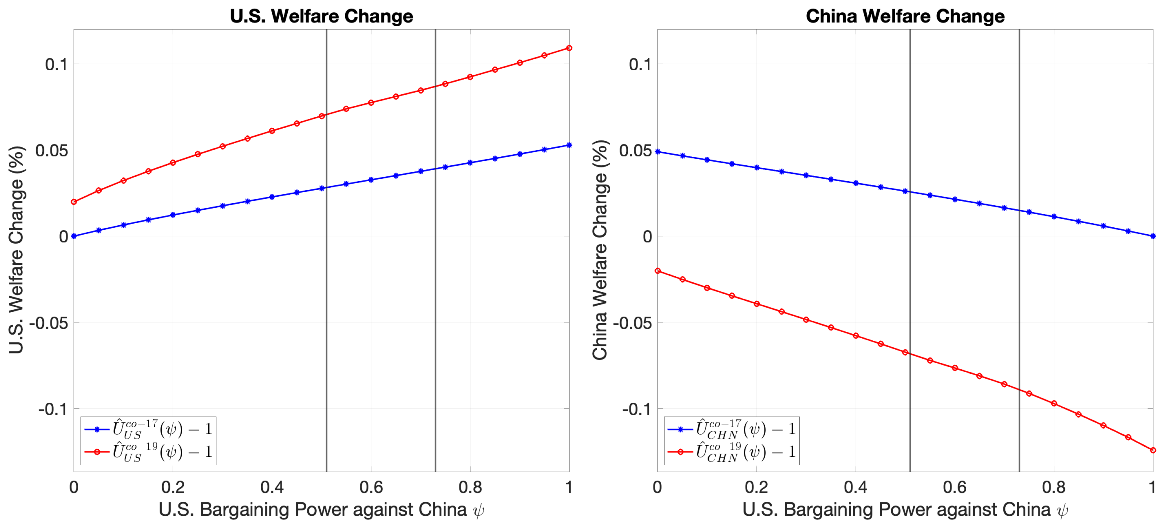


Figure 7: Post-Negotiation Welfare Change with Political Economy Weights

Note: The blue lines refer to the welfare change of the tariff negotiation starting from the 2017 tariff profile. The red lines refer to the welfare change of the tariff negotiation starting from the 2019 tariff profile. The two vertical solid lines indicate the lower bound (0.51) and upper bound (0.73) of the estimated bargaining power of the U.S. relative to China.

is very similar. Regardless of the starting point of the tariff negotiation, the Southwest Region (Arizona, New Mexico, Oklahoma, and Texas) always enjoys the largest labor inflow with a net labor influx of 1.38% and 1.30% in panel a and panel b, respectively. The New England region, on the contrary, always suffers the largest labor outflow of 1.96% and 1.90% in the two scenarios, respectively. Overall, the negotiation starting from the 2017 baseline tariffs leads to slightly smaller change in the labor distribution than starting from the trade-war tariffs.

V.5 Robustness

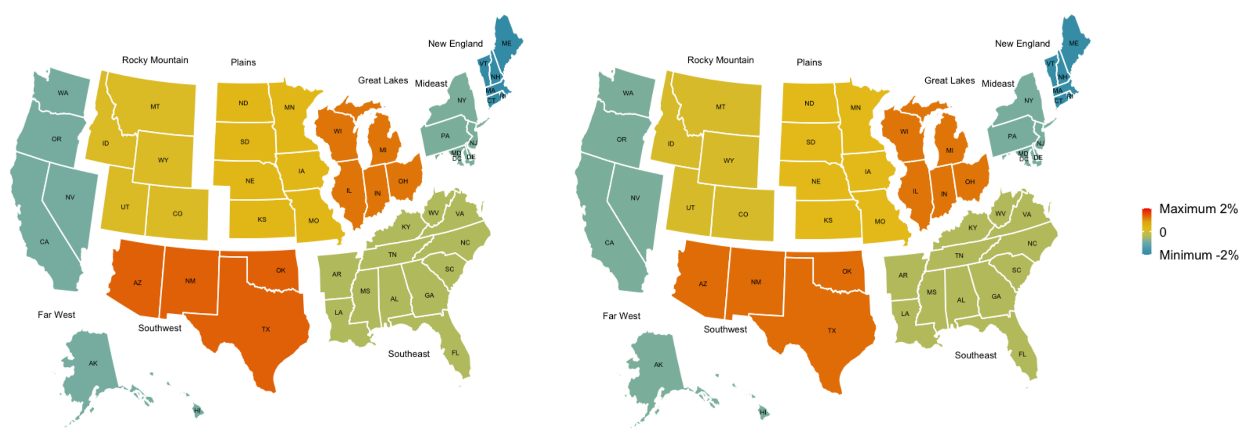
Allowing for subsidies

In the baseline analysis in Section IV, we restrict the post-negotiation tariffs to be non-negative as in previous theoretical works. Figure A.3 displays the averages of the predicted cooperative tariffs for the U.S. and China when we allow negative tariffs or import subsidies. When negative tariffs are permitted, neither country imposes zero tariffs after the tariff negotiation. However, we can still infer from Figure A.3 that the U.S. bargaining position improves if the tariff negotiation starts from the trade-war equilibrium. Similar to the results in Ossa (2014), the restricted post-negotiation tariffs displayed in Figure 2 resemble a truncated version of the unrestricted cooperative tariffs shown in Figure A.3.

Figure A.4 presents the corresponding welfare changes of the U.S. and China in the two negotiation scenarios. We can see that the welfare outcomes are very similar to the case without negative tariffs. Comparing this figure with Figure 3 reveals that allowing for negative tariffs makes very little difference from a welfare perspective.

