Tariffs as Bargaining Chips: A Quantitative Analysis of US-China Trade War*

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Abstract

U.S. president Joe Biden has maintained Trump tariffs on Chinese imports, despite the promise to remove them before the 2020 presidential election. We investigate the hypothesis that these tariffs serve as leverages in future trade talks with China. By developing a quantitative model that incorporates disaggregated U.S. regions and international trade linkages, we estimate US–China bargaining power and compute cooperative tariffs under Nash bargaining. Simulation results show that the trade war always improves U.S. welfare in the cooperative equilibrium regardless of bargaining power. With an estimated U.S. bargaining power of 0.47, the trade war with China yields a post-negotiation welfare improvement of 0.04% for the U.S.

Keywords: Tariff bargaining, US–China trade war, quantitative trade policy

JEL codes: F13, F51, R13

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I Introduction

During the 2016 United States presidential campaign, Donald Trump denounced the United States' trade relationship with China 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 raised to more than 19 percent by January 2021, up from 3 percent before the trade war. In the meanwhile, China retaliated by increasing its average tariff on U.S. goods from 8 percent to more than 20 percent. In the next presidential campaign, Joe Biden attacked trade war as reckless and irresponsible, and stated that he would remove the Trump tariffs.[1] However, Joe Biden has not kept his word after winning the 2020 election, and the existing Trump tariffs remained in place as of 2023.

We explore one plausible hypothesis that rationalizes the Biden administration's reluctance to remove the Trump-era tariffs: these tariffs can be used as bargaining chips in future trade negotiations with China.[2] In testimony before a U.S. Senate Appropriations subcommittee in June 2022, U.S. Trade Representative Katherine Tai said that "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 Katherine Tai's claim by quantitatively examining whether the trade war improves 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 across eight regions and thirteen sectors. Firms in each

[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."

[2] Other theories include lobby pressure from firms benefiting from the Trump tariffs, the worry of appearing weak on China, and campaign considerations for the 2024 presidential elections.

U.S. regions demand labor, local factors, and materials from all other markets in the economy as in Caliendo, Parro, Rossi-Hansberg and Sarte (2018). By incorporating intermediate goods, sectoral 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 match the model to the year 2017 and test whether the tariff changes during the trade war improve the U.S. post-negotiation welfare outcome.

We use the method of mathematical programming with equilibrium constraints (MPEC), popularized by Su and Judd (2012), to compute the outcomes of the tariff negotiation between the U.S. and China. Bagwell and Staiger (1999) shows 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) environment in which tariffs can be used to improve welfare through production relocation. The simulated outcome of the tariff negotiation from our reasonably comprehensive general equilibrium model is consistent with these predictions: the resulting equilibrium always involves one country imposing zero tariffs. However, which country embraces free trade post-negotiation depends on the relative bargain power between the two countries.

One key result from our simulations is that, regardless of the relative bargaining power between the U.S. and China, the trade war always improves the U.S. post-negotiation welfare. This result can also be rationalized 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. The U.S. welfare gain from tariff negotiation starting from the pre-trade-war equilibrium is limited due to low U.S. tariff rates. For the same reason, tariff negotiations starting from high tariffs after the trade war can substantially improve the U.S. welfare. Our quantitative analysis shows that, even after taking the welfare changes of the trade war into consideration, the negotiation starting from trade war tariffs leads to a higher U.S. welfare relative to the negotiation starting from low tariffs before the trade war. This result is robust to allowing negative tariffs (import subsidies), fixing trade deficits between countries, and alternative estimates of trade elasticities.

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, we can predict cooperative tariffs 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 is 0.47. Given this bargaining power, the trade war increases the U.S. post-negotiation welfare gain from 0.03% to 0.07% relative to its pre-trade-war welfare level. In the meanwhile, China's post-negotiation welfare change decreases from 0.03% to -0.06%.

Given the spatial features of our model, we can also analyze the heterogeneous impact of trade negotiations with China on different U.S. regions. Since we assume free labor mobility within the country as in Caliendo et al. (2018), the inflow and outflow of labor in each region is used to measure the impact of U.S.–China tariff negotiation. Our simulations predict that, given the estimated U.S. bargaining power of 0.47, tariff negotiations from the trade war tariffs benefit the

Southwest Region (Arizona, New Mexico, Oklahoma, and Texas) most with a 1.30% inflow of labor. In the meanwhile, the New England region would be most negatively affected by a 1.90% of labor outflow.

By quantifying how the U.S.–China trade war affect 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 noncooperative 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; de Souza, Hu, Li and Mei, 2022; Beshkar, Chang and Song, 2022; Mei, forthcoming) or analytical characterization of the 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 Bagwell et al. (2021) and Beshkar et al. (2022), both of which focus on the reciprocal tariff reductions among WTO member countries. By contrast, we focus on the tariff war between the two largest economies of the world and quantitatively analyze how tariffs can be used as bargaining chips in future tariff negotiations.

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 set of rules for tariff bargaining outcomes. We estimate the relative bargaining power between U.S. and China, and quantify the potential welfare outcomes of the tariff bargaining. The numerical results computed from the comprehensive general equilibrium model also corroborate previous analysis derived theoretically from simpler trade models.

Finally, this paper contributes to a burgeoning literature that studies the impact of the trade war initiated by the Trump administration. Existing works 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 (Chor and Li, 2021; 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), and U.S. election outcomes (Blanchard, Bown and Chor, 2019; Che, Lu, Pierce, Schott and Tao, 2022; Choi and Lim, 2023).[3] Our paper is distinct from existing works by considering the Trump tariffs as bargaining chips, hence providing the first quantitative study on 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 discusses our robustness checks and the last section concludes.

II Model

To guide our analysis on cooperative tariffs, we develop a quantitative model that features both international trade and the U.S. economy disaggregated across regions and sectors. The model incorporates intermediate goods, sectoral heterogeneity, and I-O linkages. We consider a total of

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

$N+M$ locations, in which N of them are regions in the U.S. and M of them are 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 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 for the U.S. is denoted as L_{US}, and the population in sector j, region n is denoted as 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 as I_n, is derived from two sources: households supply labor L_n inelastically at wage w_n and receive transfer at a lump-sum basis (including both tariff revenues and transfers accounting for trade imbalance, which will be discussed in more details 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 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 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, thus $1 - \gamma_n^j = \sum_{k=1}^{J} \gamma_n^{jk}$. Since the production of intermediate goods outside of the U.S. does not require fixed factor, $\beta_n = 0$ for $n \in \{N+1, \ldots, N+M\}$ and the 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 price at x_n^j / z_n^j. Denoting x_n^j as the cost of input bundle for intermediate goods in location n, sector j, we have

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

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 throughout the world. The production technology of Q_n^j is a 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 of an intermediate good from a given variety such that the vector of productivity draw from each location for that variety is $z^j = (z_1^j, z_2^j, \dots, z_{N+M}^j)$. 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. Trade costs occur due to iceberg trade costs and an ad-valorem flat-rate tariffs. 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 have to pay an ad-valorem flat-rate tariff τ_{ni}^j. For goods circulated within the U.S., only iceberg trade costs are applicable, so $\tau_{ni}^j = 1$ for $i, n \in \{1, \dots, N\}$. Combining both the iceberg trade cost and the ad-valorem tariff, we define $\kappa^j_{ni} = \tau^j_{ni} d^j_{ni}$, where $\tau^j_{ni} = 1 + t^j_{ni}$.[4] Non-tradable sectors have infinite trade costs, so $\kappa^j_{ni} = \infty$. After considering trade costs, the price of intermediate good μ^j in location n is given by

$$p^j_n(\mu^j) = \min_i \left\{ \frac{x^j_i \kappa^j_{ni}}{z^j_i(\mu^j)} \right\}.$$

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 the region n, given by

$$P^j_n = \Gamma\left(\frac{1-\eta^j_n}{\theta^j} + 1\right)^{1/(1-\eta^j_n)} \left[\sum_{i=1}^{N} T^j_i \left(x^j_i \kappa^j_{ni}\right)^{-\theta^j}\right]^{-1/\theta^j}, \tag{2}$$

where $\Gamma(.)$ is the Gamma function. When j denotes a non-tradable sector, the price index becomes $P^j_n = \Gamma\left(\frac{1-\eta^j_n}{\theta^j} + 1\right)^{1/(1-\eta^j_n)} \left[T^j_n \left(x^j_n\right)^{-\theta^j}\right]^{-1/\theta^j}$. As consumers have Cobb-Douglas preferences, the aggregate consumption price index P_n is given by

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

We can also derive location n's expenditure on the intermediate goods of sector j purchased from location i. We denote $X^j_n = P^j_n Q^j_n$ as the total expenditure on sector j goods in location n and X^j_{ni} as the expenditure of location n on sector j goods from location i. The expenditure shares $\pi^j_{ni} = X^j_{ni}/X^j_n$ is given by

$$\pi^j_{ni} = \frac{T^j_i \left[x^j_i \kappa^j_{ni}\right]^{-\theta^j}}{\sum_{h=1}^{N+M} T^j_h \left[x^j_h \kappa^j_{nh}\right]^{-\theta^j}}. \tag{3}$$

[4] Triangular inequality also holds; $\kappa^j_{nh}\kappa^j_{hi} \geq \kappa^j_{ni}$ for all n, h, i.

II.4 Income

To address the regional trade imbalance 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 and redistributing to all the agents within the U.S. However, trade imbalance between countries still exists and will be taken care 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 returns is redistributed to local residents equally. The difference between the remittances to the central government and the local factor income generates imbalance across regions within the U.S.:

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

The excess of 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 at 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 is the rental rate for fixed factor, and $r_n H_n / L_n$ 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 (will discuss later). s_n is the per capita trade surplus generated from country-wise trade imbalance. Lastly, we define the share of national portfolio received by each residents in the U.S. as $\chi = \sum_{i=1}^{N} \iota_i r_i H_i / \sum_{i=1}^{N} L_i$. 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 factors 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 of region n. In addition, the labor market clearing at national level requires $\sum_{n=1}^{N} L_n = L_{US}$. In a regional equilibrium, 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 land and structures used in sector j and 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 $n \in \{1, \dots, N\}$. Then, by defining $\omega_n \equiv [r_n/\beta_n]^{\beta_n}[w_n/(1-\beta_n)]^{(1-\beta_n)}$, free mobility along with labor market clearing condition give 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 $u_n \equiv \Upsilon_n/L_n = \iota_n r_n H_n/L_n - \chi$. Since labor is perfectly mobile within the U.S., utility $U_n = U_{US}$ is equalized for $n \in \{1, \dots, N\}$. The equilibrium condition 5 suggests that the share of employment in the region n increases in its endowment of land and structures H_n, in the factor prices captured by ω_n, and in per capital tariff revenue. On the contrary, the employment share in region n decreases with the size of the trade surplus in both regional u_n and international s_n, as these terms reduce the income available to the employee in region 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

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

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

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 location i. The sum of international trade surplus is zero, $\sum_{n=1}^{N+M} S_n = 0$, and within the U.S. the sum of sectoral surpluses in location n is the national surplus, $\sum_{j=1}^{J} S_n^j = S_n$. Sectoral surplus is defined as $S_n^j = \sum_{i=1}^{N+M} \left(X_i^j \frac{\pi_{in}^j}{\tau_{in}^j} - X_n^j \frac{\pi_{ni}^j}{\tau_{ni}^j} \right)$. Note that although sectoral surpluses are endogenously determined, surpluses at national level are exogenous.[5] Finally, using trade surplus and expenditure, we have the trade balance condition:

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

The 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 transfer within the U.S. $\{\Upsilon_n\}_{n=1}^{N}$ and prices $\{P_n^j\}_{n=1,j=1}^{N+M,J}$, that 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.

[5] Ossa (2016) discussed the implications of various approaches for managing trade deficits in counterfactual analyzes. We set all national trade deficits to zero in our quantitative exercises, as in Bagwell et al. (2021).

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 as well as the elasticity of substitution θ^j. In the last part of the section, some basic facts of the U.S.–China trade war are presented.

