Trade Wars and Industrial Policy along the Global Value Chains

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Abstract

We provide a quantitative evaluation of the welfare impacts of the US-China trade conflict starting in 2018. We first document that the first wave of tariffs on China imposed by the Trump administration targeted China's Industrial Policy rather than Chinese imports. They are concentrated on high tech manufacturing industries emphasized by the Made in China 2025 (MIC 2025) initiative. These industries exhibit strong economies of scale, and have low elasticities of substitution of intermediate inputs. Motivated by these features, we extend the quantitative trade model developed by Caliendo and Parro (2015) by incorporating sectoral external economies of scale and nested-CES input-output linkages. We calibrate the model to 7 major economies and 95 disaggregated industries in 2016 and examine the impacts of the Trumpian tariffs and the "MIC 2025" industrial policy. We find that the "MIC 2025" subsidies actually increase the US welfare and their impact on China is also positive. The direct welfare effects of the Trumpian tariffs are small,-0.008% for China and 0.025% for the US. Finally, we examine the strategic interactions between China and the US in industrial policy, tariffs, and export controls.

Keywords: *Trade War*; *Global Value Chain*; *Substitutability*; *Economies of Scale.*
JEL classification: *F12*; *F13*; *F17*; *F51.*

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1 Introduction

The trade war between China and the United States is profoundly affecting the world trading system. Some recent studies, e.g. Amiti et al (2018) and Fajgelbaum et al (2019), find that the US initiated 2018 trade war (on China and other countries in general) have resulted in significant real income losses for the US economy. This raises some natural questions: What is the motivation of the trade war? Is there any economic justification for the protectionism tariffs implemented by the Trump administration? In this paper, we examine the nature of the Trumpian tariffs and provide a quantitative estimation of the welfare impacts of these tariffs on both China and US.

We first document that the protectionism tariffs initially imposed by the Trump administration are not correlated with the size of the US imports from China. Instead, they are concentrated in a few high-tech manufacturing industries emphasized by the "Made in China 2025" initiative. These suggests that the first wave Trumpian tariffs were aimed at China's industrial policies rather than Chinese imports. We should therefore go beyond the standard trade model and consider the role of industrial policies in evaluating the impact of the China-US trade war.

We then document that the industries listed in the "Made in China 2025" (i) exhibit strong economies of scale, and (ii) have low elasticities of substitution as inputs for other sectors. Motivated by these facts, we extend the quantitative trade model developed by Caliendo and Parro (2015) by incorporating sectoral external economies of scale and nested-CES input-output linkages. We calibrate the model to 7 major economies and 95 disaggregated industries in 2016 and consider the impacts of both the "Made-in-China 2025" industrial policies and the Trumpian tariffs.

Our quantitative analysis reveal some surprising results. First, we show that the Chinese industrial policies in the form of subsidizing the industries listed in the Made-in-China 2025, actually increase the US welfare, independent of the size of the scale effects. This is because the subsidies have resulted in lower costs of the intermediate inputs imported by the US firms. In contrast, the welfare impact of these industrial policies on China's welfare depends on the size of the scale effects in these industries. China's welfare increases if the scale effects are large, but decreases if the scale effects are modest. Second, under China's industrial policies, the Trumpian tariffs more than undo the impact of China's industrial policies on intermediate input costs. As a result, the tariffs lead to welfare loss to the US.

Our quantitative results posed a puzzle? Why China implemented the industrial policies if the impact on its welfare is not clear, and why the US government targeted these policies if they actually reduce costs for US firms and increase US welfare? We think the answer lies at the strategic competition of the two large economies. We show that the "Made-in-China 2025" policies unambiguously increase the scale of the "strategic industries" in

China and reduce the scale of the same industries in the US. And the Trumpian tariffs have the exact opposite effect. Therefore, a better understanding of the current China-US trade war, we should examine more carefully the role of industry scales in shaping an economy's comparative advantage in the long-run.

2 China's "MIC 2025" and the U.S. "Section 301"

Initially announced in 2015, China's "Made in China 2025" program (henceforth MIC2025) set forth a plan to develop certain advanced technology sectors that are deemed essential to the future competitiveness of China's manufacturing industry.[1] These sectors include next-generation information technology, CNC machine tools and robotics, airplane and aerospace, high-tech shipping, advanced railway, new energy vehicles, power equipment, new materials, biotech, and agricultural machinery. We link these ten industries into manufacturing sectors in our data. Table B.1 summarizes the coverage of the "Made-in-China 2025" industries in our data. And in our quantitative exercise, we presumably impose a 10 percent subsidy to these sectors.

Viewing MIC2025 as a set of aggressive and distorting industrial policies, the US government issued the "Section 301" report on April 3, 2018, proposing an additional 25 percent tariff on approximately 50 billion of products from China that are "strategically important to and benefit from" the MIC2025 program and other Chinese industrial policies.[2] The original "Section 301" tariffs included a list of 1,333 eight-digit HS products, which was then revised on June 15. We dub this list of tariff lines as *wave 1.* Tariffs on the first tranche of wave 1 products were implemented on July 6, 2018, while tariffs on the second tranche of wave 1 products were implemented on August 23 of the same year, both of which were at 25 percent. Figure 1 shows that wave 1 only covers a few sectors in our sample. Importantly, these sectors are mostly related to the MIC2025 program.

As a response to China's retaliation against wave 1, an additional $200 billion of Chinese imports, dubbed as the *wave 2* products, was subject to 10 percent additional tariffs since September 24, 2019. This new list covers more than 6,000 eight-digit HS products. As shown in Figure 1, wave 2 substantial expands the list of products subject to additional tariffs.

Wave 3 refers to the event that the Trump administration decided to raise the 10 percent tariff on wave 2 products to 25 percent, on May 10, 2019. Wave 4 covers the 15 percent tariffs on additional Chinese imports of about 110 billion dollars, imposed on September 1, 2019. And Finally Wave 5 covers the rest of about 160 billion Chinese imports on which the

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[1] Notice on Issuing "Made in China 2025" (State Council, Guo Fa [2015] No. 28, issued May 8, 2015).

[2] See the official Section 301 report by the United State Trade Representative Office (henceforth USTR) where MIC2025 is cited for 119 times.

US has scheduled to imposed additional 15 percent tariffs on December 15, 2019. Figure 1 illustrates the escalating feature of Trump's trade war against China.

3 Model

In this section, we build a framework to quantify the transmission of trade conflicts along global value chains, and in particular, how few critical industries shape overall effects of trade war. To this end, we propose a multi-country general equilibrium model featured with sectoral external economies of scale and general CES input-output linkages.

Consider a world with N countries, indexed by i and n, with a mass L_i workers in each i. There are J sectors, indexed by j and s. Workers are immobile across countries but perfectly mobile across sectors. Each sector consists a unit mass of varieties. The representative consumer of country i has a two-tiered nested-CES preference:

$$U_i = \left[\sum_{j=1}^{J} \alpha_i^j \left[\int_0^1 \left[C_i^j(\omega) \right]^{\frac{\sigma_j - 1}{\sigma_j}} d\omega \right]^{\frac{\sigma_j}{\sigma_j - 1} \frac{\rho_C - 1}{\rho_C}} \right]^{\frac{\rho_C}{\rho_C - 1}}, \tag{1}$$