ROW as fixed

In the main analysis, the applied tariff rates between the two countries and ROW change slightly from the 2017 baseline equilibrium to the trade-war equilibrium in 2019. To rule out the potential impact of this change, we now fix the U.S.–ROW and China–ROW bilateral tariffs at 2017 level and present the welfare outcomes in Figure A.5. In this way, the only exogenous changes from the 2017 baseline to the 2019 equilbrium are trade-war tariffs between the U.S. and China. The welfare outcomes displayed in Figure A.5 are very similar to those in Figure 3.



(a) Negotiation from 2017 Baseline

(b) Negotiation from Trade War

Figure 8: Population Change across U.S. Regions

Note: For both panels, the population change of each region is relative to the 2017 baseline equilibrium.

Fixed deficit

In the main analysis, we follow the approach of Ossa (2014) and treat the purged trade data without imbalances as the 2017 baseline. We also experiment with an alternative setup as a robustness check: instead of removing trade imbalances across countries, we now fix the international trade imbalances at the 2017 level when simulating the tariff negotiation from China. As can be seen in Figure A.6, the main welfare results from the main analysis in Section IV still hold.

Elasticity of substitution from Caliendo and Parro (2015)

In the main analysis, we use the popular approach developed by Feenstra (1994) to estimate the elasticities of substitution. Caliendo and Parro (2015) estimate the same elasticities using the variation in tariffs and trade volumes before and after the North American Free Trade Agreement, and their estimates are on average larger than estimates using the Feenstra (1994) method. We repeat the simulation with the estimated elasticity of substitution from Caliendo and Parro (2015), and the corresponding welfare results are reported in Fig A.7. We can see that, for both countries, the welfare improvement from the tariff negotiation is greater than in Figure 3. A similar pattern is also observed in Ossa (2014) when computing the world cooperative tariffs with different elasticities of substitution. From Figure A.7, we still find that the U.S. always enjoys greater welfare improvement by starting the tariff negotiation from the trade-war equilibrium.

Estimation of bargaining power ψ

When we calibrate the U.S. bargaining weight ψ in Section III, we assume that China is fully aware of the U.S. post-negotiation tariffs after China's accession to the WTO. We also estimate ψ without this assumption. That is, China and the U.S. simultaneously bargain over tariffs still using the same starting point as in Section III.2. In this case, ψ is estimated by solving

$$\min_{\psi}\left[\left(\boldsymbol{\tau}_{chn,US}(\psi)-\boldsymbol{\tau}^{2005}_{chn,US}\right)'\left(\boldsymbol{\tau}_{chn,US}(\psi)-\boldsymbol{\tau}^{2005}_{chn,US}\right)+\left(\boldsymbol{\tau}_{US,chn}(\psi)-\boldsymbol{\tau}^{2005}_{US,chn}\right)'\left(\boldsymbol{\tau}_{US,chn}(\psi)-\boldsymbol{\tau}^{2005}_{US,chn}\right)\right].$$

When using 1997 applied tariffs as the threat point for the U.S., the estimated bargaining power of the U.S. relative to China is $\hat{\psi} = 0.03$. This result is consistent with the estimates in Bagwell et al. (2021), which also assume that both countries simultaneously bargain over tariffs. Focusing on the Uruguay Round of tariff bargaining, the estimated bargaining weights of the U.S. relative to the European Union, South Korea, and Japan are 0.01, 0.01, and 0.05, respectively. The small U.S. bargaining weight is again because of the negligible U.S. tariff changes after China's accession to the WTO. As argued in Bagwell et al. (2021), a country tends to be assigned a smaller bargaining power in a bilateral bargaining pair if the tariffs of this country under negotiation are reduced to a greater degree than those of its negotiating partner. However, the very small estimate of U.S. bargaining power is inconsistent with the widely accepted perception that the U.S. had the upper hand in the bilateral negotiation with China.

In the main analysis, we provide the estimated upper and lower bounds of U.S. bargaining power ψ because the U.S. has two possible threat points in the WTO accession negotiation with China. Handley and Limão (2017) estimates a 0.13 probability of transition from China's temporary MFN status to "column 2" tariffs. Using this estimated probability, a back-of-envelop calculation generates an expected U.S. bargaining power of $\psi = 0.58$. However, we do not consider it to be the point estimate from our method of simulated moments because this back-of-envelop calculation may not be consistent with the solution of the Nash bargaining with two possible threat points.

VI Conclusion

This paper quantitatively analyzes the potential role of the Trump tariffs from 2018 through 2019 as bargaining chips for future trade negotiations with China. We develop a general equilibrium quantitative model that features both international trade and the U.S. economy disaggregated into eight regions and thirteen sectors. We find that, regardless of the relative bargaining power between the U.S. and China, the trade war always improves the U.S. post-negotiation welfare. We then estimate the bilateral bargaining power between the U.S. and China by examining China's accession to the WTO in 2001. The estimated U.S. bargaining power ranges from 0.47 to 0.70. With this estimated range, the trade war increases the U.S. post-negotiation welfare gain by 0.04%–0.05% relative to its pre-trade-war welfare level. Meanwhile, China's post-negotiation welfare change decreases 0.09%–0.10%. These results are consistent with U.S. Trade Representative Katherine Tai's claim that the Trump-era tariffs can be used as a leverage in future tariff negotiations with China.