III.1 Data

In our quantitative analysis, we consider two major economies, the U.S. and China, and 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, including *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. Figure 4 depicts the geographical distribution of these regions on a map. 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 bargaining power between the U.S and China. Consequently, we need to calibrate two sets of parameters, namely in 1997 and 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 of the year 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 flow between the U.S. and other trading countries into 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 in region-sector level are obtained from BEA of 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 implied intermediate good expenditures in some industries exceed that of 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.[6]

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 numerical search for a vector of $\boldsymbol{\iota}$ that minimizes the sum of the squared regional surpluses within the U.S.

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

Lastly, we calibrate β_n, the input share of land and structures in intermediate goods production. We follow Caliendo et al. (2018) 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 the 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 bargaining power between the U.S. and China by examining China's accession to the WTO in 2001. After joining the WTO, China significantly reduced its most favored nation (MFN) tariff rates. In the meanwhile, U.S. applied tariffs toward China remained largely unchanged.[7] As discussed in Handley and Limão (2017) and Alessandria, Khan and Khederlarian (2023), the U.S. granted China the normal trade relations (NTR) status and significantly reduced tariffs on Chinese products to MFN levels in 1980. China's NTR status was renewed annually until 2001 when China gained the permanent NTR status after joining the WTO.

Our estimation strategy closely follows the approach introduced in Bagwell et al. (2021). In particular, given the estimated parameters of the trade model, we can predict cooperative tariffs

[7] In Figure A.1 of the Appendix, we plot the U.S. and China tariff rates at sector level in 1997 and 2005. The U.S. tariff rates against China remained almost the same with only a slight decline, whereas China significantly lowered its tariffs against the U.S. after joining the WTO.

with any bargaining weight by solving the following Nash bargaining problem below

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

where bargaining power of the U.S. against China is denoted by ψ. When $\psi = 1$, the U.S. maximizes its own welfare while keeps China welfare non-decreasing. $\boldsymbol{\tau}_{US,chn}$ refers to the predicted vector of sectoral cooperative tariffs imposed by U.S. on Chinese goods. Similarly, $\boldsymbol{\tau}_{chn,US}$ is the vector of sectoral cooperative tariffs imposed by China on U.S. exports. $U_{US}\left(\boldsymbol{\tau}^{0}_{US,chn},\boldsymbol{\tau}^{0}_{chn,US}\right)$ 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 $(\boldsymbol{\tau}^{0}_{US,chn},\boldsymbol{\tau}^{0}_{chn,US})$. In practice, we also adopt exact hat algebra approach to solve the Nash bargaining problem, and the hat-algebra equilibrium details are in Appendix Section A.2. We use the world economy in 1997 and 2005 to approximate the pre- and post-negotiation equilibrium, respectively.

Given the institutional background of China's accession to the WTO, we make three assumptions when solving the Nash bargaining problem numerically. First, since the U.S. already reduced tariffs towards China in 1980, the 1997 tariffs may not accurately reflect the threat point of the U.S. To address this concern, we use the "column 2 tariffs" as the U.S. pre-negotiation tariffs $\boldsymbol{\tau}^{0}_{US,chn}$. As discussed in Ossa (2014), the column 2 tariffs are applied to U.S. imports from non-WTO member countries and are considered appropriate measures of non-cooperative tariffs. In Section V.5, we also provide quantitative results without this assumption as a robustness check. We consider the bilateral tariffs in 2005 between China and the U.S. as an outcome of negotiations subsequent to China's WTO membership.[8]

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. In other words, $\boldsymbol{\tau}_{US,chn}$ in (8) 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. That is, China and the U.S. simultaneously bargain over tariffs at the starting point of the year 1997. 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 bargaining between the U.S. and China. Unlike the Uruguay round which involves 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).

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

[8]As documented in Dorsey (2003), "China will reduce tariffs on nonagricultural products (which account for 95 percent of its imports) to 8.9 percent by 2005, and tariffs on agricultural products to 15 percent by January 2004."

solutions to China's cooperative tariffs given this ψ. Formally, the bargaining power of the U.S. against 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, 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 estimation of the bargaining power of the U.S. against China to be $\hat{\psi} = 0.47$.

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. For all the tradable sectors, China is designated as the reference exporting country. The estimated elasticities are reported in Table 1. The average of estimated elasticities of substitution equals 2.77, which is similar to 2.80 in Mei (forthcoming) and falls within the range of previous findings in the literature. Ossa (2014) used United Nations' (UN) Comtrade trade data for the time period 1994–2008 and estimated a mean elasticity of 3.42 with a range from 1.19 to 10.07, which is higher than our estimates. This is because Ossa (2014) adopts a granular sector framework where disaggregated agricultural sectors such as wheat ($\theta = 10.07$) and rice ($\theta = 7.01$) exhibit notably elevated elasticity of substitution. In the robustness check part, we also adopt estimates of elasticity of substitution from Caliendo and Parro (2015), leading to a more disperse range of estimation from

1.01 (transportation) to 51.08 (petroleum) with mean of 8.62.

III.4 Trade War Facts

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 U.S. and China's tariff war until the end of 2019.[9]

In Figure 1, we show the factual tariff before and after the U.S.–China trade war by sectors. The upper panel plots are the factual bilateral tariff rates between the U.S. and China in 2017 and on December 31, 2019, respectively. The simple average pre-war tariff level imposed by the U.S. on China is 2.99% with range from 0.57% to 11.81%, and China's simple average pre-war tariff rate is 6.79% ranging from 0.87% to 12.38%.[10] By the end of 2019, both countries are observed to raise their tariffs against each other to a large degree in the trade war: the mean of the U.S. tariff level rises to 13.30% and that of China also climbs up to 14.76%. The lower left plot shows the trade war tariff increments between the two countries by sector. Specifically, the machinery sector in the U.S. received the most protection by a steepest tariff increase from 0.88% before the trade war to 15.73% after the trade war. The U.S. also imposed a large tariff on China's transportation sector export, with an increase from 1.66% to 16.45%. These sectors contain a large share of intermediate

[9]Tariff changes in each round are obtained from 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. For example, if China raised tariffs on a US product in September 2018 by 10% but then suspended it in January 2019, the scaled tariff change over the two-year window would be $(16/24) \times 10\% + (12/24) \times (-10\%) = 1.67\%$.

[10]Despite using the same data source, the average tariff changes calculated by us are different from those in Bown (2021) because we first aggregate tariffs at sector level before taking the simple average.

inputs and constitute a large share of targeted varieties and products. China retaliated the most in petroleum, and food, beverage and tobacco sectors of the U.S. export, with tariff increments of 17.73% and 16.98%, respectively.[11] Fajgelbaum et al. (2020) investigates the period between 2017 and December 2018 and also documents the U.S. increased average statutory tariff rates on China from 3.0% to 15.5%, which is subsequently retaliated by China's increase in tariff rate from 8.4% to 18.9%. Fajgelbaum et al. (2021) focuses on the same time window as ours and also sees the most protection of the U.S. industry in machinery, transport and metals sectors, and the most retaliation of China on the U.S. agriculture export. Interestingly, as demonstrated in the lower right panel of Figure 1, we find that the U.S. remains the stable tariff rates on the remaining countries during the trade war, but China has lowered its tariff levels, especially in transportation sector, against the rest of the world with an average decline of 1.84%, which aligns with the illustration in Fajgelbaum et al. (2021).

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, the corresponding welfare changes, and the heterogeneous impact across U.S. regions.

[11] China's tariff on Transportation sector declines after the trade war. This is because on July 1, 2018, China declined the MFN tariffs on motor vehicles. On July and August 2018, China retaliated against US Section 301 Investigations by raising tariffs, including the transportation industry. But the retaliation action against the U.S. auto was suspended on January 1, 2019.

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 model constructed in Section II with the 2017 data. Next, using the MPEC approach popularized by Su and Judd (2012), we compute the cooperative tariffs between the U.S. and China given bargaining power ψ. We use $\hat{\boldsymbol{U}}^{co-17}(\psi)$ to denote the corresponding the vector of welfare change from the 2017 baseline when the computed cooperative tariffs are imposed. Similarly, we can define $\hat{U}_{US}^{co-17}(\psi)$ and $\hat{U}_{chn}^{co-17}(\psi)$ as the relative welfare change of the U.S. and China, respectively.

We then apply the trade war tariffs rates observed in 2019 to the 2017 baseline model. Given the tariff changes, the resulting vector of welfare change relative to the 2017 pre-trade-war equilibrium is denoted as $\hat{\boldsymbol{U}}^{war}$. Note that $\hat{\boldsymbol{U}}^{war}$ does not depend on ψ since 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. The corresponding vector of welfare change relative to the trade-war equilibrium is denoted as $\hat{\boldsymbol{U}}^{co-war}(\psi)$. Let $\hat{\boldsymbol{U}}^{co-19}(\psi) \equiv \hat{\boldsymbol{U}}^{war} \times \hat{\boldsymbol{U}}^{co-war}(\psi)$ to denote the vector of welfare change relative to the 2017 baseline and $\hat{U}_{US}^{co-19}(\psi)$ be the relative welfare change of the U.S. By comparing $\hat{U}_{US}^{co-19}(\psi)$ with $\hat{U}_{US}^{co-17}(\psi)$, we can quantitatively evaluate the Katherine Tai's claim about using the Trump tariffs as bargaining chips: if $\hat{U}_{US}^{co-19}(\psi) > \hat{U}_{US}^{co-17}(\psi)$, then the trade war does improve the U.S. bargaining outcome relative to the outcome using 2017 as the starting point.

IV.2 Cooperative tariffs

Figure 2 displays the average cooperative tariff rates of the U.S. and China in both pre- and post-war tariff negotiation given different bargaining powers. The dashed asterisk line represents the average bilateral cooperative tariff rates between the U.S. and China before the trade war. It can be observed that irrespective of the U.S. bargaining power, the average cooperative tariffs of the U.S. remained around zero level in its talks with China in the pre-war scenario, while China consistently maintained a positive tariff margin, although this beneficial tariff position deteriorates as the bargaining power of the U.S. increases. At our estimated $\hat{\psi} = 0.47$, the average cooperative tariff rate of China is 5.60%. Even the US possesses all of the bargaining power against China (ψ=1), the average of China's predicted cooperative tariff rates is still 1.76%. This reflects China's advantage in the tariff negotiation before the trade war.

The solid line in the same figure refers to the average bilateral cooperative tariff rates for both countries after the trade war. We observe that with weak bargaining strength, the predicted cooperative tariff of the U.S. is still zero. When the U.S. has a relatively large bargaining power (just larger than the equal bargaining weight of one half), it has a positive tariff negotiation margin, and the advantage in tariff negotiation will increase in bargaining power of the U.S, reaching the average cooperative tariff rates at 5.86% given its largest bargaining power. On the other hand, the average tariffs that China can impose after negotiation decrease at any bargaining power, compared to the pre-trade war level. And the loss of tariff negotiation advantage becomes larger with the increasing bargaining power of the U.S. When ψ excesses 0.65, it is China that reaches the zero tariff level in the trade talks. It is notable that even if the U.S. has a relatively small bargaining power without tariff margin in trade talks, China's tariff negotiation position has deteriorated after the trade war. For example, at the estimated $\hat{\psi} = 0.47$, the U.S. average cooperative tariff rate is still predicted to be zero. However, China's tariff margin declines from 5.60% to 1.61% in the post-war negotiation. In addition, it is noteworthy that the estimation of bargaining power is based on the context of China's accession to the WTO in December 2001, and it may not accurately reflect the current situation. In summary, our findings align with Katherine Tai's perspective that the trade war served as an important leverage point in negotiations with China, irrespective of the U.S. current bargaining power.

Ossa (2011) demonstrates that the zero tariff level contributes to Pareto's efficiency from the perspective of the effect of production relocation and the effect of import prices based on the new trade model of Krugman (1980). Our analysis is carried out under the assumption of perfect competition with no entry condition, and stands a position closer to the framework established in Bagwell et al. (2021). Nevertheless, our quantitative finding of zero tariff rates at any given bargaining weight aligns with the prediction of Ossa (2011). Furthermore, as argued in Bagwell and Staiger (1999), Bagwell and Staiger (2010) and Bagwell et al. (2021), there are two channels through which tariff changes under negotiation affect the national welfare of each country, namely, the terms of trade and domestic price. When tariffs are reduced, countries that liberalize tend to experience negative effects on national welfare through the former channel. On the contrary, countries that reduce tariffs benefit from a reduction in domestic price distortions through the latter channel. When the U.S. has limited bargaining power, the income effect of the induced terms-of-trade movements is overshadowed by the welfare benefits arising from the reduction in domestic price distortions, resulting in the zero tariff level depicted in Figure 2. With a substantial bargaining power, the U.S. places a higher value on the international redistribution of income triggered by the favorable terms-of-trade changes, as predicted by the positive tariff margin, compared to the welfare implication caused by domestic price distortion.