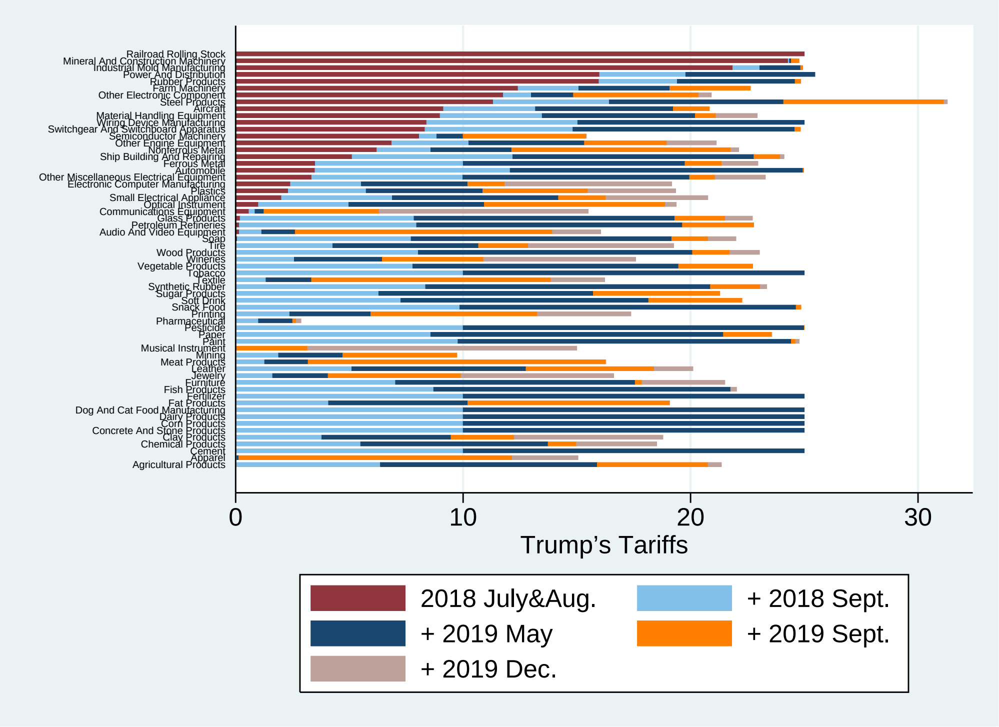
where ρ_C is the elasticity of substitution across final sectors and σ_j is the elasticity of substitution across consumption varieties in sector j. We assume that each variety is produced under perfect competition using labor and composite intermediates.

International trade is subject to three types of trade costs. First, there is an iceberg trade cost τ_{in}^j of shipping goods from i to n, with $\tau_{ii}^j = 1$. Second, there is an *ad valorem* tariff t_{in}^j imposed by importing country n on goods j from country i, with $t_{ii}^j = 0$. Third, there is an *ad valorem* tariff e_{in}^j imposed by exporting country i on goods j from country i, with $e_{ii}^j = 0$.

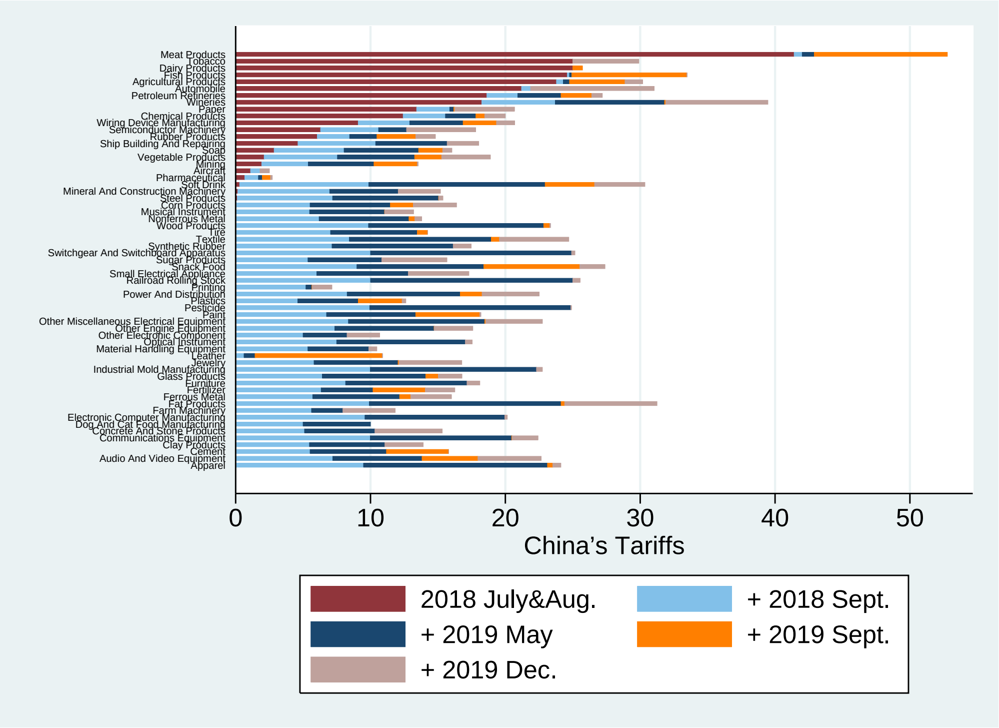
3.1 Technology

We extend the production technology in Caliendo and Parro (2015) in two dimensions: (i) sectoral external economies of scale, and (ii) nested-CES input-output linkages. We summarize our production technology by the following unit cost function: the unit cost of variety ω of intermediate j in country i is $c_i^j(\omega) = \frac{1}{z_i^j(\omega)} c_i^j$ where

$$c_i^j = \frac{1}{\left(L_i^j\right)^{\psi_j}} \left[\left(\beta_i^j\right)^{\rho_j^L} w_i^{1-\rho_j^L} + \left(1 - \beta_i^j\right)^{\rho_j^L} \left(P_i^{Mj}\right)^{1-\rho_j^L} \right]^{\frac{1}{1-\rho_j^L}}, \quad \sum_s \gamma_i^{sj} = 1, \tag{2}$$



(a) U.S. Tariff



(b) Chinese Tariff

Figure 1: The Trump Tariffs and China's Retaliation

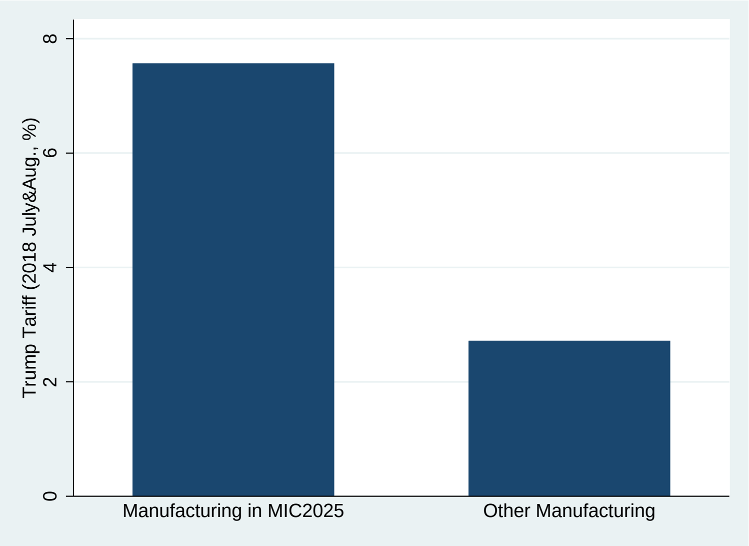


Figure 2: The Trump Tariffs (Wave 1) and "Made-in-China 2025"

where

$$P_i^{Mj} := \left(\sum_{g \in G_i^j} \left[\sum_{s \in g} \left(\gamma_i^{sj}\right)^{\eta_i^{gj}} \left(P_i^s\right)^{1-\eta_i^{gj}} \right]^{\frac{1-\mu_i^j}{1-\eta_i^{gj}}} \right)^{\frac{1}{1-\mu_i^j}} \tag{3}$$

is the price index of composite intermediates for producing good j in country i, and ρ_j^L is the elasticity of substitution between labor and composite intermediates in sector j. Notably, L_i^j is the labor allocated to sector j of country i.

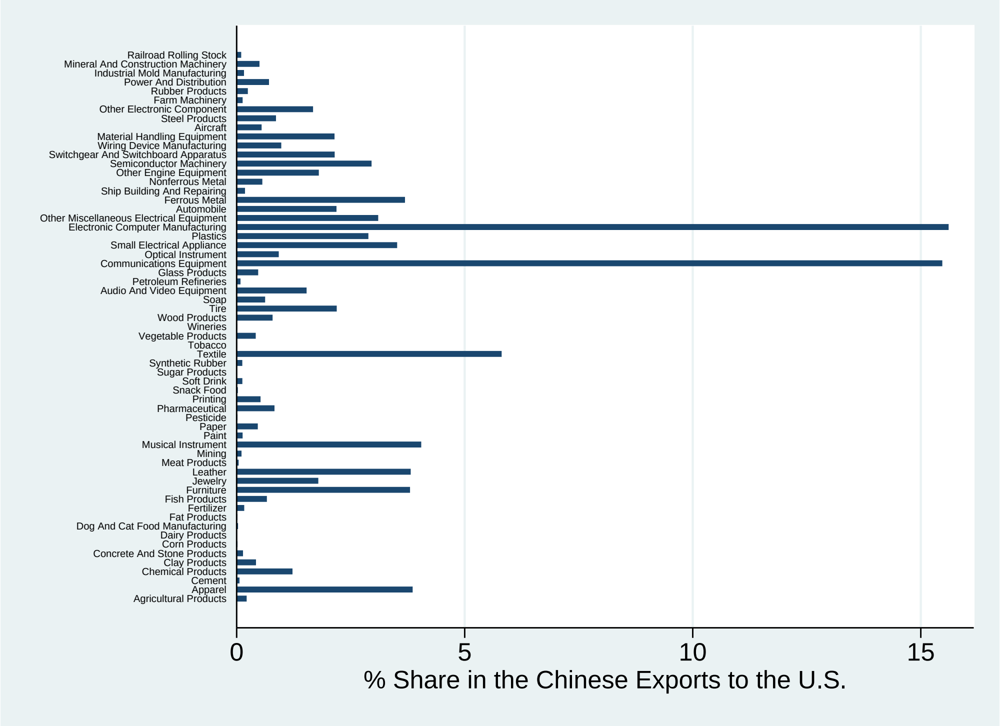
Production exhibits sectoral economies of scale. $\psi_j \geq 0$ characterizes the external economies of scale in sector j.