By quantifying how the U.S.–China trade war affected the outcomes of tariff bargaining, this paper connects two separate but related fields in the literature. On the one hand, previous works on cooperative tariffs have mostly focused on the reciprocal tariff reductions among WTO member countries. On the other hand, previous studies on the U.S.–China trade war have mostly emphasized the impact of higher tariffs on economic activities in the U.S. and China. By contrast, we consider the role of tariffs as bargaining chips, thereby providing the first quantitative study on the potential outcomes of negotiations between the U.S. and China.

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Appendix

A.1 Equilibrium conditions in relative changes

To solve the competitive general equilibrium, we adopt the hat-algebra approach, as in Dekle et al. (2007), to avoid calibrating unchanged underlying parameters. The equivalent hat-algebra equilibrium is stated as follows. For given tariff changes, an equilibrium is a set of $\{\hat{\omega}_n, \hat{x}_n^j, \hat{L}_n, X_n^{j\prime}\}$ such that:

Input bundle:

$$\hat{x}_n^j = (\hat{\omega}_n)^{\gamma_n^j} \prod_{k=1}^{J} \left(\hat{P}_n^k\right)^{\gamma_n^{jk}}$$

Labor mobility condition:

$$\hat{L}_n = \frac{\left(\frac{\hat{\omega}_n}{\varphi_n \hat{P}_n \hat{U} + (1-\varphi_n)\hat{b}_n}\right)^{1/\beta_n}}{\sum_i L_i \left(\frac{\hat{\omega}_i}{\varphi_i \hat{P}_i \hat{U} + (1-\varphi_i)\hat{b}_i}\right)^{1/\beta_i}} L$$

Regional market clearing in final goods:

$$X_n^{j\prime} = \sum_{k=1}^{J} \gamma_n^{k,j} \left(\sum_{i=1}^{N+M} \frac{\pi_{in}^{k\prime}}{\tau_{in}^{k\prime}} X_i^{k\prime} \right) + \alpha^j I_n' L_n'$$

for $n \in \mathcal{US}$, $I_n' L_n' = \left(\hat{\omega}_n \left(\hat{L}_n\right)^{1-\beta_n} (I_n L_n + \Upsilon_n + S_n - \Lambda_n) + \sum_{j=1}^{J} \sum_{i=1}^{N+M} t_{ni}^{j\prime} \frac{\pi_{ni}^{j\prime}}{\tau_{ni}^{j\prime}} X_n^{j\prime} - S_n' - \Upsilon_n' \right)$

for $n \in \overline{\mathcal{US}}$, $I_n' L_n' = \hat{\omega}_n \omega_n L_n + \sum_{j=1}^{J} \sum_{i=1}^{N+M} t_{ni}^{j\prime} \frac{\pi_{ni}^{j\prime}}{\tau_{ni}^{j\prime}} X_n^{j\prime} - S_n$

Labor market clearing:

$$VA' = \sum_j \gamma_n^j \sum_i \frac{\pi_{in}^{j\prime}}{\tau_{in}^{j\prime}} X_i^{j\prime}$$

for $n \in \mathcal{US}$, $VA_n' = \hat{\omega}_n \left(\hat{L}_n\right)^{1-\beta_n} (L_n I_n + \Upsilon_n + S_n - \Lambda_n)$

for $n \in \overline{\mathcal{US}}$, $VA_n' = \hat{\omega}_n \omega_n L_n$

Price index:

$$\hat{P}_n^j = \left(\sum_{i=1}^{N+M} \pi_{ni}^j \left[\hat{\kappa}_{ni}^j \hat{x}_i^j \right]^{-\theta^j} \right)^{-1/\theta^j}$$

Expenditure shares:

$$\pi_{ni}^{j\prime} = \pi_{ni}^j \left(\frac{\hat{x}_i^j}{\hat{P}_n^j} \hat{\kappa}_{ni}^j \right)^{-\theta^j}$$

Aggregate price index:

$$\hat{P}_n = \prod_{j=1}^{J} \left(\hat{P}_n^j\right)^{\alpha^j}$$

Utility level outside of the U.S.:

$$\hat{U}_n = \frac{\hat{I}_n}{\hat{P}_n} = \frac{I'_n}{I_n \hat{P}_n}$$

Utility level within the U.S.:

$$\hat{U} = \frac{1}{L} \sum_n L_n \left(\frac{1}{\varphi_n} \frac{\hat{\omega}_n}{\hat{P}_n} \left(\hat{L}_n\right)^{1-\beta_n} - \frac{1-\varphi_n}{\varphi_n} \frac{\hat{L}_n \hat{b}_n}{\hat{P}_n} \right)$$

$$\hat{b}_n = \frac{u'_n + s'_n - \lambda'_n}{u_n + s_n - \lambda_n}, \ \varphi_n = \frac{1}{1 + \frac{\Upsilon_n + S_n - \Lambda_n}{L_n I_n}}$$