More specifically, we first consider an extreme case in which the US possesses all of the bargaining power against China in tariff negotiation. The cooperative tariffs predicted by the model are reported in Figure A.3. The upper plots reflect the cooperative tariffs in the pre-trade war scenario. We can see there has been no room for the U.S. to reduce its tariffs in the negotiation, even if the U.S. now has the strongest bargaining power. China, however, still has the leverage to further decrease its tariffs against the U.S. before the trade war. The bottom two plots shows the bargaining situation flips after the trade war. Specifically, the post-war import tariffs of China reach to zero level, while the U.S. has additional room for further decline. Given the estimated bargaining power $\hat{\psi} = 0.47$, the predicted cooperative tariffs between the U.S. and China are shown in Figure A.4. In this case, although China can further decrease its tariffs in both pre- and post-trade war scenarios due to its relatively larger bargaining power, the tariff margin that China can impose declines to a large extent, and China's tariff negotiation position has deteriorated after trade war. This lends support to Katherine Tai's argument in this country-pair tariff bargaining game.

IV.3 Welfare Changes

Table 2 reports welfare changes under different scenarios given different bargaining powers of the U.S. against China. Figure 3 demonstrates in detail the welfare changes of the U.S. and China with respect to different bargaining powers. In the figure, the blue line represents the welfare change under the pre-war cooperative negotiation and the red line reflects that change under the post-war cooperative bargaining. With increased bargaining power against China, the welfare changes of the US in both pre- and post-war scenarios are monotonically increasing curves, while those of China are decreasing. Besides, no matter what its bargaining power is, the total welfare increment of the U.S. under the post-war cooperation dominates that at the pre-war factual level, with additional improvement ranging from 0.02% to 0.05%. China, however, always suffers a negative welfare change and experiences a reduction in welfare ranging from −0.07% to −0.12% in the post-war cooperative scenario compared to its pre-war level, regardless of the level of bargaining power it has. Although trade talk itself can ameliorate both partners' welfare, the large drop in welfare caused by trade war tariff damages any welfare gains from tariff cooperation. At the estimated bargaining power $\hat{\psi} = 0.47$, the gains from pre-war cooperation are 0.03% for both the U.S. and China, while the total welfare changes in post-war trade talk relative to pre-war factual level are 0.07% and −0.06%, respectively.

We also observe the increasing welfare gain/loss gap for both the U.S. and China with the U.S. increasing bargaining power. This is because before the trade war, since the U.S. cooperative tariff rates are predicted to be as low as zero level given any bargaining power, any welfare gains of the U.S. from trade talks are derived from the concession in China's cooperative tariffs, as shown by the dashed asterisk line in Figure 2. After trade war, on the one hand, the drop of Chinese cooperative tariff rates relative to the pre-war cooperative level is increasing with respect to the U.S. bargaining power. On the other hand, the U.S. can have an increasing positive tariff margin when its bargaining power is relatively large, thus leading to another gain of its welfare in trade talks. Both sources of gains results in the increasing welfare gain gap between the pre-war cooperation and the post-war negotiation.

IV.4 Heterogeneity across U.S. Regions

Since our model incorporates eight regions in the U.S. economy, we can analyze the heterogeneous impact of 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. We use the labor inflow and outflow to measure the how the post-negotiation outcome differs across regions. Figure 4 shows the changes in population in different regions when cooperative tariffs as as result of U.S.–China tariff negotiation are imposed. Panel a depicts the equilibrium using the pre-trade-war tariffs as the starting point of the negotiation, whereas Panel b depicts the equilibrium using post-trade-war tariffs as the starting point.

From Figure 4, we can see that the spatial pattern of the two panels 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. The New England region, to the contrary, always suffers a largest labor outflow. Specifically, the post-war cooperative scenario predicts a net 1.30% influx of labor into the Southwest region and a net 1.90% outflow from the New England region. Overall, negotiations starting from the pre-trade-war tariffs leads to a slightly milder change in the labor distribution than starting from the post-trade-war tariffs.

V Robustness

In this section, we perform a series of checks to establish the robustness of our findings discussed in Section IV.

V.1 Allowing for subsidies

Our baseline results are robust if countries are allowed for subsidies in tariff negotiations. Figure A.5 displays the averages of the predicted cooperative tariffs of the U.S. and China. As shown by dashed asterisk lines, the U.S. always needs to subsidize its import from China for any bargaining power in the pre-war tariff negotiation, while China can keep its advantage with positive tariff margin in most scenarios except for facing quite large bargaining power of the U.S. After trade war, as shown by solid circle lines, the average cooperative tariff curve of China shifts down and that of the U.S. moves up. With relatively large bargaining power, the U.S. has additional tariff room to lower as a leverage in trade talks with China, while China needs to subsidize importing products from the U.S. Panel B in Table 2 shows the welfare changes under different scenarios when subsidies are allowed. The results are similar to those of the baseline model. Figure A.6 further presents the welfare changes before and after the trade war given different bargaining powers. Similarly, the U.S. still benefits in the post-war scenario relative to the pre-war cooperation level, with additional increasing welfare improvement from 0.02% to 0.06%, while cooperation after trade war leads to further damages on China's overall welfare ranging from −0.07% to −0.12%.

V.2 Rest-of-World as fixed

In this exercise, we maintain fixed bilateral tariffs between the U.S. and ROW, as well as between China and ROW, at the pre-war level of 2017. That is, we only consider the variation of tariffs in the U.S.–China pair. Panel C in Table 2 and Figure A.7 display similar welfare change results to the baseline. The U.S. benefits from an additional welfare improvement ranging from 0.01% to 0.04% in the post-war negotiation, and Chinese welfare suffers a loss from −0.01% to

-0.07%. We further show that our baseline results are robust to the combination of the previous two robustness settings. The welfare results, shown in Panel D in Table 2 and Fig A.8, deliver the same message as the baseline setting.

V.3 Fixed deficit

In the previous analysis, we adopt the non deficit assumption, which is commonly used in the trade literature, to address the international trade surplus. However, one striking feature of the trade relation between the U.S. and China is the substantial trade imbalance: using 2017 OECD-ICIO table, the trade deficit of the U.S. is \$727.35 billion and the trade surplus of China is \$843.17 billion. In this exercise, we fix international trade deficits at the pre-trade-war level of the year 2017 and and show the robust results of welfare implications in Fig A.9.

V.4 Caliendo and Parro (2015) elasticity of substitution

Our estimation of elasticity of substitution is based on the well-known approach developed by Feenstra (1994). In this robustness check, we adopt the estimates directly from Caliendo and Parro (2015) and the corresponding results are reported in Fig A.10. The cooperative tariff prediction contains some noisy and the welfare change between pre- and post-war tariff negotiation is smaller than the baseline results. This is because Caliendo and Parro (2015) use the variation in tariffs and volume of trade before and after NAFTA was active and obtain a more disperse range of estimation from 1.01 (transportation) to 51.08 (petroleum) with mean of 8.62. Nevertheless, the welfare implication remains the same as the previous analysis.

V.5 Estimation of bargaining power with alternative steup

In the previous baseline part, one key assumption in the estimation of bargaining power is that from being a non-WTO member to a WTO member, China is aware of the degree to which the U.S. would lower its tariff rates. Instead, we now assume the tariff concession of the U.S. after China's accession to WTO is not given as a known information to China in the tariff bargaining problem. That is, China and the U.S. simultaneously bargain over tariffs, still using the same starting point as in Section III.2. The remaining assumptions remains the same as before. The estimated bargaining power of the U.S. against China in this case is $\hat{\psi} = 0.03$.

Bagwell et al. (2021) also assume that both countries simultaneously bargain over tariffs when estimating the bilateral bargaining weights. Adopting the structure of Uruguay Round tariff bargaining, the estimated bargaining weights of the U.S. against the EU, South Korea, and Japan are 0.01, 0.01 and 0.05, respectively. Our estimate of the bargaining power for the U.S. falls in the mid-range of those found in the literature. 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. As shown in Figure A.2, it is the U.S. that has decreased its tariffs to a larger extent on Chinese exports in most of the sectors after China's accession to the WTO, which results in the small bargaining power estimate.

In the main analysis, we use U.S. column 2 tariffs as the pre-negotiation tariffs of the U.S. when estimating ψ. As a robustness check, we also experiment with using the U.S. applied tariffs in 1997 instead. The resulting bargaining power of the U.S. is much larger and is estimated to be $\hat{\psi} = 0.94$. This is because, as seen in Figure A.1, the U.S. only slightly reduced the tariff levels from 1997 to 2005. Since China lowered its tariff substantially after its accession to the WTO, this outcome of the Nash bargaining can only be rationalized by a large bargaining weight of the U.S. relative to China.

VI Conclusion

This paper quantitatively analyzes the potential role of the Trump tariffs from 2018 through 2019 as bargaining chips in future trade negotiations with China. We develop a general equilibrium quantitative model that features both international trade and the U.S. economy disaggregated across 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 World Trade Organization (WTO) in 2001. Given the estimated U.S. bargaining power of 0.47, the trade war increases the U.S. post-negotiation welfare gain from 0.03% to 0.07% relative to its pre-trade-war welfare level. In the meanwhile, China's post-negotiation welfare change decreases from 0.03% to -0.06%.

By quantifying how the U.S.–China trade war affect the outcomes of tariff bargaining, this paper connects two separate but related fields in the literature. On one hand, existing works on cooperative tariffs mostly focus on the reciprocal tariff reductions among WTO member countries. On the other hand, the burgeoning literature on the U.S.–China trade war emphasize the impact of higher tariffs on economic activities in the U.S. and China. In contrast, we consider the role of tariffs as bargaining chips, hence providing the first quantitative study on the potential negotiation outcomes between the U.S. and China.

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Table 1: Elasticity of Substitution Estimates by Sector

Sector	Estimate
Chemical	2.43
Computer, electronic and electrical equipment	2.70
Food, beverages and tobacco	2.30
Machinery	2.56
Mineral	1.98
Miscellaneous	3.66
Petroleum	2.76
Primary and fabricated metal	2.82
Rubber	2.72
Service	3.31
Textiles	2.97
Transportation	2.98
Wood and paper	2.78
Mean	2.77

Notes: Estimates of elasticity of substitution θ are reported by sector in ascending order of alphabet.