The nested-CES structure of input-output linkages in Equation (2) allows flexible substitutability across sectors in producing downstream goods. For downstream sector j in country i, its inputs are partitioned into groups $g \in G_i^j$. We denote P_i^s as the price index of good s in country i, η_i^{gj} as the elasticity of substitution within group g for producing good j in country i, and μ_i^j as the elasticity of substitution across groups for producing good j in country i. If $\eta_i^{gj} \geq \mu_i^j$ for all (i, j, g), then intermediates are more substitutable within each group than across groups.

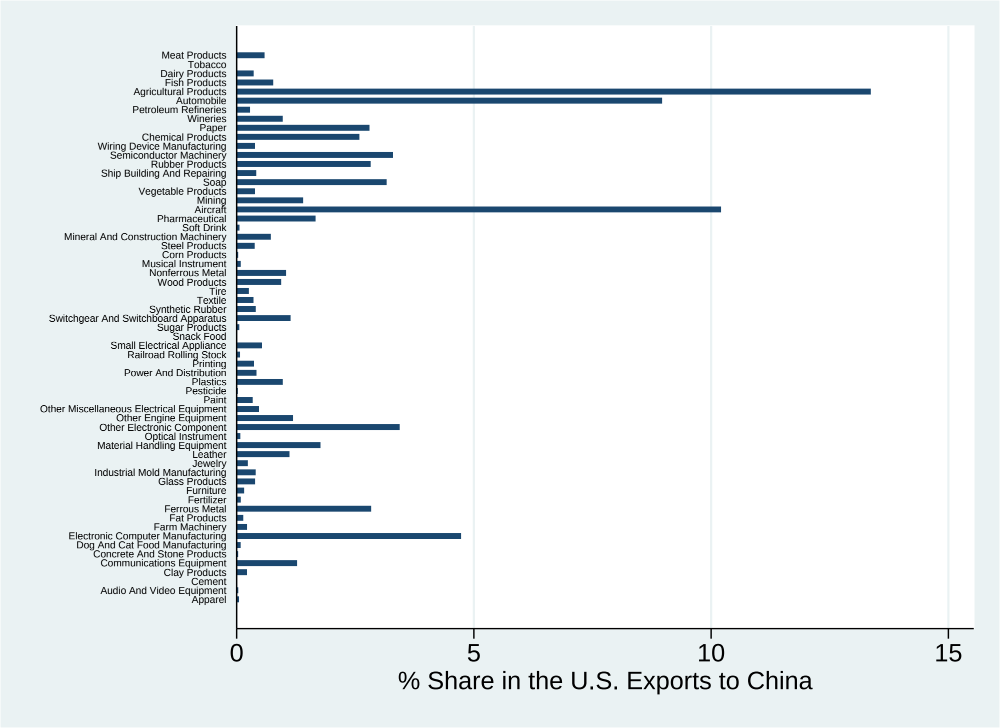
The Hicks-neutral productivity $z_i^j(\omega)$ is drawn independently from the following Frechet distribution:

$$Pr\left[z_i^j(\omega) \leq z\right] = \exp\left\{-T_i^j z^{-\theta_j}\right\}, \quad z > 0, \quad \theta_j > \max\{\sigma_j - 1, 1\}, \tag{4}$$

where T_i^j characterizes the average productivity of sector j in country i and θ_j characterizes the dispersion of productivities in sector j.

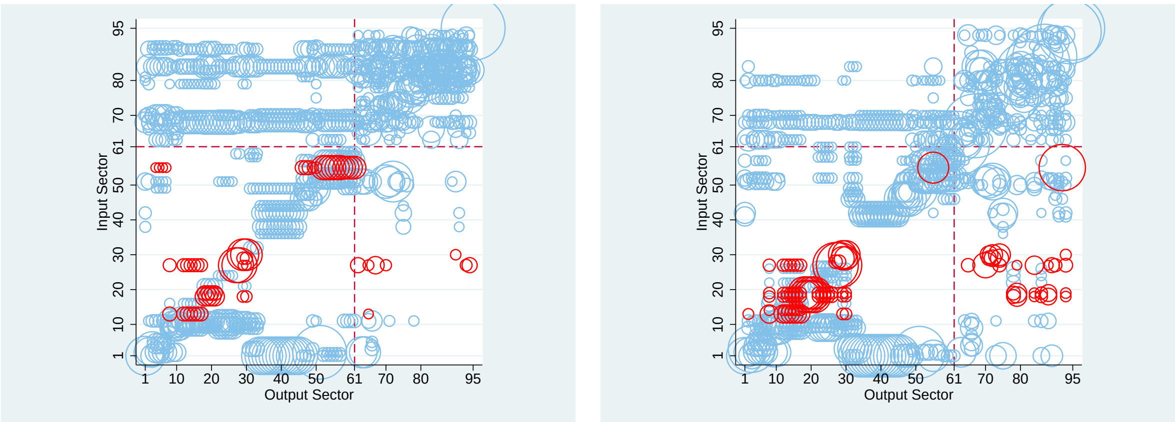


(a) Chinese Exports to the U.S.



(b) U.S. exports to China

Figure 3: US-China Trade before Recent Trade Conflicts



(a) U.S.

(b) China

Figure 4: IO Linkages in the U.S. and China

3.2 Equilibrium

In this subsection, we characterize the aggregate economy and define the equilibrium. Based on the property of Frechet distribution and the ideal price index of CES preferences, the sectoral price index can be expressed as

$$P_n^j = \left[\sum_{i=1}^{N} T_i^j \left[c_i^j \tau_{in}^j \left(1 + t_{in}^j\right) \left(1 + e_{in}^j\right) \right]^{-\theta_j} \right]^{-\frac{1}{\theta_j}}. \tag{5}$$

Following Eaton and Kortum (2002), the expenditure share of country n on good j from country i is given by

$$\pi_{in}^j = \frac{X_{in}^j}{X_n^j} = \frac{T_i^j \left[c_i^j \tau_{in}^j \left(1 + t_{in}^j\right) \left(1 + e_{in}^j\right) \right]^{-\theta_j}}{\left(P_n^j\right)^{-\theta_j}}. \tag{6}$$

Sectoral employment satisfies:

$$w_i L_i^j = \frac{\left(\beta_i^j\right)^{\rho_j^L} \left(w_i\right)^{1-\rho_j^L}}{\left(\beta_i^j\right)^{\rho_j^L} \left(w_i\right)^{1-\rho_j^L} + \left(1 - \beta_i^j\right)^{\rho_j^L} \left(P_i^{Mj}\right)^{1-\rho_j^L}} \sum_{n=1}^{N} \frac{X_{in}^j}{\left(1 + t_{in}^j\right) \left(1 + e_{in}^j\right)}. \tag{7}$$

Then wage is determined by labor market clearing:

$$\sum_{j=1}^{J} L_i^j = L_i. \tag{8}$$

We assume that export tariffs, if there are any, are collected before import tariffs. Therefore, the total income is given by

$$Y_i = w_i L_i + \sum_{j=1}^{J} \sum_{n=1}^{N} \frac{e_{in}^j}{1+e_{in}^j} X_{in}^j + \sum_{j=1}^{J} \sum_{k=1}^{N} \frac{t_{ki}^j}{\left(1+t_{ki}^j\right)\left(1+e_{ki}^j\right)} X_{ki}^j. \tag{9}$$