The derivation is as follows. For regions in the U.S., using the equilibrium condition $r_n H_n = \frac{\beta_n}{1-\beta_n} w_n L_n$ and the definition of $\omega_n = (r_n/\beta_n)^{\beta_n} (\omega_n/(1-\beta_n))^{1-\beta_n}$, we can express wages as $\frac{\omega_n}{1-\beta_n} = \omega_n \left(\frac{H_n}{L_n}\right)^{\beta_n}$. Therefore, U can be expressed as

$$U = \left(\frac{H_n}{L_n}\right)^{\beta_n} \frac{\omega_n}{P_n} - \frac{u_n}{P_n} - \frac{s_n}{P_n} + \frac{\lambda_n}{P_n},$$

where $u_n = \Upsilon_n / L_n = (\iota r_n H_n - \chi L_n)$, $s_n = S_n / L_n$, and $\lambda_n = \Lambda_n / L_n = \sum_j^J \sum_{i=1}^{N+M} t_{ni}^j \frac{\pi_{ni}^j}{\tau_{ni}^j} X_n^j / L_n$. After solving for L_n and using the labor market clearing condition $\sum_n^N L_n = L$, we can get

$$U = \frac{1}{L} \sum_{n=1}^{N} \left(\frac{\omega_n}{P_n} (H_n)^{\beta_n} L_n^{1-\beta_n} - \frac{\Upsilon_n}{P_n} - \frac{S_n}{P_n} + \frac{\Lambda_n}{P_n} \right),$$

and labor in each location n can be expressed as

$$L_n = \frac{H_n \left[\frac{\omega_n}{P_n U + u_n + s_n - \lambda_n}\right]^{1/\beta_n}}{\sum_{i=1}^{N} H_i \left[\frac{\omega_i}{P_i U + u_i + s_i - \lambda_i}\right]^{1/\beta_i}} L.$$

A.2 Cooperative tariff bargaining in hat-algebra

We use the hat-algebra approach to solve the cooperative tariff bargaining problem (8) stated in the main text to avoid calibrating unchanged underlying parameters. The equivalent hat-algebra version of the cooperative tariff bargaining problem is as follows:

$$\max_{\left\{\hat{\omega}_n, \hat{x}_n^j, X_n^{j\prime}, \hat{L}_n, \hat{\tau}_{US,chn}\right\}} \left(\hat{U}_{US} - 1\right)^{\psi} \left(\hat{U}_{chn} - 1\right)^{1-\psi},$$

subject to competitive equilibrium conditions in relative changes, as in A.1, and $\hat{U}_{US} \geq 1$, $\hat{U}_{chn} \geq 1$.

A.3 Extending to Infinite Periods

In addition to the two-period setup discussed in Section V.1, we also consider an alternative setup with infinite periods. Similar to the two-period setup, the U.S. and China either impose cooperative tariffs with welfare changes $\hat{U}^{co-17}$ (scenario one) or enter the trade war equilibrium with welfare changes $\hat{U}^{war}$ (scenario two) when $t = 1$. In scenario two, the two countries engage in tariff negotiation from the trade-war equilibrium. Once the two countries engage in tariff negotiation, the resulting cooperative tariffs will remain in all future periods. In this setup, the two countries' total welfare change relative to the 2017 baseline in period 0 is:

$$\hat{U}_n^{total-17}(\psi) = \frac{\beta^t}{1-\beta^t}\hat{U}_n^{co-17}(\psi)$$

$$\hat{U}_n^{total-19}(\psi) = \hat{U}_n^{war} + \frac{\beta^t}{1-\beta^t}\hat{U}_n^{war}\hat{U}_n^{co-war}(\psi).$$

Figure A.9 presents $\Delta\hat{U}_{US}^{total}(\psi)$ and $\Delta\hat{U}_{chn}^{total}(\psi)$ for discount factor $\beta^t \in [0.80, 0.99]$. We can see that, similar to the two-period setup, both $\Delta\hat{U}_{US}^{total}(0.47)$ and $\Delta\hat{U}_{US}^{total}(0.70)$ are positive. When $\beta^t = 0.97$, $\Delta\hat{U}_{US}^{total}(0.47) = 1.32\%$ and $\Delta\hat{U}_{US}^{total}(0.70) = 1.47\%$. At the same time, $\Delta\hat{U}_{chn}^{total}(0.47)$ and $\Delta\hat{U}_{chn}^{total}(0.70)$ are always negative for the shown range of β^t.

A.4 Cooperative tariff bargaining in hat-algebra with political weights

We rewrite the cooperative tariff bargaining problem in changes if governments now maximize their politically weighted welfare defined in (11). All the equilibrium conditions in A.2 remain the same, except for the change in welfare levels within and outside of the U.S. which are equal to the following:

Utility level outside of the U.S.:

$$\hat{U}_n = \sum_{j=1}^{J} \frac{\sigma^j \hat{X}^j X^j \gamma^j}{\sum_{j=1}^{J}\sigma^j X^j \gamma^j} \frac{\sum_{j=1}^{J} X^j \gamma^j}{\sum_{j=1}^{J}\hat{X}^j X^j \gamma^j} \frac{I_n'}{I_n \hat{P}_n}$$

Utility level within the U.S.:

$$\hat{U} = \frac{1}{L}\sum_{n=1}^{N}\sum_{j=1}^{J} \frac{\sigma^j \sum_{n=1}^{N}\hat{X}_n^j X_n^j \gamma_n^j}{\sum_{j=1}^{J}\sigma^j \sum_{n=1}^{N} X_n^j \gamma_n^j} \frac{\sum_{j=1}^{J}\sum_{n=1}^{N} X_n^j \gamma_n^j}{\sum_{j=1}^{J}\sum_{n=1}^{N}\hat{X}_n^j X_n^j \gamma_n^j} L_n \left(\frac{1}{\varphi_n}\frac{\hat{\omega}_n}{\hat{P}_n}\left(\hat{L}_n\right)^{1-\beta_n} - \frac{1-\varphi_n}{\varphi_n}\frac{\hat{L}_n \hat{b}_n}{\hat{P}_n}\right)$$

$$\hat{b}_n = \frac{u_n' + s_n' - \lambda_n'}{u_n + s_n - \lambda_n}, \varphi_n = \frac{1}{1 + \frac{\Upsilon_n + S_n - \Lambda_n}{L_n I_n}}$$