Table 2: Welfare Changes under Different Scenarios

	2017 cooperation $\hat{U}^{co-17}$			Trade war $\hat{U}^{war}$	Post-war cooperation $\hat{U}^{co-war}$			Post-war total $\hat{U}^{co-19}$		
ψ_{US-CHN}	0.0	0.47	1.0	All	0.0	0.47	1.0	0.0	0.47	1.0
Panel A. Baseline										
US	0.00%	0.03%	0.06%	0.02%	0.00%	0.05%	0.10%	0.02%	0.07%	0.12%
China	0.06%	0.03%	0.00%	–0.12%	0.11%	0.07%	0.00%	–0.01%	–0.06%	–0.12%
ROW	0.00%	0.00%	0.00%	0.03%	0.00%	–0.01%	0.00%	0.03%	0.02%	0.02%
Panel B. Allowing for subsidies										
US	0.00%	0.03%	0.06%	0.02%	0.00%	0.05%	0.10%	0.02%	0.07%	0.12%
China	0.08%	0.04%	0.00%	–0.12%	0.13%	0.07%	0.00%	–0.01%	-0.06%	–0.12%
ROW	0.00%	0.00%	0.00%	0.03%	0.00%	0.00%	0.00%	0.02%	0.02%	0.02%
Panel C. Given ROW fixed										
US	0.00%	0.03%	0.06%	0.01%	0.00%	0.05%	0.10%	0.01%	0.06%	0.10%
China	0.06%	0.03%	0.00%	–0.07%	0.12%	0.06%	0.00%	0.05%	0.00%	–0.07%
ROW	0.00%	0.00%	0.00%	0.00%	0.00%	–0.01%	0.00%	0.00%	0.00%	0.00%
Panel D. Allowing for subsidies and given ROW fixed										
US	0.00%	0.03%	0.06%	0.01%	0.00%	0.05%	0.10%	0.01%	0.06%	0.11%
China	0.08%	0.04%	0.00%	–0.07%	0.13%	0.07%	0.00%	0.07%	0.00%	–0.07%
ROW	0.00%	0.00%	0.00%	0.00%	–0.01%	–0.01%	–0.01%	0.00%	0.00%	0.00%

Notes: Each column represents changes in the row relative to the pre US-China trade war tariff level. ψ_{US-CHN} is the bargaining power of the U.S. against China. Our estimate of the bargaining power of the U.S. against China is 0.47. In the first three columns, we compute the welfare changes from the 2017 baseline under the predicted pre-trade-war cooperative tariffs. Column 4 reports the welfare changes from the 2017 baseline given US–China trade war tariffs. In columns 5-8, we compute welfare changes from the trade-war equilibrium under the predicted post-trade-war cooperative tariffs. The last three columns report the total welfare changes relative to the 2017 baseline. Panel A refers to the baseline analysis. In Panel B, subsidies are allowed. In Panel C, we maintain the fixed bilateral tariffs between the U.S. and ROW, as well as between China and ROW, at the pre-war level of 2017, and only consider the variation of tariffs in the U.S.-China pair during the trade war. Panel D refers to the robustness check result given the combination of Panel B and C.

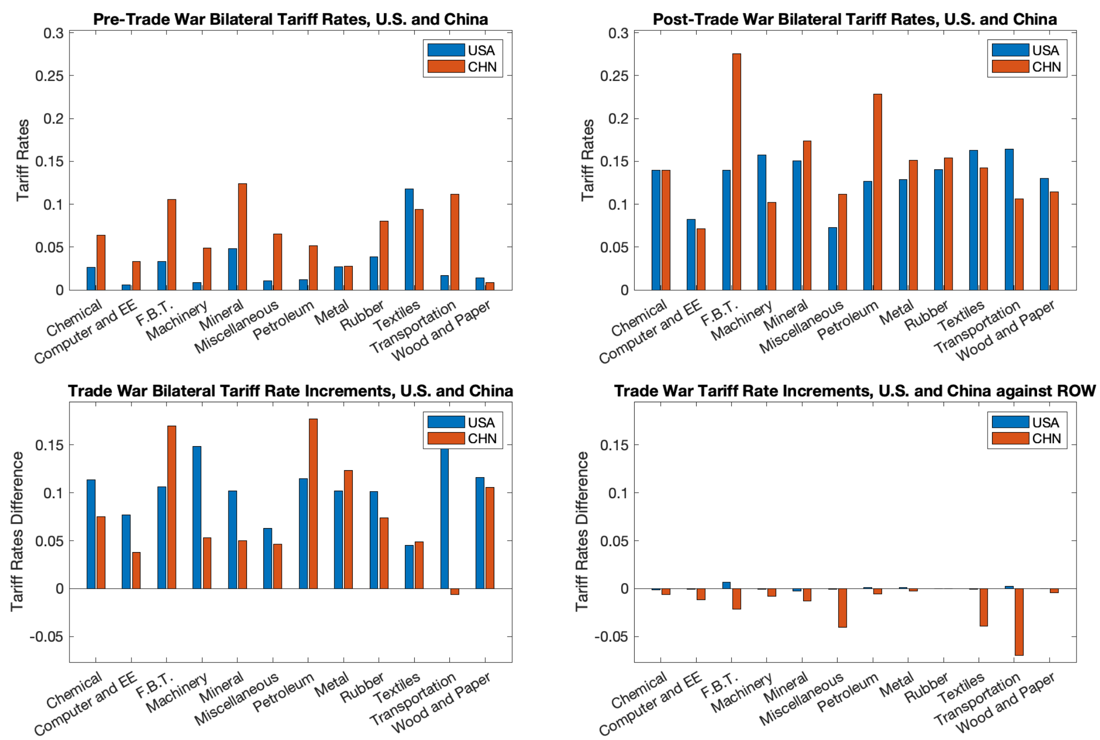


Figure 1: Tariff rates during the US-China trade war

Notes: The upper panel displays the factual bilateral tariff rates between the U.S. and China in 2017 (before the trade war) and by December 31, 2019 (after the trade war), respectively. The lower-left figure shows the bilateral tariff increments between the U.S. and China during the trade war. The lower-right figure shows the tariff increments of the U.S and China against Rest of World (ROW) during the trade war. Sectors are arranged in ascending order of alphabet.

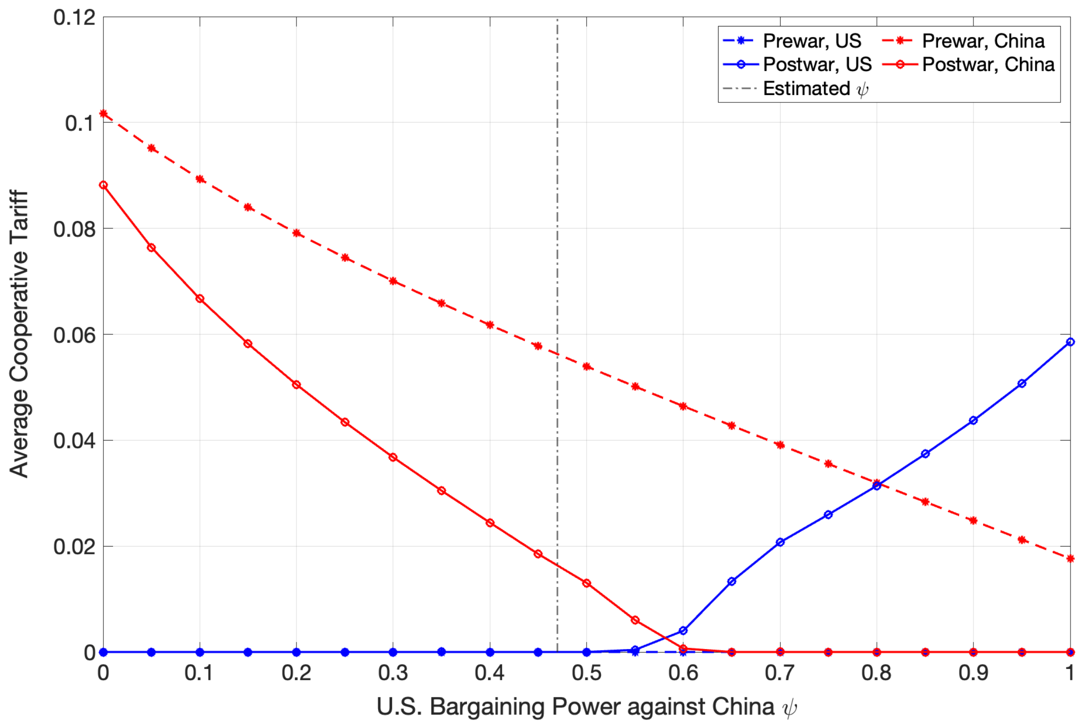
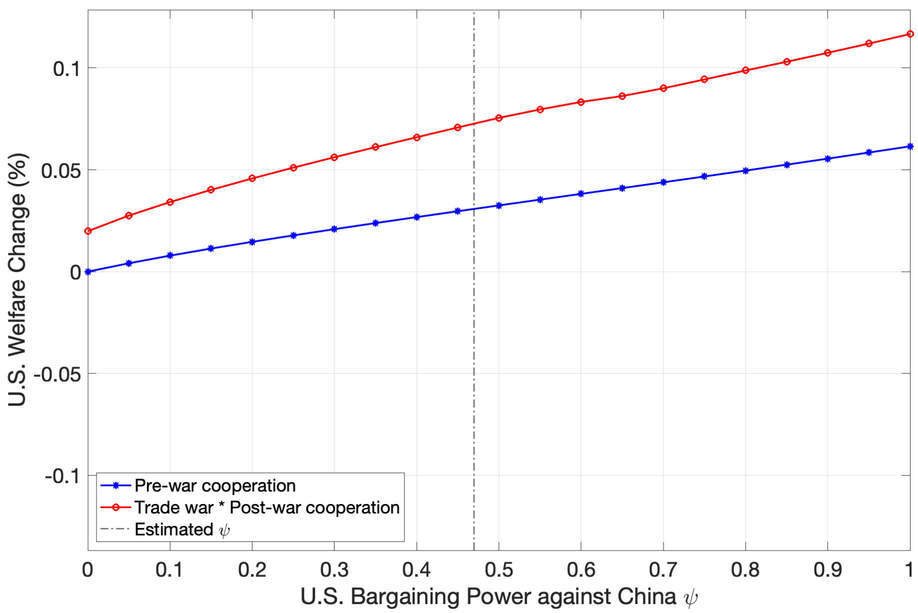
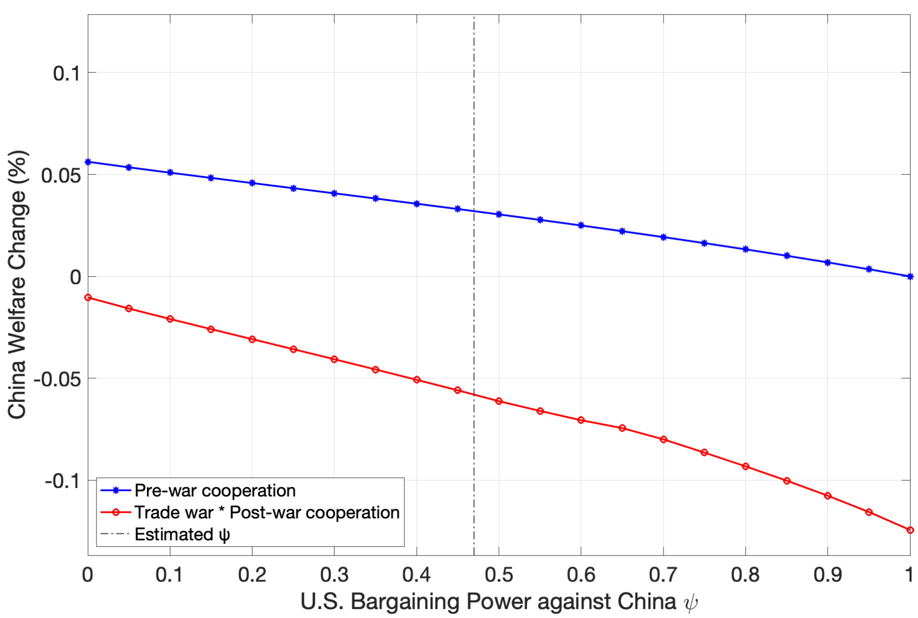


Figure 2: Average cooperative tariffs for different bargaining powers of the U.S. against China

Notes: Subsidies are not allowed. We compute the simple average of predicted cooperative tariff across sectors for each country. The dashed asterisk lines refer to the average cooperative tariffs between the U.S. and China in the 2017 pre-war scenario, and the dashed circle lines refer to the average cooperative tariffs between the U.S. and China in 2019 post-war scenario. The blue lines represent the U.S. tariff against China, and the red lines represent China's tariff against the U.S. The vertical dashed dot line indicates the estimated bargaining power of the U.S. against China, $\hat{\psi} = 0.47$.