The aggregate price index for final consumption goods can be expressed as

$$P_n = \left[\sum_{j=1}^{J} \left(\alpha_n^j\right)^{\rho_C} \left(P_n^j\right)^{1-\rho_C} \right]^{\frac{1}{1-\rho_C}}. \tag{10}$$

Finally, the sectoral expenditure can be expressed by

$$X_i^j = \left(\alpha_i^j\right)^{\rho_C} \left(\frac{P_i^j}{P_i}\right)^{1-\rho_C} Y_i + \sum_{s=1}^{J} \frac{\left(1-\beta_i^s\right)^{\rho_s^L} \left(P_i^{Ms}\right)^{1-\rho_s^L}}{\left(\beta_i^s\right)^{\rho_s^L} \left(w_i^j\right)^{1-\rho_s^L} + \left(1-\beta_i^s\right)^{\rho_s^L} \left(P_i^{Ms}\right)^{1-\rho_s^L}} \frac{\left(\gamma_i^{js}\right)^{\eta_i^{gs}} \left(P_i^j\right)^{1-\eta_i^{gs}}}{\sum_{j' \in g} \left(\gamma_i^{j's}\right)^{\eta_i^{gs}} \left(P_i^{j'}\right)^{1-\eta_i^{gs}}}$$

$$\times \frac{\left[\sum_{j' \in g} \left(\gamma_i^{j's}\right)^{\eta_i^{gs}} \left(P_i^{j'}\right)^{1-\eta_i^{gs}}\right]^{\frac{1-\mu_i^s}{1-\eta_i^{gs}}}}{\left(P_i^{Ms}\right)^{1-\mu_i^s}} \sum_{n=1}^{N} \frac{X_{in}^s}{\left(1+t_{in}^s\right)\left(1+e_{in}^s\right)}. \tag{11}$$

Definition 1 (Equilibrium) *Given parameters* $\left(\theta_j, \psi_j, \rho^C, \rho_j^L, \alpha_i^j, \beta_i^j, \gamma_i^{js}, \eta_i^{gj}, \mu_i^j; L_i, e_{in}^j, t_{in}^j, T_i^j, \tau_{in}^j\right)$, *the equilibrium consists of* $\left(w_i^j, L_i^j, P_i^j, X_i^j\right)$ *such that*

1. *Price indices* (P_n^j) *are given by Equation (5).*
2. *Sectoral labor allocation satisfies Equation (7).*
3. *Wage is pinned down by Equation (8).*
4. *Sectoral good market clearing holds as in Equation (11).*

3.3 Equilibrium in Relative Changes

Definition 1 establishes a system of $4NJ$ nonlinear equations in the $4NJ$ unknowns which can be solved given a numeraire. A challenge is that this system depends on the set of parameters $\left(T_i^j, \tau_{in}^j\right)$ which are difficult to calibrate.

To address this problem, we compute the changes of equilibrium outcomes with respect to tariff changes using the "exact-hat" algebra developed by Dekle, Eaton, and Kortum (2008). We denote the value of any variable Z after change as Z' and $\hat{Z} = Z'/Z$.

We first introduce some notations that will be used for the "exact-hat" algebra. Let $\tilde{\alpha}_j := \frac{\alpha_j^{\rho_C} P_j^{1-\rho_C}}{\sum_{j'=1}^{J} \alpha_{j'}^{\rho_C} P_{j'}^{1-\rho_C}}$ be the consumption share. Let $\tilde{\beta}_s = \frac{\beta_s^{\rho_s^L}}{\beta_s^{\rho_s^L} + \left(1-\beta_s^{\rho_s^L}\right)(P_s^M)^{1-\rho_s^L}}$ be the value-added share. Let χ_i^{gj} be the input expenditure share on group g for producing good j in country i, and $\tilde{\gamma}_i^{sj}$ be the input expenditure share of sector s within group g for all $s \in g$.

Suppose that we have the values of $\left(\mu_i^j, \eta_i^{gj}, \psi_j, \rho_j^L, \rho^C, \theta_j\right)$. Also we have the data on $\left(X_{in}^j, t_{in}^j, e_{in}^j, \tilde{\alpha}_i^j, \tilde{\beta}_i^j, \chi_i^{gj}, \tilde{\gamma}_i^{sj}\right)$. Then we can compute the equilibrium changes, $\left(\hat{w}_i^j, \hat{L}_i^j, \hat{P}_i^j, \hat{X}_i^j\right)$, by solving a system of $4NJ$ nonlinear equations. The details of the equation system are presented in the Appendix A.1.

3.4 Decomposing Welfare Effects of Trade Wars

We proceed by discussing how important it is to account sectoral external economies of scale and nested-CES IO linkages to quantify welfare effects from tariff changes. In particular, we decompose welfare gains from trade into three parts: (i) gains from being able to consume foreign goods; (ii) gains from changes in intermediate inputs prices; and (iii) gains from changes in sectoral size.

For any variable y, we denote the level of y after tariff changes as y' and let $\hat{y} = y'/y$. Then we have the following results:

Proposition 2 (Decomposing Welfare Effects from Tariff Changes) *Suppose that $\rho_C = \rho_j^L = 1$. Then changes in the real wage income with respect to tariff changes are*

$$\log\left(\frac{\widehat{\sum_{j=1}^{J} w_i^j L_i^j}}{\hat{P}_i}\right) = \sum_{j=1}^{J} \alpha_i^j \left[\underbrace{-\frac{1}{\theta_j}\log\left(\hat{\pi}_{ii}^j\right)}_{\textit{Final Goods}} + \underbrace{\frac{\psi_j}{\beta_i^j}\log\left(\hat{L}_i^j\right)}_{\textit{Scale Economy}} \underbrace{-\frac{1-\beta_i^j}{\beta_i^j}\left(\log\hat{\Xi}_i^j + \frac{1}{\theta_j}\log\left(\hat{\pi}_{ii}^j\right)\right)}_{\textit{Intermediates}}\right], \tag{12}$$

where the sectoral linkages are summarized by

$$\hat{\Xi}_i^j = \left(\sum_{g \in G_i^j} \chi_i^{gj} \left[\sum_{s \in g} \tilde{\gamma}_i^{sj} \left(\frac{\hat{P}_i^s}{\hat{P}_i^j}\right)^{1-\eta_i^{gj}}\right]^{\frac{1-\mu_i^j}{1-\eta_i^{gj}}}\right)^{\frac{1}{1-\mu_i^j}}. \tag{13}$$

The first term on the right-hand-side of Equation (12) is the standard sufficient statistic for the welfare gains from trade figured out by Arkolakis, Costinot, and Rodriguez-Clare (2012). It captures welfare gains from being able to access more foreign varieties.

$\hat{\Xi}_i^j$ captures the welfare effects of IO linkages. Notice that it depends not only on the observed expenditure shares, say δ_i^{gj} and χ_i^{sj}, but also on the elasticities of substitution across sectors, i.e. η_i^{gj} and μ_i^j. Under small μ_i^j, the price changes in group g could be magnified into large welfare changes, even if the expenditure share δ_i^{gj} is small. This captures an important feature of high-tech industries such as semi-conductors: their shares in total input expenditure may not be substantial during the period without trade wars, but can rise dramatically when protectionism tariffs are imposed.

The economies of scale depend crucially on parameters $(\psi_j)_{j=1}^J$. For sectors with large ψ_j, small changes in the sectoral sizes could lead to large productivity and welfare effects. Notice that producers do not internalize their impacts on sector sizes. So there is room for the government of each country to manipulate its own and other countries' sectoral sizes.

3.5 A First-Order Approximation of Welfare Effects

In this subsection, we investigate how trade shocks transmit via input-output linkages. It is difficult to characterize multi-country equilibrium due to the complexity of terms-of-trade effects. However, Baqaee and Farhi (2019) have established the duality between shocks iceberg trade costs in the open economy and shocks to productivities in the close economy. Therefore, to understand the transmission of trade shocks, we can explore the impacts of sectoral productivity shocks in a close economy.