A.5 Table appendix

Table A.1: Welfare Changes in Selected Scenarios

	2017 cooperation $\hat{U}^{co-17}-1$		Trade war $\hat{U}^{war}-1$	Post-war cooperation $\hat{U}^{co-war}-1$		Post-war total $\hat{U}^{co-19}-1$	
ψ	0.47	0.70	All	0.47	0.70	0.47	0.70
US	0.030%	0.044%	0.020%	0.051%	0.070%	0.071%	0.090%
China	0.033%	0.019%	−0.124%	0.069%	0.044%	−0.056%	−0.080%
ROW	−0.002%	−0.002%	0.029%	−0.006%	−0.006%	0.023%	0.023%

Note: ψ is the bargaining power of the U.S. against China, ranging from 0.47 to 0.70 in our estimates from China's accession to the WTO in 2001. In the first two columns, we compute the welfare changes from tariff negotiations starting from the 2017 factual tariff profile, relative to the 2017 baseline. The third column reports the welfare changes from the trade-war tariffs, relative to the 2017 baseline. The fourth and fifth columns show the welfare changes from tariff negotiations starting from the trade-war equilibrium. In the last two columns, we compute the overall welfare changes from post-war negotiations, relative to the 2017 baseline.

A.6 Figure appendix

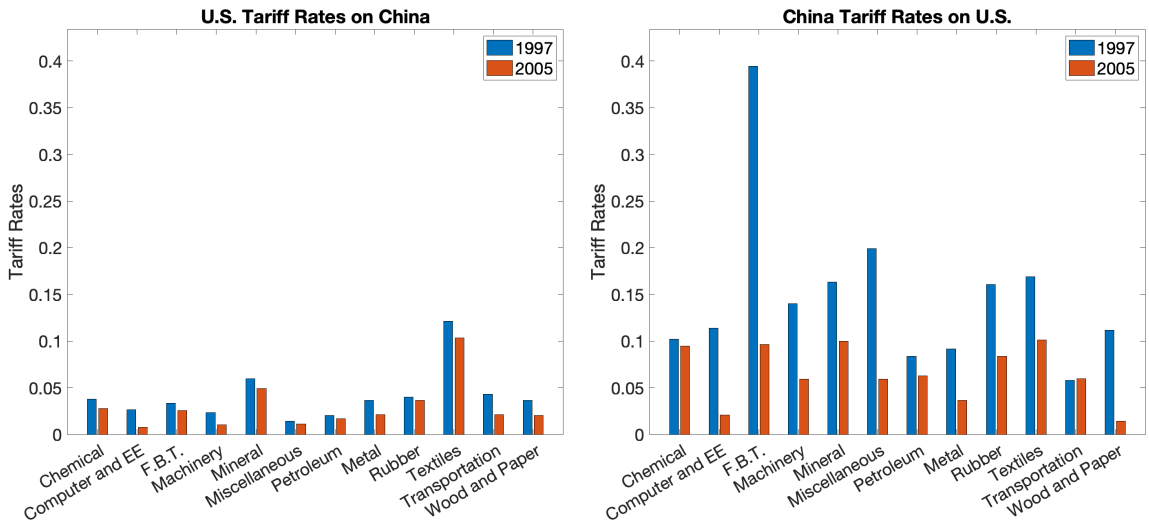

Figure A.1: Applied Tariff Rates of the U.S. and China

Note: This figure displays the applied tariff rates between the U.S. and China in 1997 (before China's accession to the WTO) and in 2005 (after China's accession to the WTO). Tariff data are aggregated into sectors based on trade volume. Sectors are arranged in alphabetical order.

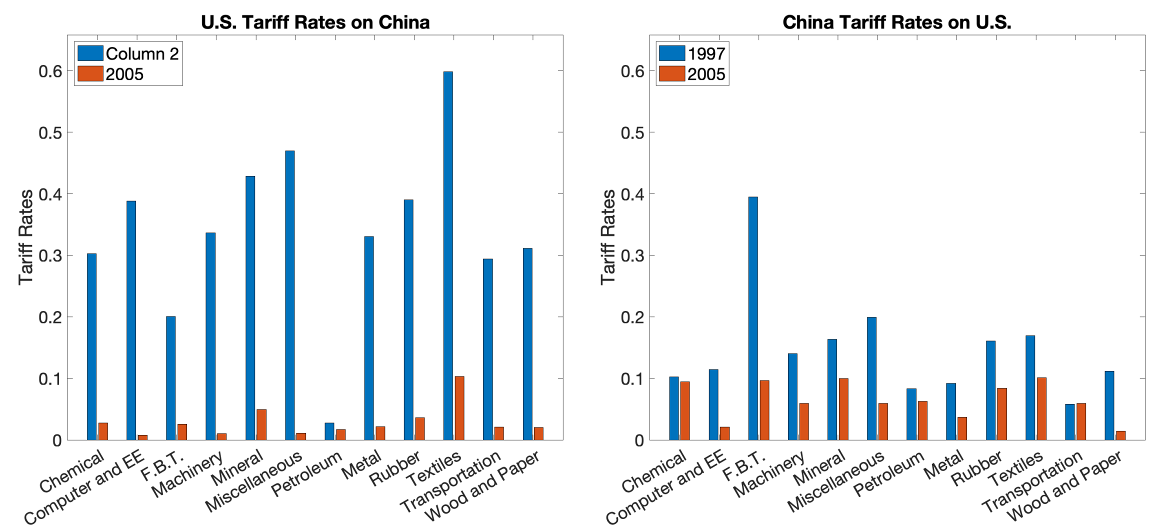

Figure A.2: Applied Tariff Rates versus U.S. Column 2 Tariff Rates

Note: The left panel displays U.S. column 2 tariff rates and the 2005 applied rates. The right panel is the same as the right panel of Figure A.1 and is shown for comparison purposes. Tariff data are aggregated into sectors based on trade volume. Sectors are arranged in alphabetical order.