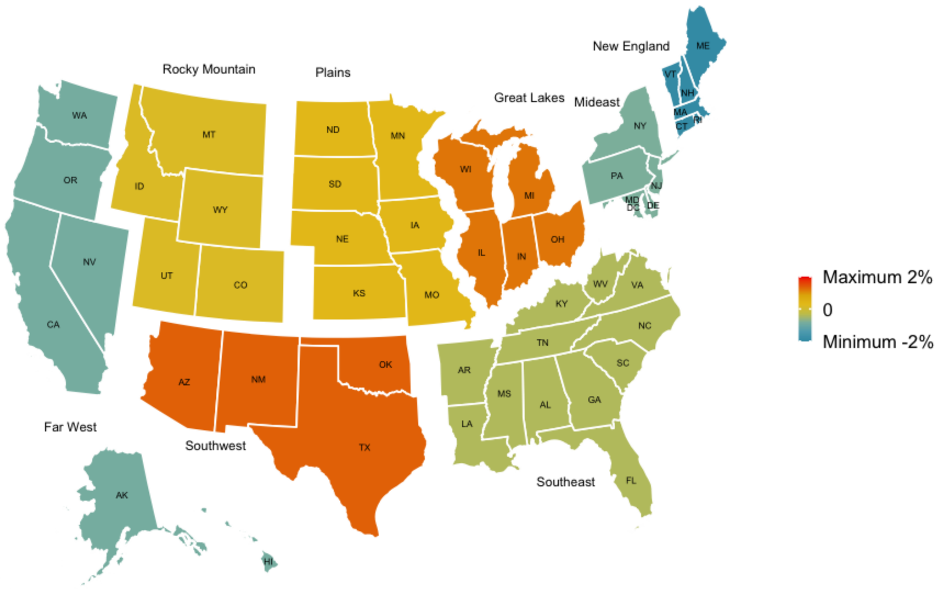
(a) U.S. welfare change



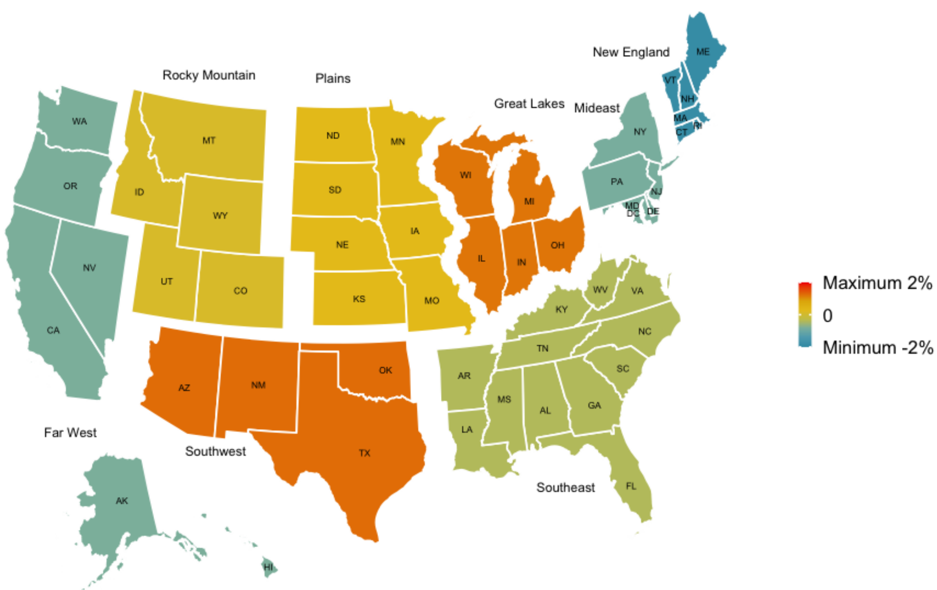
(b) China welfare change

Figure 3: Welfare changes for different bargaining powers of the U.S. against China

Notes: Subsidies are not allowed. The solid asterisk blue lines refer to the welfare changes under cooperation between the U.S. and China in the 2017 pre-war scenario, and the solid circle red lines refer to the total welfare changes of post-war cooperation between the U.S. and China relative to pre-war level. The vertical dashed dot line indicates the estimated bargaining power of the U.S. against China, $\hat{\psi} = 0.47$.



(a) Pre-war negotiation scenario



(b) Post-war negotiation scenario

Figure 4: Labor migration

Notes This figure shows labor mobility by regions under the pre- and post-war cooperative tariff scenarios. The post-war negotiation scenario induces less migration, suggesting an average of 0.87% labor changes across regions. On the contrary, the pre-war cooperative tariff scenario leads to an average of 0.90% labor mobility across regions.

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* $\{\hat{\omega}_n, \hat{x}^j_n, \hat{L}_n, X^{j\prime}_n\}$ *such that:*

Input bundle $J(N+M)$ equations:

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

Labor mobility condition N equations:[12]

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

Regional market clearing in final goods $J(N+M)$ equations:

$$X^{j\prime}_n = \sum_{k=1}^{J} \gamma^{k,j}_n \left(\sum_{i=1}^{N+M} \frac{\pi^{k\prime}_{in}}{\tau^{k\prime}_{in}} X^{k\prime}_i\right) + \alpha^j I'_n L'_n$$

for $n \in \mathcal{US}$ $I'_n L'_n = \left(\hat{\omega}_n \left(\hat{L}_n\right)^{1-\beta_n} (I_n L_n + \Upsilon_n + S_n - \Lambda_n) + \sum_{j=1}^{J} \sum_{i=1}^{N+M} t^{j\prime}_{ni} \frac{\pi^{j\prime}_{ni}}{\tau^{j\prime}_{ni}} X^{j\prime}_n - S'_n - \Upsilon'_n\right)$

for $n \in \overline{\mathcal{US}}$ $I'_n L'_n = \hat{\omega}_n \omega_n L_n + \sum_{j=1}^{J} \sum_{i=1}^{N+M} t^{j\prime}_{ni} \frac{\pi^{j\prime}_{ni}}{\tau^{j\prime}_{ni}} X^{j\prime}_n - S_n$

Labor market clearing $(N+M)$ **equations:**

$$VA' = \sum_j \gamma^j_n \sum_i \frac{\pi^{j\prime}_{in}}{\tau^{j\prime}_{in}} X^{j\prime}_i$$

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 $n \in \overline{\mathcal{US}}$ $VA'_n = \hat{\omega}_n \omega_n L_n$ *where*

Price index $J(N+M)$ equations:

$$\hat{P}^j_n = \left(\sum_{i=1}^{N+M} \pi^j_{ni} \left[\hat{\kappa}^j_{ni} \hat{x}^j_i\right]^{-\theta^j}\right)^{-1/\theta^j}$$

[12]Labor is mobile within the U.S.

Expenditure shares $J(N+M)^2$ equations:

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

Aggregate price index $(N+M)$ equations:

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

Utility level within the U.S.:

$$\hat{U} = \frac{1}{L} \sum_n L_n \left(\frac{1}{\varphi_n} \frac{\hat{\omega}_n}{\hat{P}_n} \left(\hat{L}_n \right)^{1-\beta_n} - \frac{1-\varphi_n}{\varphi_n} \frac{\hat{L}_n \hat{b}_n}{\hat{P}_n} \right)$$
$$\hat{b}_n = \frac{u_n' + s_n' - \lambda_n'}{u_n + s_n - \lambda_n}, \ \varphi_n = \frac{1}{1 + \frac{\Upsilon_n + S_n - \Lambda_n}{L_n I_n}}$$

Utility level outside of the U.S.:

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

To see this: 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.

Solve

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

subject to

$$0 = \hat{x}_n^j - (\hat{\omega}_n)^{\gamma_n^j} \prod_{k=1}^{J} \left(\hat{P}_n^k\right)^{\gamma_n^{jk}}$$

$$0 = \hat{L}_n - \frac{\left(\frac{\hat{\omega}_n}{\varphi_n \hat{P}_n \hat{U} + (1-\varphi_n)\hat{b}_n}\right)^{1/\beta_n}}{\sum_i L_i \left(\frac{\hat{\omega}_i}{\varphi_i \hat{P}_i \hat{U} + (1-\varphi_i)\hat{b}_i}\right)^{1/\beta_i}} L$$

$$0 = X_n^{j\prime} - \sum_{k=1}^{J} \gamma_n^{k,j} \left(\sum_{i=1}^{N} \frac{\pi_{in}^{k\prime}}{\tau_{in}^{k\prime}} X_i^{k\prime}\right) - \alpha^j I_n^{\prime} L_n^{\prime}$$

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

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

For $n \in \{1, \ldots, N\}$

$$0 = VA_n^{\prime} - \sum_j \gamma_n^j \sum_i \frac{\pi_{in}^{j\prime}}{\tau_{in}^{j\prime}} X_i^{\prime j}$$

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

For $n \in \{N+1, \ldots, N+M\}$

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

where $\hat{P}_n^j$, $\pi_{ni}^{j\prime}$, $\hat{P}_n$, and $\hat{U}_n$ are given by

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

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

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

Utility level within the U.S.:

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

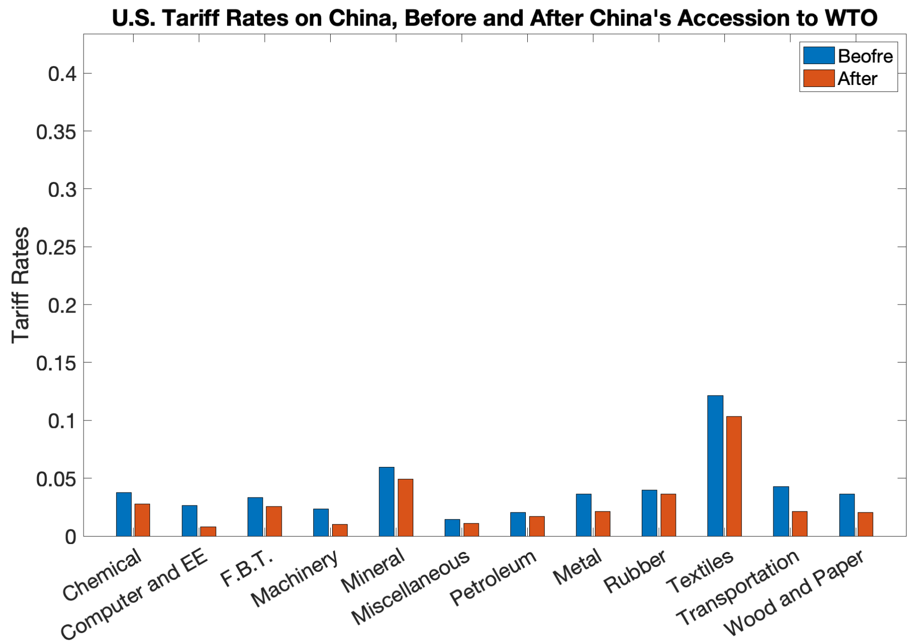
$$\hat{b}_n = \frac{u'_n + s'_n - \lambda'_n}{u_n + s_n - \lambda_n}, \varphi_n = \frac{1}{1 + \frac{\Upsilon_n + S_n - \Lambda_n}{L_n I_n}}$$

Utility level outside of the U.S.:

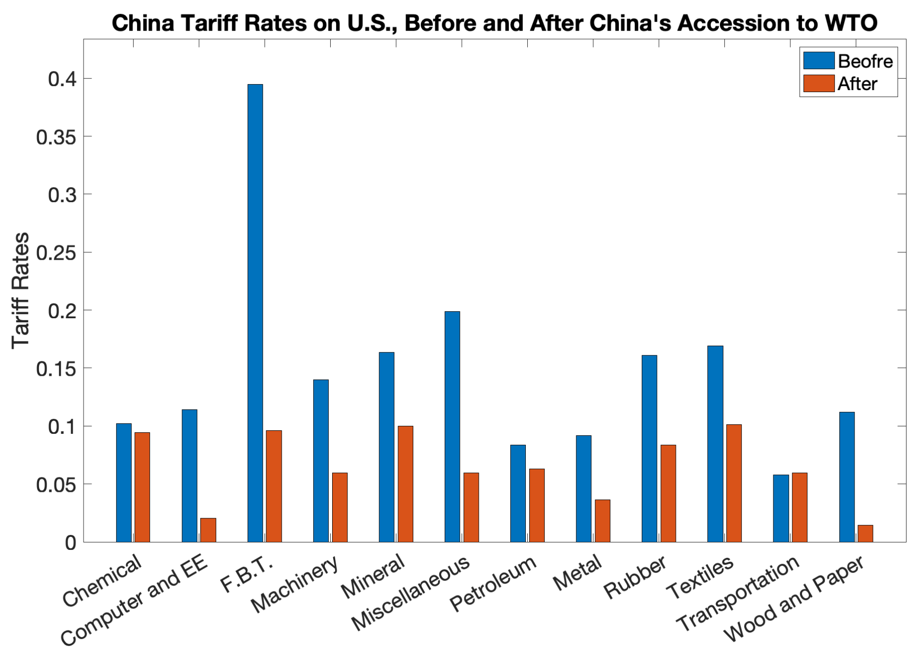
$$\hat{U}_n = \frac{\hat{I}_n}{\hat{P}_n} = \frac{I'_n}{I_n \hat{P}_n}$$