In particular, we set $N = 1$ and $t_{ii}^j = e_{ii}^j = 0$ for all j. For simplicity, we assume that $\mu^j = \eta^{gj}$ for all j and g. We take wage as the numeraire. For convenience, in this subsection, we omit the country subscript and denote sector in the subscript. The equilibrium system can then be expressed as

$$L_j\left[1+\left(\frac{1-\beta_j}{\beta_j}\right)^{\rho_j^L}\left(P_j^M\right)^{1-\rho_j^L}\right]=\frac{\alpha_j^{\rho_C}P_j^{1-\rho_C}}{\sum_{j'=1}^J\alpha_{j'}^{\rho_C}P_{j'}^{1-\rho_C}}L+\sum_{s=1}^J\frac{1-\beta_s^{\rho_s^L}}{\beta_s^{\rho_s^L}}\left(P_s^M\right)^{1-\rho_s^L}\frac{\gamma_{js}^{\mu_s}P_j^{1-\mu_s}}{\sum_{j'=1}^J\gamma_{j's}^{\mu_s}P_{j'}^{1-\mu_s}}L_s, \tag{14}$$

where $P_s^M := \left(\sum_{j'=1}^J\gamma_{j's}^{\mu_s}P_{j'}^{1-\mu_s}\right)^{\frac{1}{1-\mu_s}}$. And

$$P_j = T_j^{-\frac{1}{\theta_j}}L_j^{-\psi_j}\left(\sum_{s=1}^J\gamma_{sj}^{\mu_j}P_s^{1-\mu_j}\right)^{\frac{1-\beta_j}{1-\mu_j}}. \tag{15}$$

Now we investigate how shocks on $(T_j)_{j=1}^J$ affect equilibrium prices and labor allocation.

Let $\delta_{sj} := \frac{\gamma_{sj}^{\mu_j}P_s^{1-\mu_j}}{\sum_{s'=1}^J\gamma_{s'j}^{\mu_j}P_{s'}^{1-\mu_j}}$ be the intermediate expenditure share and $\mathbf{\Sigma} = [\Sigma_{js}] := \left[\left(1-\tilde{\beta}_j\right)\delta_{sj}\right]$.

Let $\mathbf{A} = [\tilde{\alpha}_j]$ be the $J \times 1$ vector of consumption shares.

Let $\mathbf{\Psi}$ be the $J \times J$ diagonal matrix whose diagonal is $[\psi_j]$, the sectoral economies of scale. Let $\mathbf{\Lambda}$ be the $J \times J$ diagonal matrix whose diagonal is $\left[\frac{1}{\tilde{\beta}_j}\frac{L_j}{L}\right]$, the sectoral expenditure shares.

Let $\mathbf{S}$ be the $J \times J$ diagonal matrix whose diagonal is

$$S_j = \left[(1-\rho_C)\,\tilde{\alpha}_j + \sum_{s=1}^{J} (1-\mu_s)\,\frac{1}{\tilde{\beta}_s}\frac{L_s}{L}\left(1-\tilde{\beta}_s\right)\delta_{js}\right], \tag{16}$$

which is the elasticity of sector j's labor demand on its own price.

Moreover, let $\mathbf{\Omega} = [\Omega_{jj'}]$ where

$$\Omega_{jj'} = (1-\rho_C)\,\tilde{\alpha}_j\tilde{\alpha}_{j'} + \frac{1}{\tilde{\beta}_j}\frac{L_j}{L}\left(1-\tilde{\beta}_j\right)\left(1-\rho_j^L\right)\delta_{j'j} + \sum_{s=1}^{J}\left(\rho_s^L-\mu_s\right)\frac{1}{\tilde{\beta}_s}\frac{L_s}{L}\left(1-\tilde{\beta}_s\right)\delta_{js}\delta_{j's}, \tag{17}$$

which is the cross-sector price elasticity of labor demand.

Let $\tilde{T}_j = T_j^{\frac{1}{\theta_j}}$, $\mathbf{L} = [L_j]$, $\mathbf{P} = [P_j]$, and $\mathbf{e}_j$ is the $J \times 1$ vector with the j-th element as one and zero otherwise.

Proposition 3 *The price effects of sector j's productivity shocks can be expressed as*

$$\frac{d\log\mathbf{P}}{d\log\tilde{T}_j} = -\left[(\mathbf{I}-\mathbf{\Sigma}) + \underbrace{\mathbf{\Psi}\left(\mathbf{\Lambda}-\mathbf{\Sigma}'\mathbf{\Lambda}\right)^{-1}(\mathbf{S}-\mathbf{\Omega})}_{\textit{Amplification of Scale Economies via CES IO Linkages}}\right]^{-1}\mathbf{e}_j. \tag{18}$$

Moreover, the sectoral size effects can be summarized by

$$\frac{d\log\mathbf{L}}{d\log\tilde{T}_j} = -\left(\mathbf{\Lambda}-\mathbf{\Sigma}'\mathbf{\Lambda}\right)^{-1}(\mathbf{S}-\mathbf{\Omega})\left[(\mathbf{I}-\mathbf{\Sigma}) + \mathbf{\Psi}\left(\mathbf{\Lambda}-\mathbf{\Sigma}'\mathbf{\Lambda}\right)^{-1}(\mathbf{S}-\mathbf{\Omega})\right]^{-1}\mathbf{e}_j. \tag{19}$$

Finally, the welfare effects can be given by

$$\frac{d\log W}{d\log\tilde{T}_j} = \mathbf{A}'\left[(\mathbf{I}-\mathbf{\Sigma}) + \mathbf{\Psi}\left(\mathbf{\Lambda}-\mathbf{\Sigma}'\mathbf{\Lambda}\right)^{-1}(\mathbf{S}-\mathbf{\Omega})\right]^{-1}\mathbf{e}_j. \tag{20}$$

By Theorem 3 of Baqaee and Farhi (2019), the sectoral productivity shock in the closed economy can be approximated, to the first-order, by changes in domestic trade shares in response to trade shocks in the dual open economy:

$$d\log\tilde{T}_j = -d\log\pi_{ii}^{j}. \tag{21}$$

Notably, changes in domestic trade share, $d\log\pi_{ii}^{j}$, can be observed directly from trade data before and after trade shocks.

4 Quantification

4.1 Calibration

Guided by the "exact-hat" algebra, we need data on bilateral trade shares $\left(\pi_{in}^{j}\right)$, sectoral consumption shares $\left(\tilde{\alpha}_{i}^{j}\right)$, sectoral value-added shares $\left(\tilde{\beta}_{i}^{j}\right)$, sectoral expenditure (X_{n}^{j}), input expenditure shares δ_{i}^{js}, and the tariff rates $\left(t_{in}^{j}, e_{in}^{j}\right)$, to conduct counterfactual exercises. We need the values of parameters $\left(\mu_{i}^{j}, \eta_{i}^{gj}, \psi_{j}, \rho_{C}, \rho_{j}^{L}, \theta_{j}\right)$.

In our quantification, we consider 7 major economies and 95 industries in the year 2016. These 7 economies are Brazil, China, European Union, India, Japan, the U.S., and the rest of the world. There are 60 manufacturing sectors, 34 service sectors, and the agricultural sector. We obtain bilateral trade flows across 7 economies from UNCOMTRADE and combine these trade flows with sectoral expenditure data in WIOD. We obtain input expenditure share from national IO tables, and tariff rates from the WTO database. The details for data sources and data construction are presented in the appendix.

Parameter	Definition	Value	Source
ρ_C	Elasticity of Sub. across consumption industries	$\rho_C = 1$	ILES
ρ_j^L	Elasticity of Sub. b/w labor and intermediates	$\rho_j^L = 1$	ILES
θ_j	Trade elasticity	Table B.1	Lashkaripour and Lugovskyy (2017)
ψ_j	Sectoral scale economies	Table B.1	Lashkaripour and Lugovskyy (2017)

Table 1: Parameters Calibrated from the Literature

We calibrate sectoral trade elasticities and scale economies as follows. Lashkaripour and Lugovskyy (2017) have utilized the firm-partner-product-level import data in Colombia[3] to jointly estimate trade elasticities and increasing returns to scale in several industries. We map their industries to our 95 industries and calibrate (θ_j, ψ_j) accordingly. The parameter values are summarized in Table B.1.

We follow the "idiots' law of the elasticity of substitution" (ILES) and set $\rho_C = \rho_j^L = 1$ for all j, which are also broadly consistent with recent empirical evidence.

4.2 Estimating (μ_j)

We proceed by specifying our nested-CES IO linkages. Although there is evidence supporting the nested-CES IO linkages, it is difficult to identify the nests and empirically estimate the elasticities of substitution within and between nests. Therefore, in our benchmark setting, we assume that the elasticity of substitution across input sectors is output-industry-specific, i.e. $\mu_i^j = \eta_i^{gj} = \mu_j$ for all (i, g, j). In this specification, Equation (A.2) can be

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[3] The majority of these imports come from the United States.