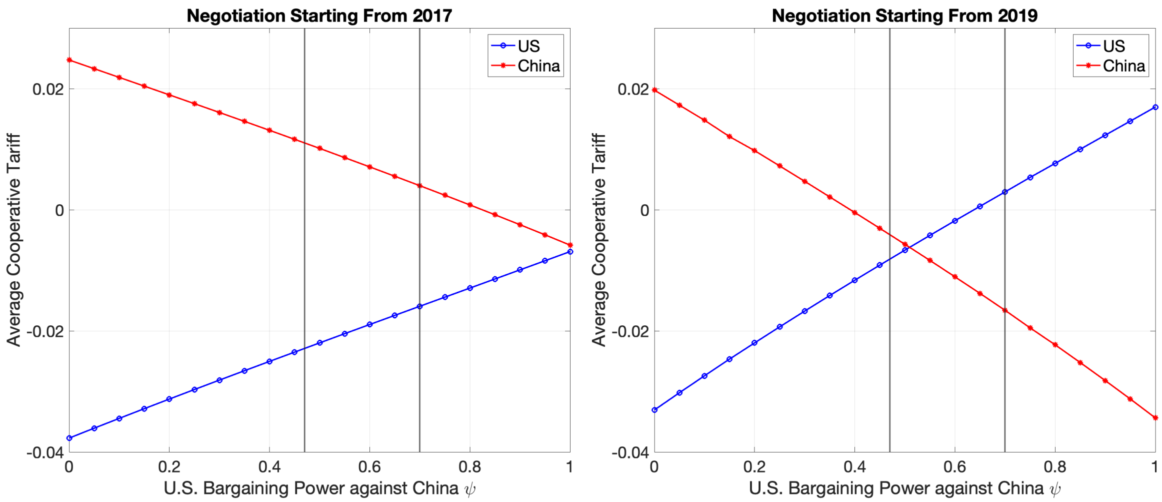

Figure A.3: Average Post-Negotiation Tariffs of the U.S. and China (Negative Tariffs Allowed)

Note: This figure plots the the simple average of post-negotiation tariffs across sectors for the U.S. and China as in Figure 2, but allows for negative tariff rates.

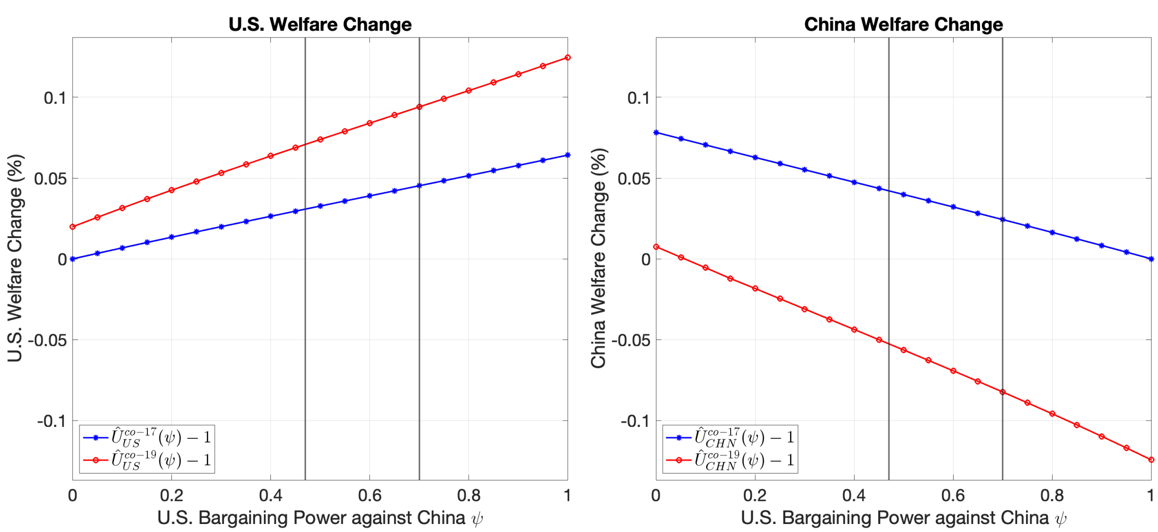

Figure A.4: Post-Negotiation Welfare Change (Negative Tariffs Allowed)

Note: This figure illustrates the post-negotiation welfare change (relative to the 2017 baseline) of the two scenarios for the U.S. and China as in Figure 3, but allows for negative tariff rates.