And lastly, the non-decreasing welfare level condition:

$$\hat{U}_{US} \geq 1,\ \hat{U}_{chn} \geq 1$$



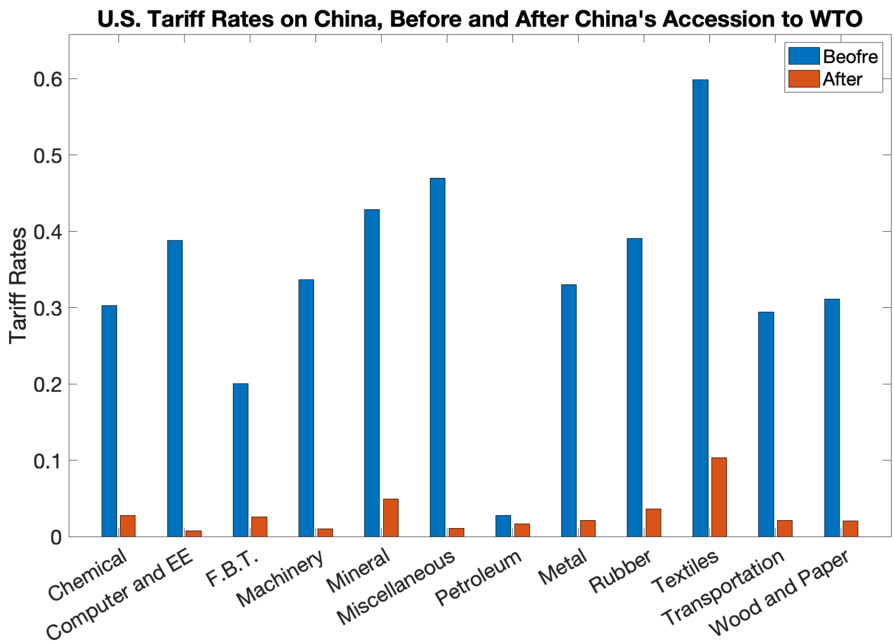
(a) U.S. tariff rates on China



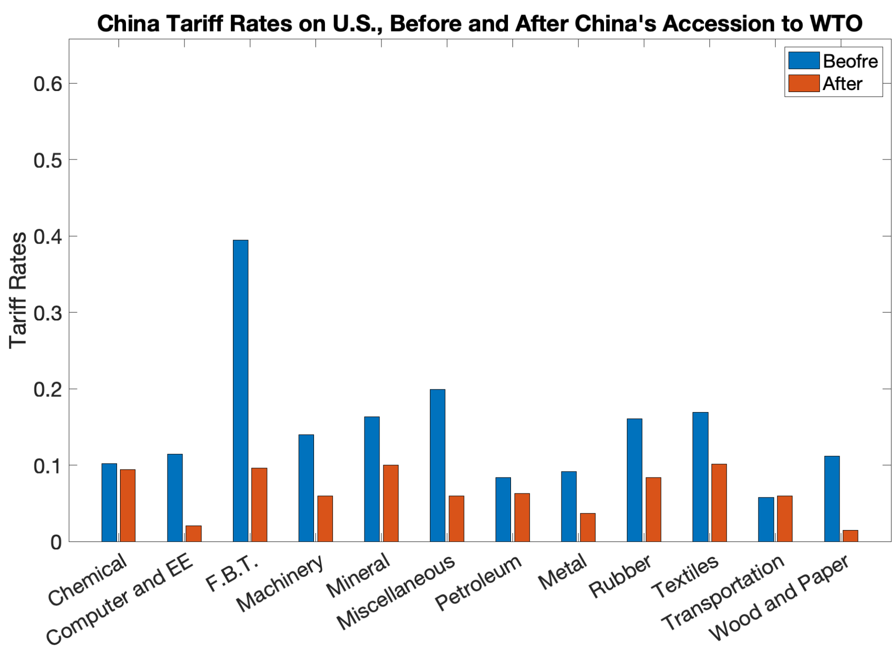
(b) China tariff rates on U.S.

Figure A.1: Tariff rates before and after China's accession to the WTO

Notes: This figure display the tariff rates (a) imposed by U.S. on Chinese exports and (b) imposed by China on the U.S. goods in 1997 (before China's accession to the WTO) and in 2005 (after China's accession to the WTO). Sectors are arranged in ascending order of alphabet.



(a) U.S. tariff rates on China



(b) China tariff rates on U.S.

Figure A.2: Tariff rates before and after China's accession to the WTO, given U.S. column 2 tariffs

Notes: This figure display the tariff rates (a) imposed by U.S. on Chinese exports and (b) imposed by China on the U.S. goods in 1997 (before China's accession to the WTO) and in 2005 (after China's accession to the WTO). In Figure (a), the U.S. tariff rates in 1997 are its column 2 tariffs. Sectors are arranged in ascending order of alphabet.

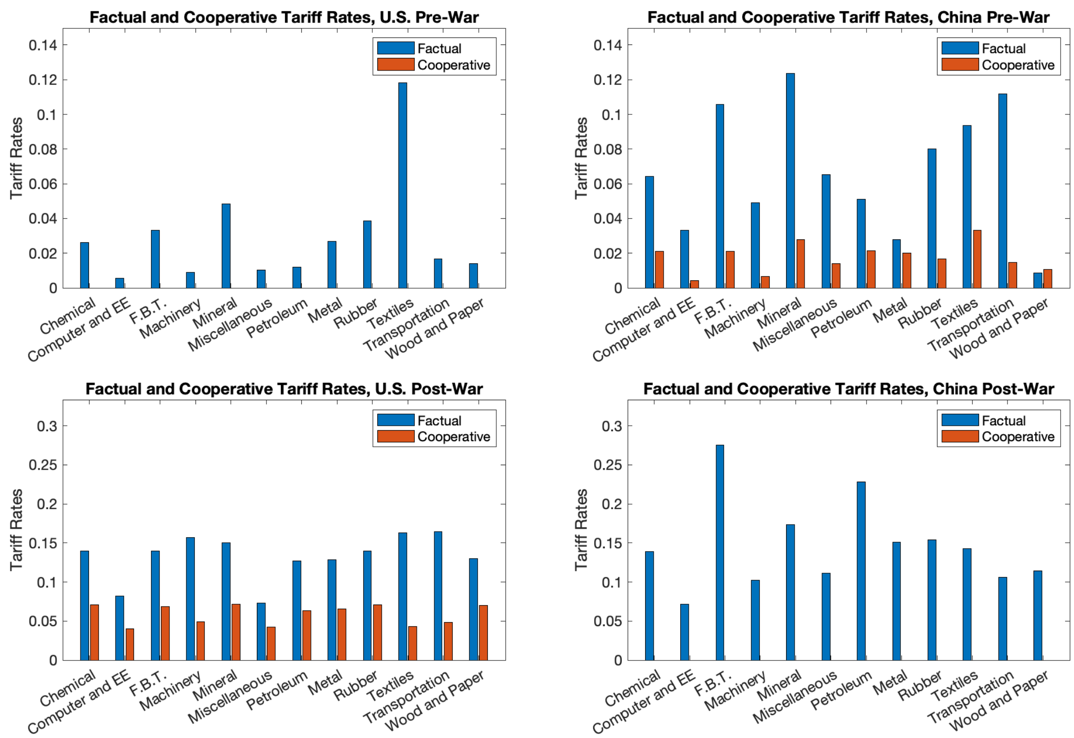


Figure A.3: Cooperative tariffs at the bargaining power of the U.S. against China $\psi_{US-CHN} = 1.00$

Notes: We set the bargaining power of the U.S. against China at $\psi_{US-CHN} = 1.00$. The upper panel displays the factual tariff rates in 2017 and the cooperative tariffs of the U.S. and China against each other predicted by the model in the prewar scenario. The bottom panel shows the factual tariff rates by December 31, 2019 and the cooperative tariffs of the two countries against each other predicted by the model in the post-war scenario.

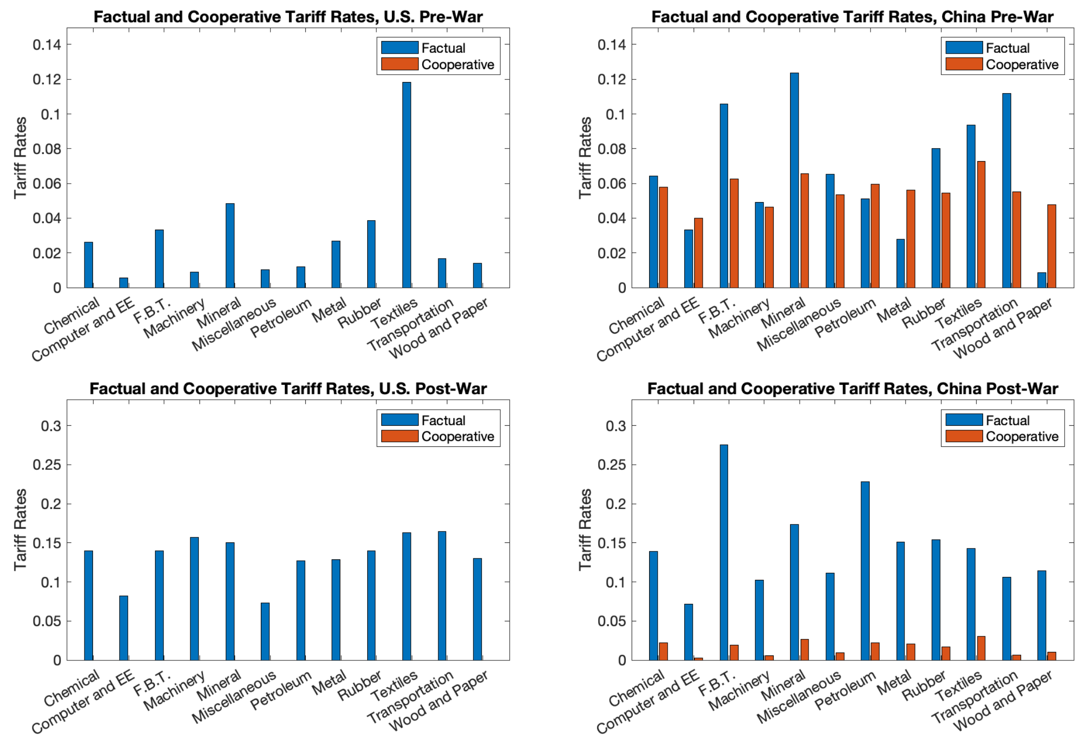


Figure A.4: Cooperative tariffs at the estimated bargaining power of the U.S. against China $\hat{\psi}_{US-CHN} = 0.47$

Notes: We set the bargaining power of the U.S. against China at the estimate $\hat{\psi}_{US-CHN} = 0.47$. The upper panel displays the factual tariff rates in 2017 and the cooperative tariffs of the U.S. and China against each other predicted by the model in the prewar scenario. The bottom panel shows the factual tariff rates by December 31, 2019 and the cooperative tariffs of the two countries against each other predicted by the model in the post-war scenario.