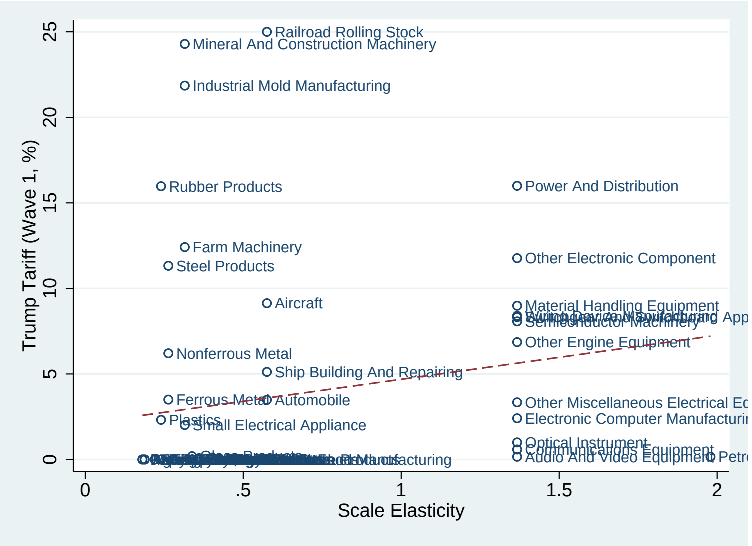


Figure 5: The Trump Tariffs (Wave 1) and Sectoral Economies of Scale

simplified into:

$$\hat{P}_i^{Mj} := \left[\sum_{s=1}^{J} \delta_i^{sj} \left(\hat{P}_i^s \right)^{1-\mu_j} \right]^{\frac{1}{1-\mu_j}}, \tag{22}$$

where δ_i^{sj} is the fraction of industry j's intermediate expenditure on industry s in country i.

To estimate (μ_j), we utilize data from the U.S. BEA's GDP by Industry and Input-Output Accounts data spanning 1997-2017. The main variables that we use are changes in (i) the fraction of industry j's intermediate expenditure on industry s, $\Delta \log \delta_i^{sj}$; (ii) industry s's output price index, $\Delta \log P_i^s$, and (iii) industry j's intermediate input price index, $\Delta \log P_i^{Mj}$.

Based on the definition of δ_i^{sj} and the properties of CES IO linkages, we have:

$$\Delta \log \delta_i^{sj} = (1 - \mu_j) \left(\Delta \log P_i^s - \Delta \log P_i^{Mj} \right) + \epsilon_i^{sj}, \tag{23}$$

where ϵ_i^{sj} is the measurement error.

4.3 Trump Tariffs and China's Industrial Policies

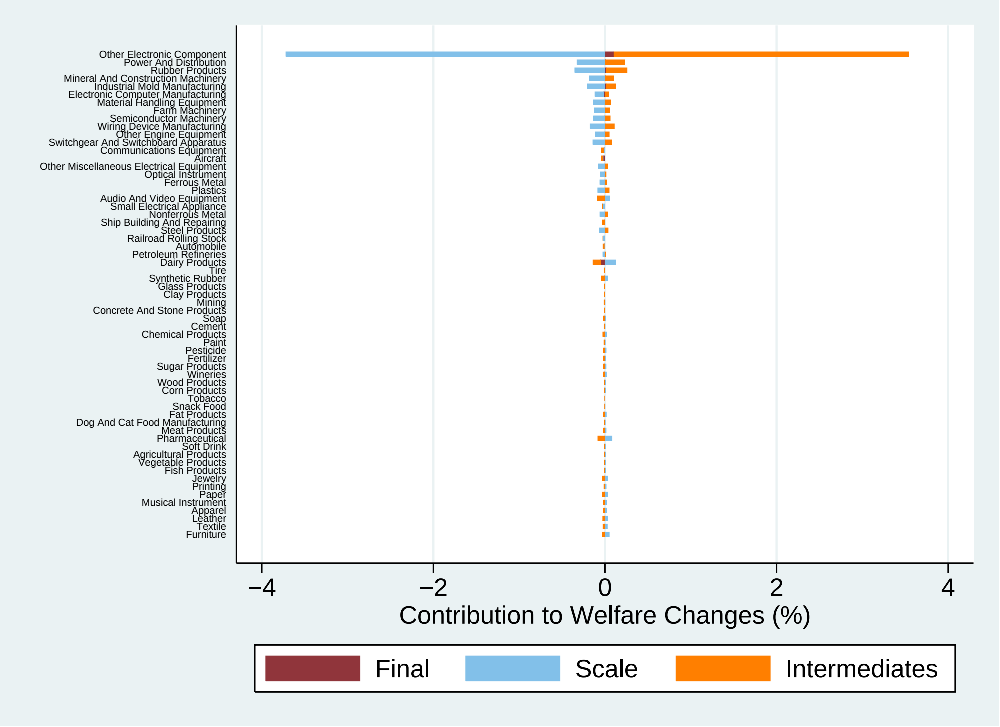
4.4 Nonlinear Welfare Effects of Trade Wars

4.5 A First-Order Approximation of Welfare Effects

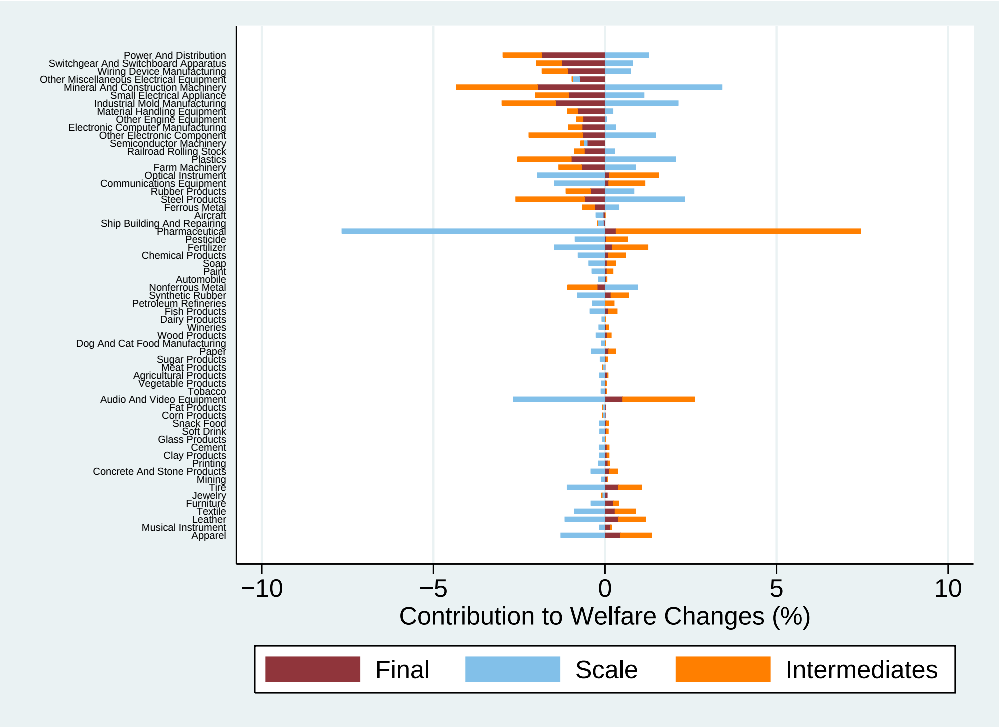
Figure 6: The Trump Tariffs (Wave 1) and Elasticity of Substitution as Inputs

Table 2: Trump Tariffs (Wave 1) and "Made-in-China 2025"

	China							
%Δ in:	Welfare	Real Wage	Final Goods		Scale		Intermediates	
			Goods	Services	Goods	Services	Goods	Services
Trump Wave 1	-0.139	-0.136	-0.003	-0.001	-0.139	-0.001	0.063	-0.055
MIC 2025	1.582	4.280	-0.214	0.002	3.544	-0.005	-4.786	1.234
Both	1.450	4.148	-0.217	0.001	3.405	-0.006	-4.722	1.182
MIC under Trump Wave 1	1.591	4.291	-0.214	0.002	3.549	-0.005	-4.781	1.238
Trump Wave 1 under MIC	-0.130	-0.126	-0.004	-0.001	-0.134	-0.001	0.068	-0.051
	U.S.							
%Δ in:	Welfare	Real Wage	Final Goods		Scale		Intermediates	
			Goods	Services	Goods	Services	Goods	Services
Trump Wave 1	-0.429	-0.842	-0.350	0.013	0.131	-0.004	-0.290	-0.343
MIC 2025	0.017	0.017	0.103	-0.001	-0.528	0.000	0.431	0.012
Both	-0.411	-0.902	-0.288	0.013	-0.345	-0.004	0.083	-0.360
MIC under Trump Wave 1	0.018	-0.060	0.062	0.000	-0.476	0.000	0.374	-0.017
Trump Wave 1 under MIC	-0.428	-0.919	-0.391	0.014	0.184	-0.004	-0.347	-0.371