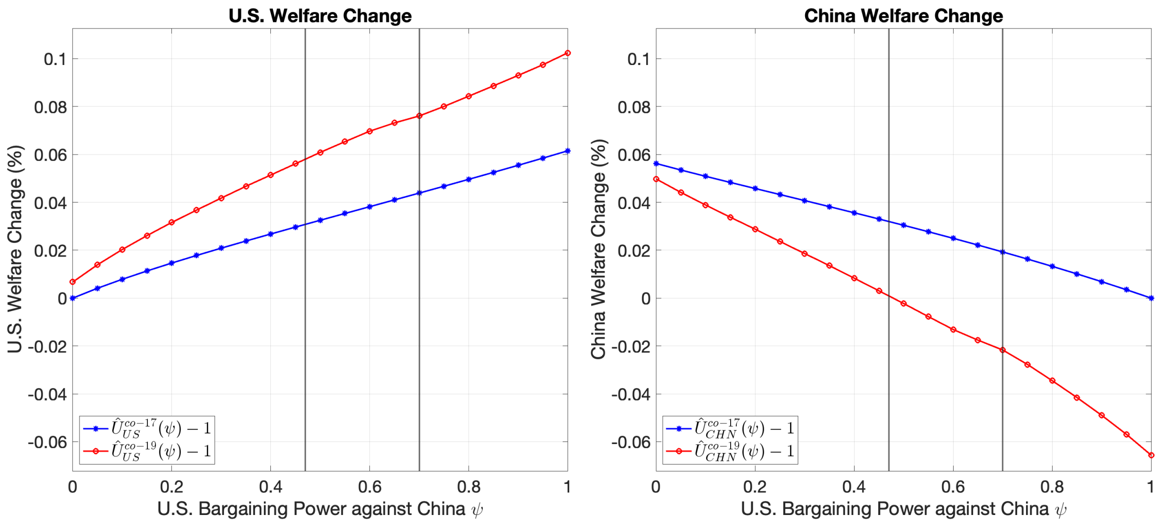

Figure A.5: Post-Negotiation Welfare Change (ROW Fixed)

Note: This figure illustrates the post-negotiation welfare change (relative to the 2017 baseline) of the two scenarios for the U.S. and China as in Figure 3, but keeps the U.S. and Chinese tariffs on goods from ROW unchanged.

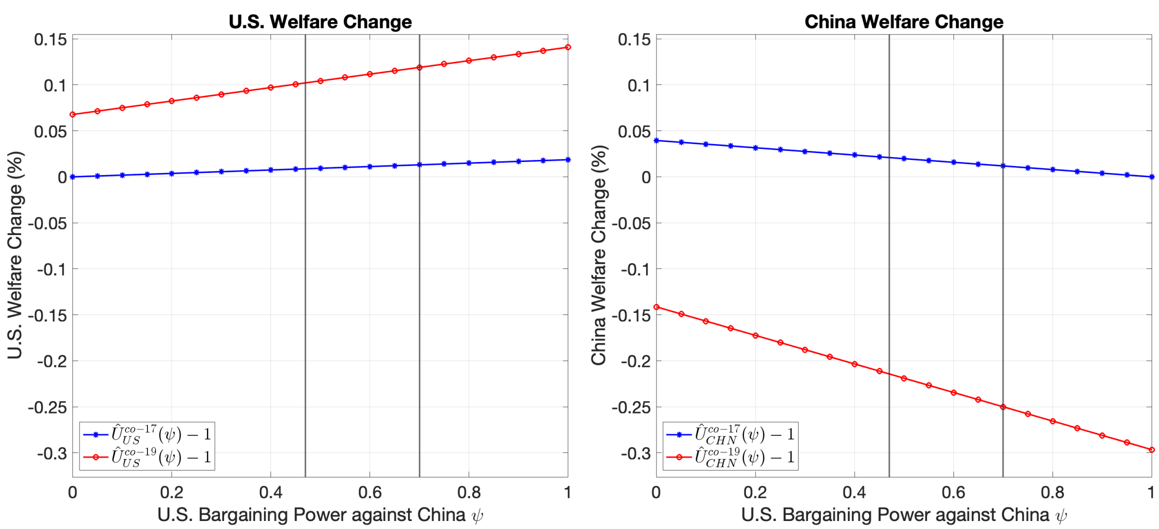

Figure A.6: Post-Negotiation Welfare Change (Fixed Trade Balances)

Note: This figure illustrates the post-negotiation welfare change (relative to the 2017 baseline) of the two scenarios for the U.S. and China as in Figure 3, but fixes the trade balance between the U.S. and China at 2017 level.

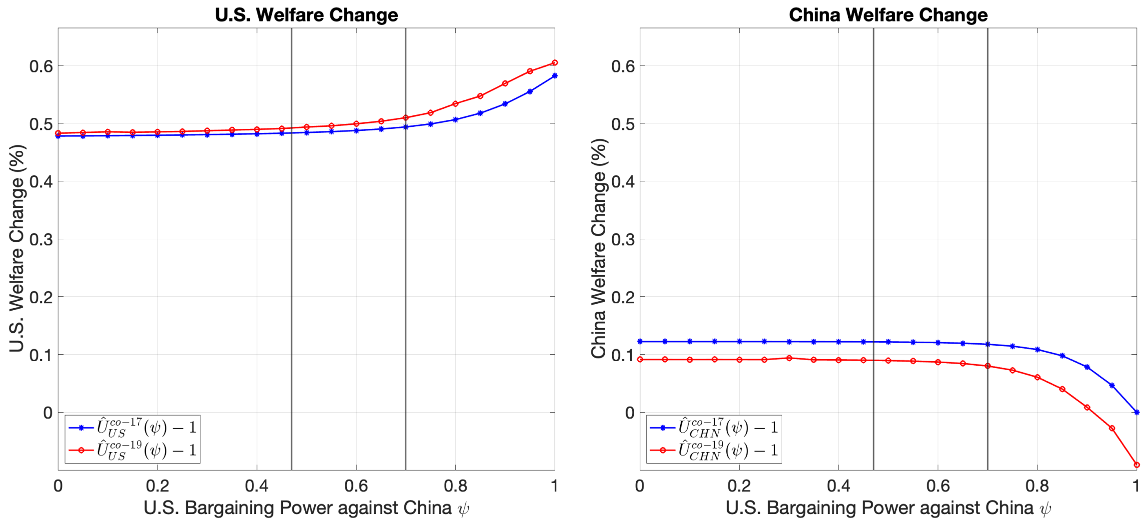

Figure A.7: Post-Negotiation Welfare Change (Elasticities from Caliendo and Parro (2015))

Note: This figure illustrates the post-negotiation welfare change (relative to the 2017 baseline) of the two scenarios for the U.S. and China as in Figure 3, but uses the elasticities of substitution from Caliendo and Parro (2015).