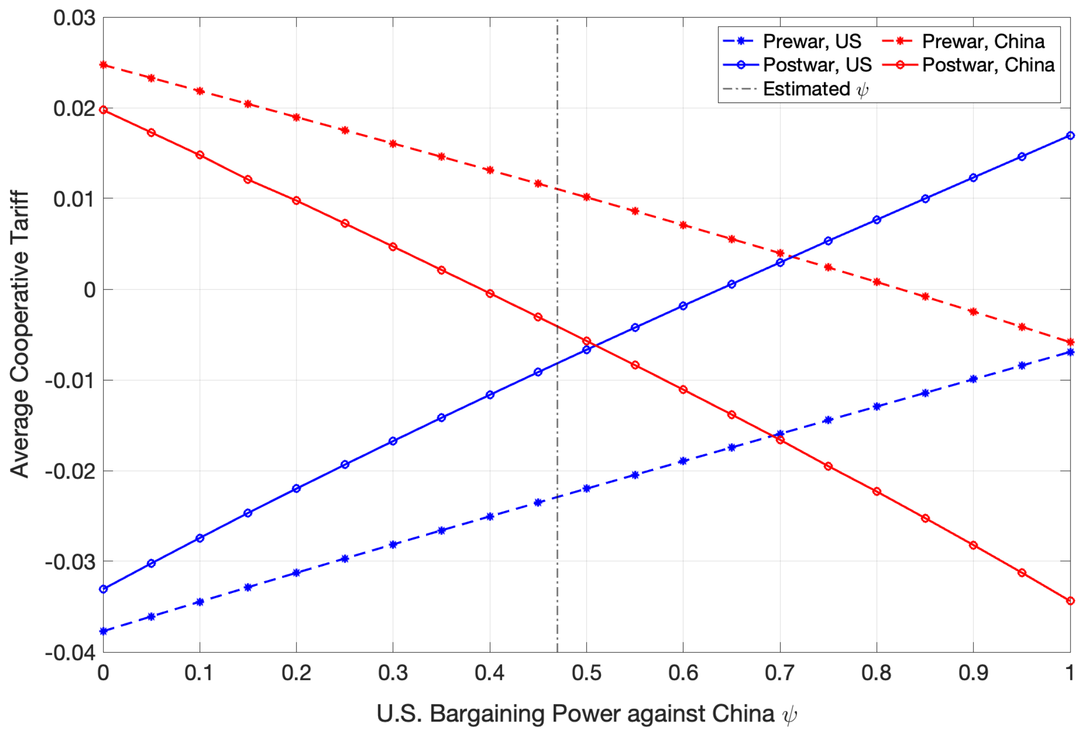
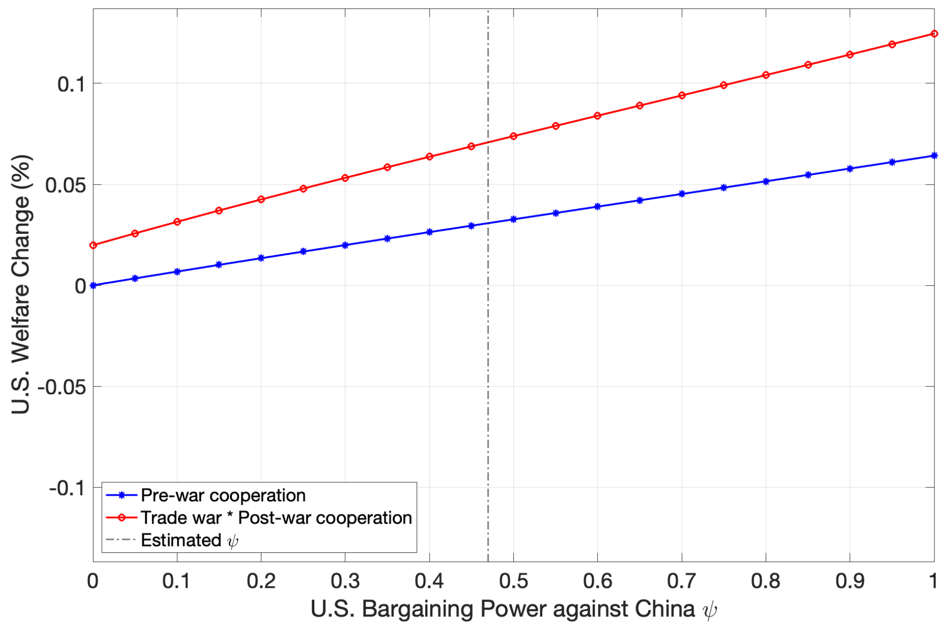
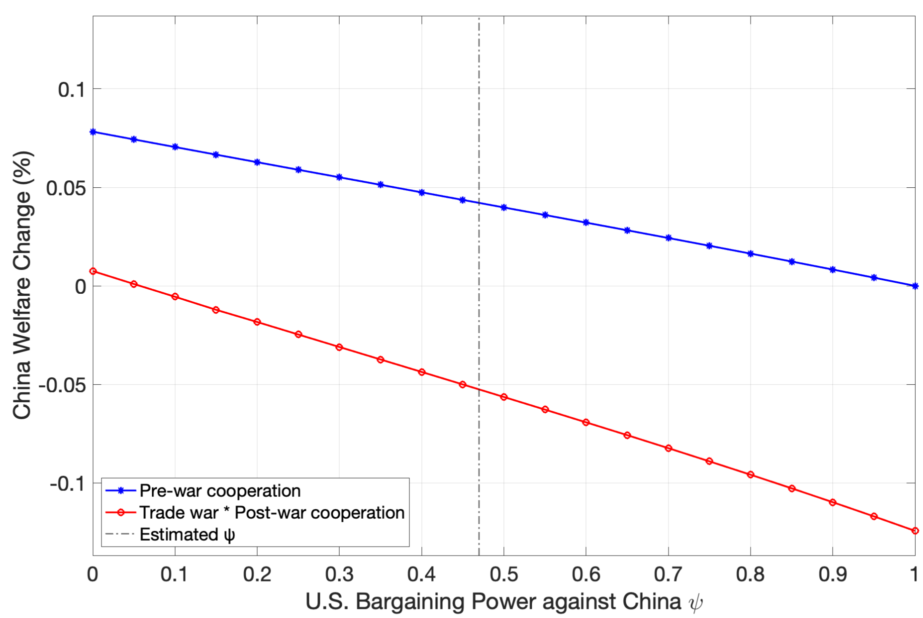


Figure A.5: Average cooperative tariffs for different bargaining powers of the U.S. against China, allowing for subsidies

Notes: Subsidies are allowed. We compute the simple average of predicted cooperative tariff across sectors for each country. The dashed asterisk lines refer to the average cooperative tariffs between the U.S. and China in the 2017 pre-war scenario, and the dashed circle lines refer to the average cooperative tariffs between the U.S. and China in 2019 post-war scenario. The blue lines represent the U.S. tariff against China, and the red lines represent China's tariff against the U.S. The vertical dashed dot line indicates the estimated bargaining power of the U.S. against China, $\hat{\psi} = 0.47$.



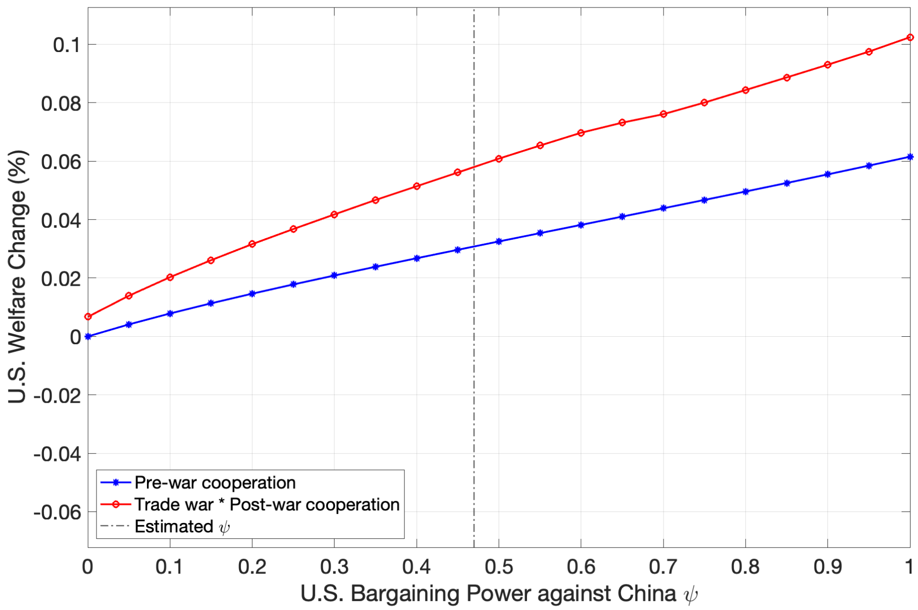
(a) U.S. welfare change



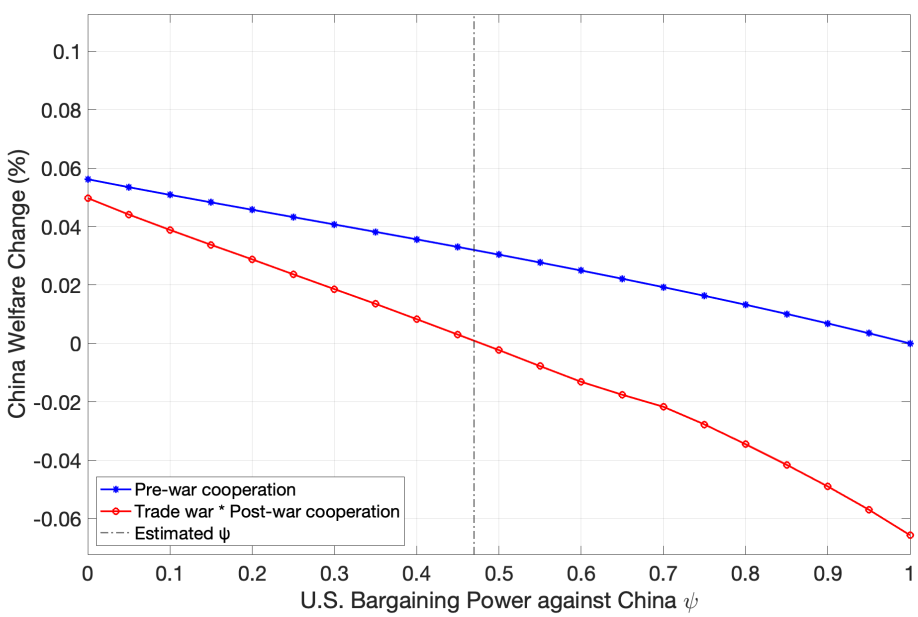
(b) China welfare change

Figure A.6: Welfare changes for different bargaining powers of the U.S. against China, allowing for subsidies

Notes: Subsidies are allowed. The solid asterisk blue lines refer to the welfare changes under cooperation between the U.S. and China in the 2017 pre-war scenario, and the solid circle red lines refer to the total welfare changes of post-war cooperation between the U.S. and China relative to pre-war level. The vertical dashed dot line indicates the estimated bargaining power of the U.S. against China, $\hat{\psi} = 0.47$.