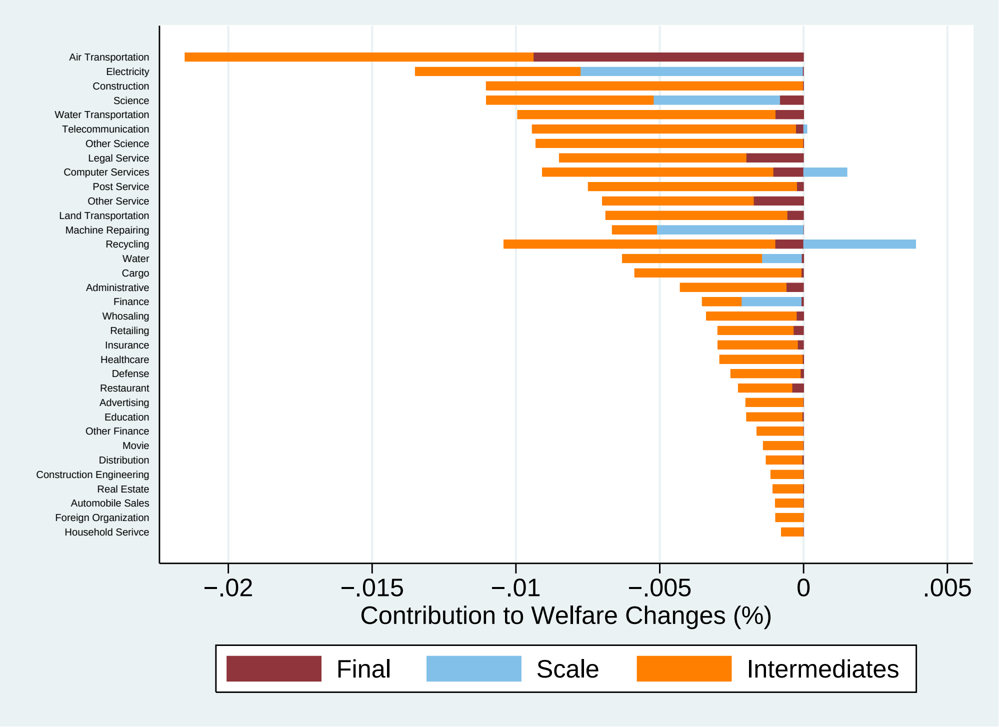


(a) China

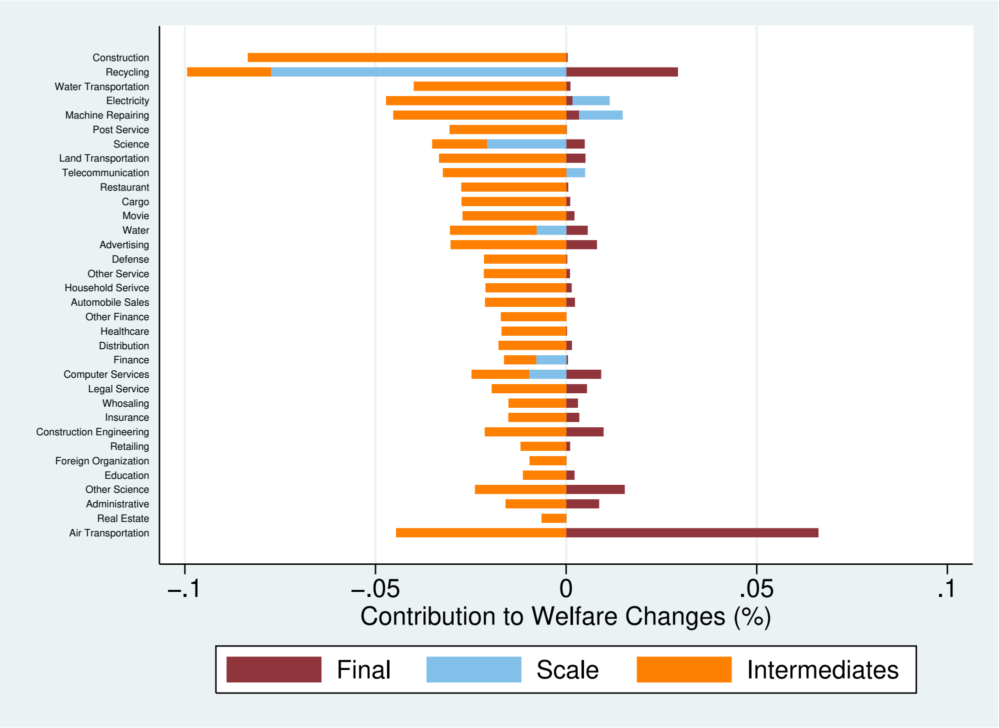


(b) U.S.