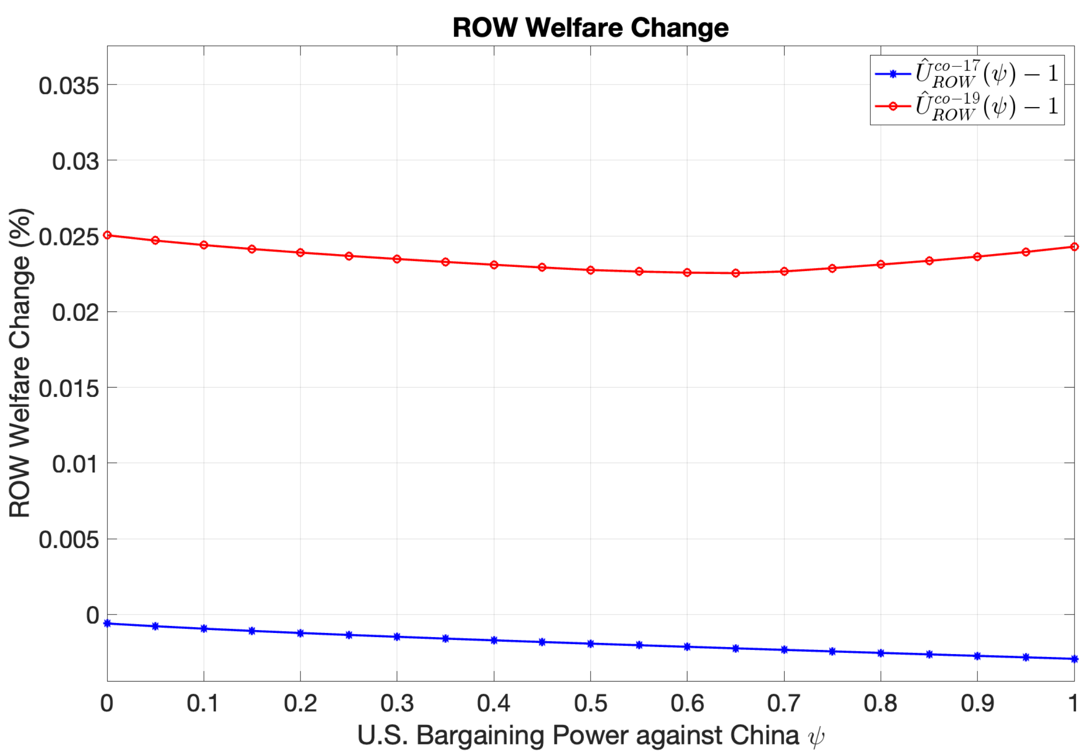

Figure A.8: Post-Negotiation Welfare Changes

Note: This figure plots the post-negotiation welfare change (relative to the 2017 baseline) of the two scenarios for the Rest of World.

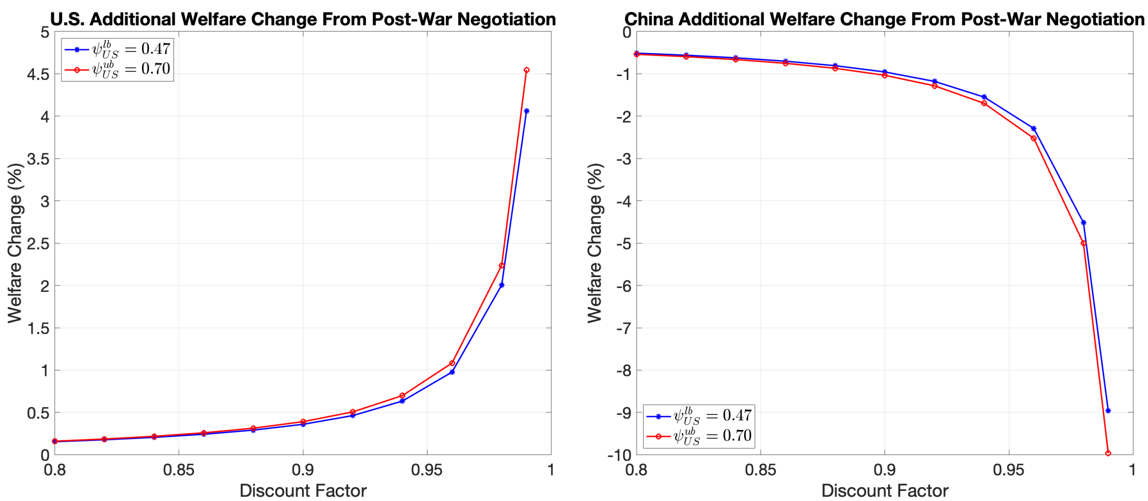

Figure A.9: Dynamic Welfare Changes in an Infinite Period Setup

Note: This figure plots $\Delta \hat{U}_n^{total}(\psi)$ for the U.S. and China in the infinite period setup. For each country, we consider the lower and upper bound of our estimated U.S. bargaining power ψ (0.47 and 0.70, respectively).