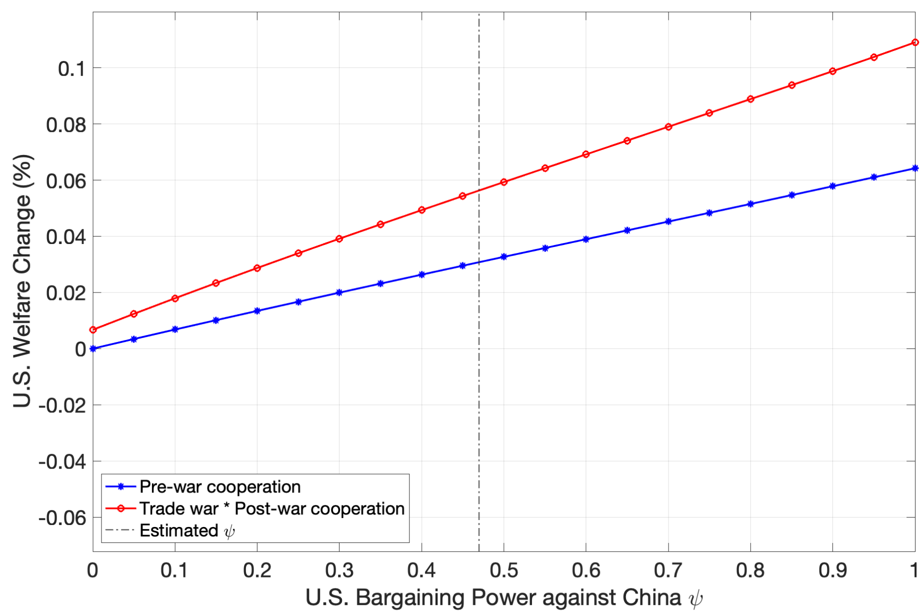
(a) U.S. welfare change



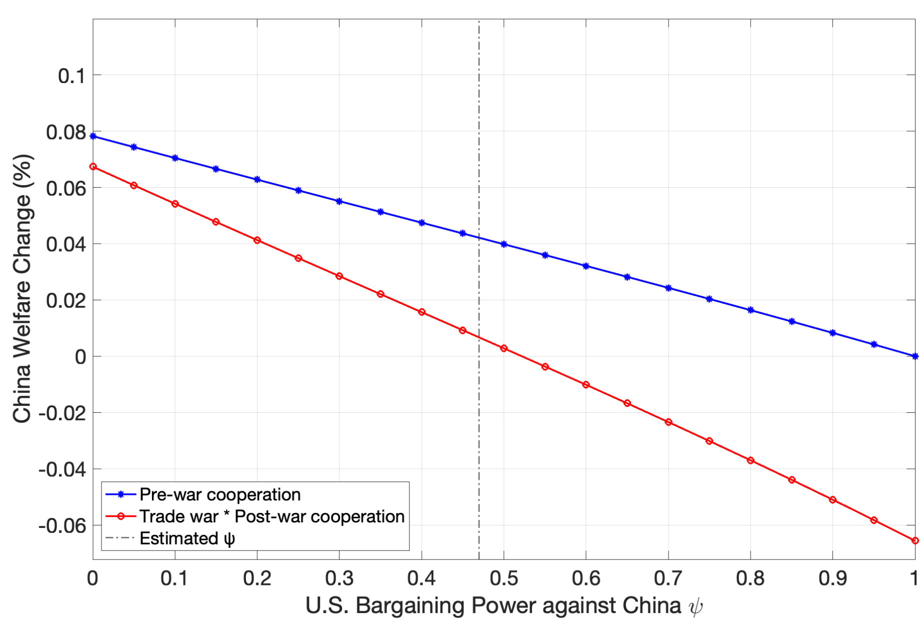
(b) China welfare change

Figure A.7: Welfare changes for different bargaining powers of the U.S. against China, given ROW fixed

Notes: We maintain the fixed bilateral tariffs between the U.S. and ROW, as well as between China and ROW, at the pre-war level of 2017, and only consider the variation of tariffs in the U.S.-China pair during the trade war. The solid asterisk blue lines refer to the welfare changes under cooperation between the U.S. and China in the 2017 pre-war scenario, and the solid circle red lines refer to the total welfare changes of post-war cooperation between the U.S. and China relative to pre-war level. The vertical dashed dot line indicates the estimated bargaining power of the U.S. against China, $\hat{\psi} = 0.47$.



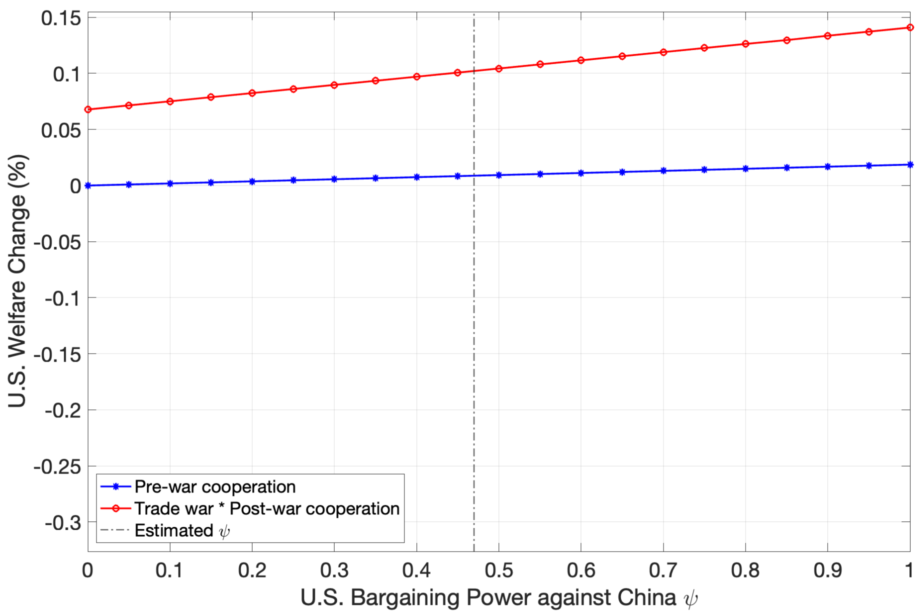
(a) U.S. welfare change



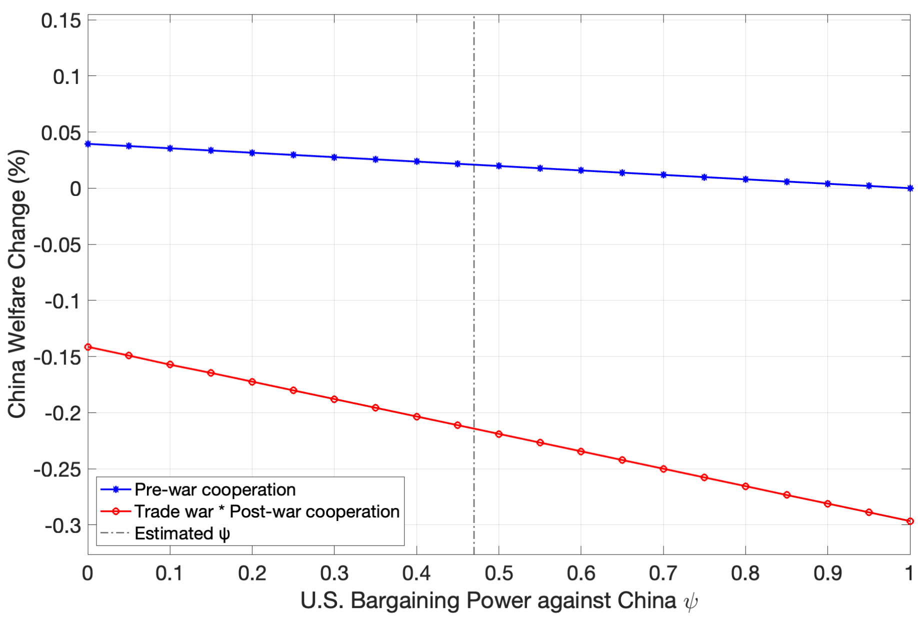
(b) China welfare change

Figure A.8: Welfare changes for different bargaining powers of the U.S. against China, allowing for subsidies and given ROW fixed

Notes: Subsidies are allowed. We maintain the fixed bilateral tariffs between the U.S. and ROW, as well as between China and ROW, at the pre-war level of 2017, and only consider the variation of tariffs in the U.S.-China pair during the trade war. The solid asterisk blue lines refer to the welfare changes under cooperation between the U.S. and China in the 2017 pre-war scenario, and the solid circle red lines refer to the total welfare changes of post-war cooperation between the U.S. and China relative to pre-war level. The vertical dashed dot line indicates the estimated bargaining power of the U.S. against China, $\hat{\psi} = 0.47$.



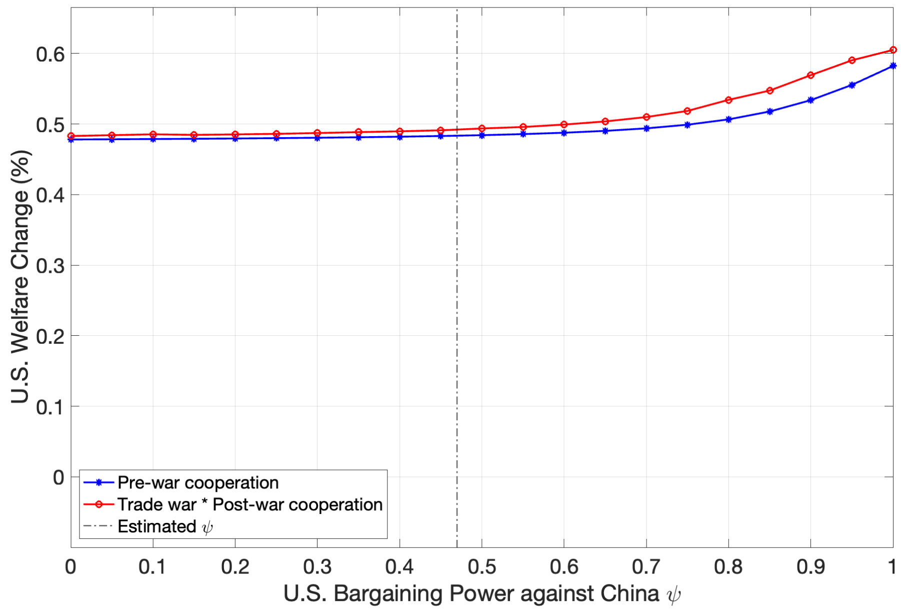
(a) U.S. welfare change



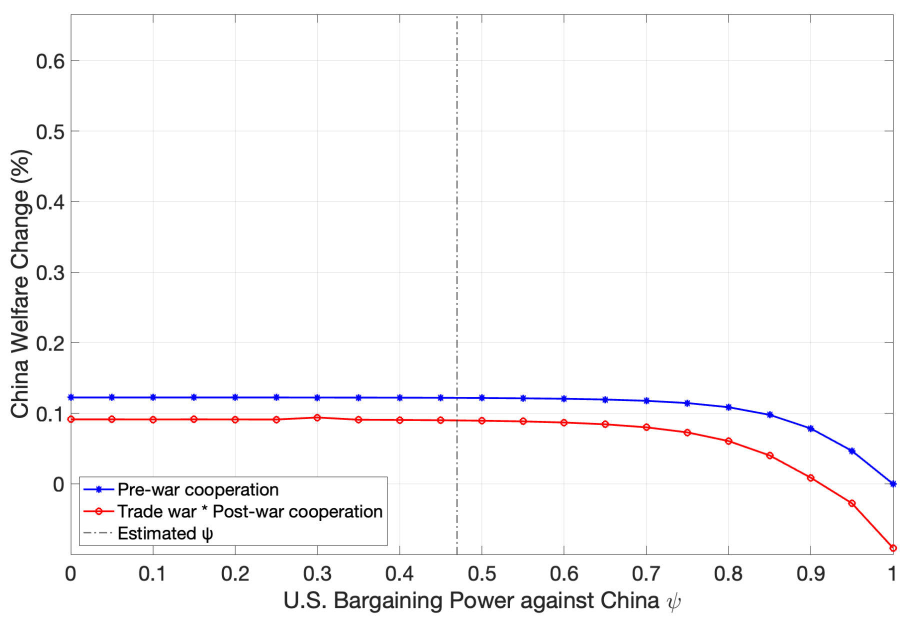
(b) China welfare change

Figure A.9: Welfare changes for different bargaining powers of the U.S. against China, given fixed deficit at the pre-war level

Notes: Trade deficits are fixed at the pre-war level of year 2017. Subsidies are not allowed. We compute the simple average of predicted cooperative tariff across sectors for each country. The dashed asterisk lines refer to the average cooperative tariffs between the U.S. and China in the 2017 pre-war scenario, and the dashed circle lines refer to the average cooperative tariffs between the U.S. and China in 2019 post-war scenario. The blue lines represent the U.S. tariff against China, and the red lines represent China's tariff against the U.S. The vertical dashed dot line indicates the estimated bargaining power of the U.S. against China, $\hat{\psi} = 0.47$.



(a) U.S. welfare change



(b) China welfare change

Figure A.10: Welfare changes for different bargaining powers of the U.S. against China, given Caliendo and Parro (2015) elasticity of substitution

Notes: Estimates of elasticity of substitution are borrowed from Caliendo and Parro (2015). Subsidies are not allowed. We compute the simple average of predicted cooperative tariff across sectors for each country. The dashed asterisk lines refer to the average cooperative tariffs between the U.S. and China in the 2017 pre-war scenario, and the dashed circle lines refer to the average cooperative tariffs between the U.S. and China in 2019 post-war scenario. The blue lines represent the U.S. tariff against China, and the red lines represent China's tariff against the U.S. The vertical dashed dot line indicates the estimated bargaining power of the U.S. against China, $\hat{\psi} = 0.47$.