Figure 7: The Impacts of Trump Tariffs (Wave 1) on Goods Sectors

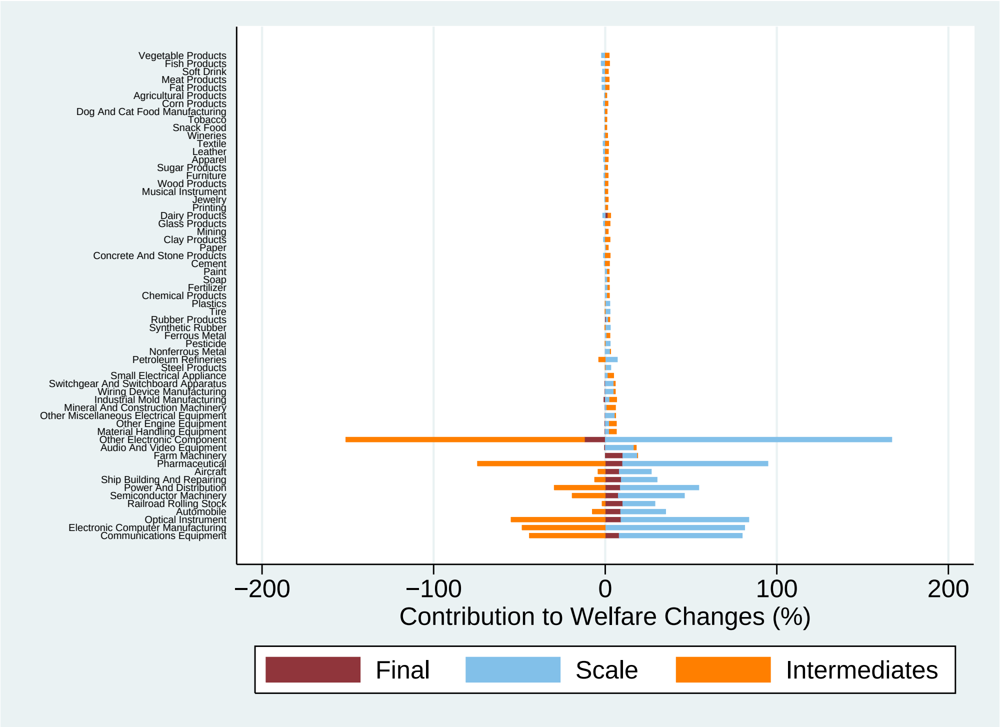


(a) China

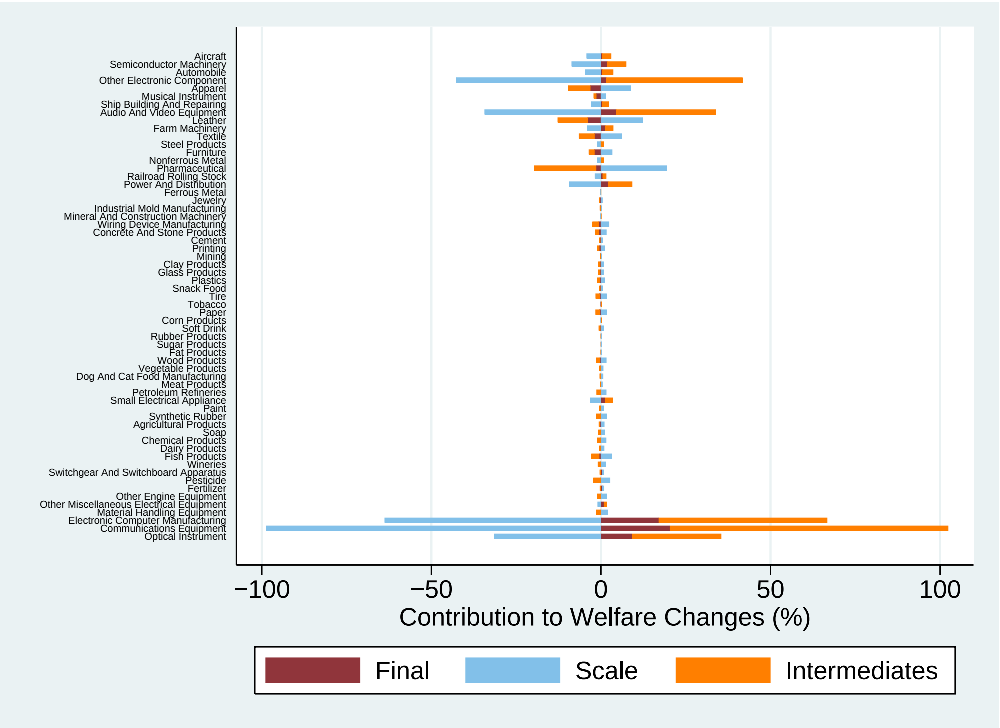


(b) U.S.

Figure 8: The Impacts of Trump Tariffs (Wave 1) on Service Sectors

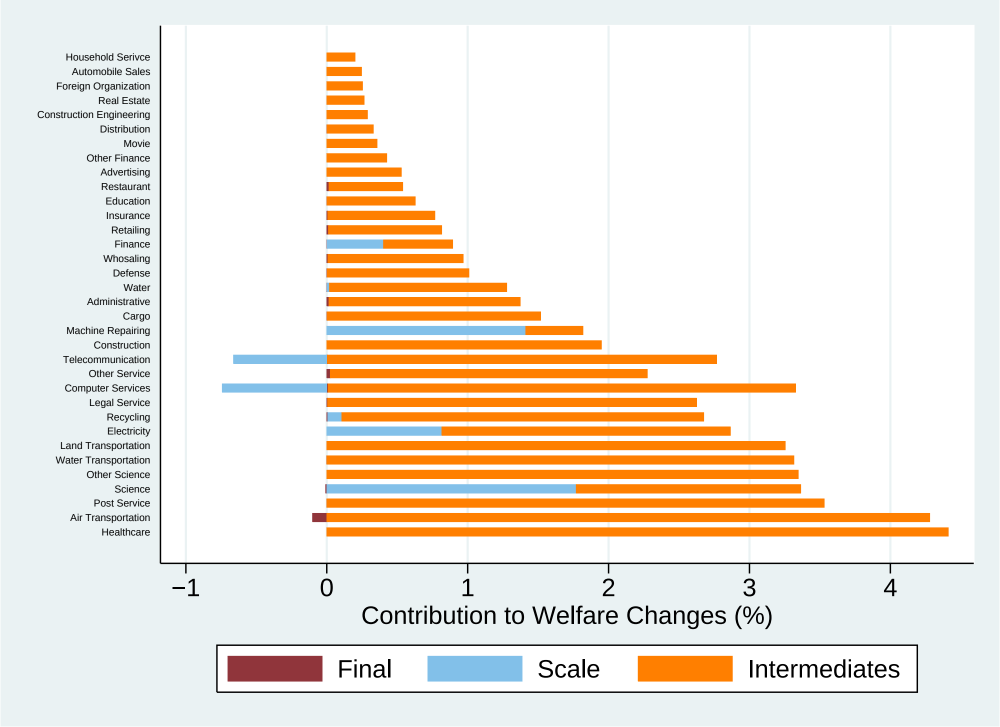


(a) China

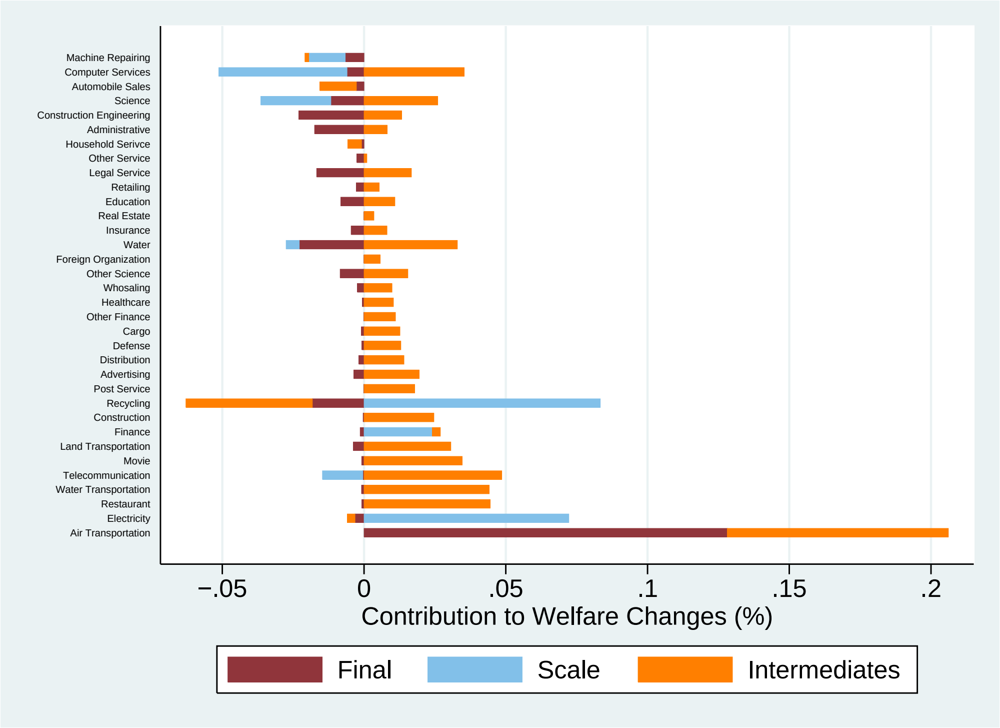


(b) U.S.

Figure 9: The Impacts of “Made in China 2025” on Goods Sectors

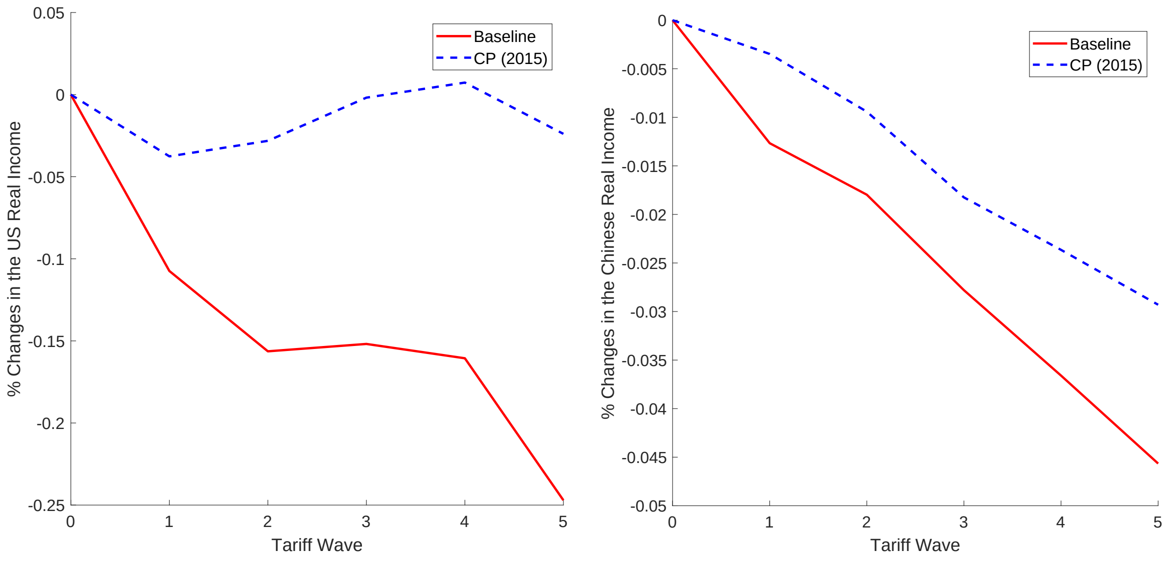


(a) China

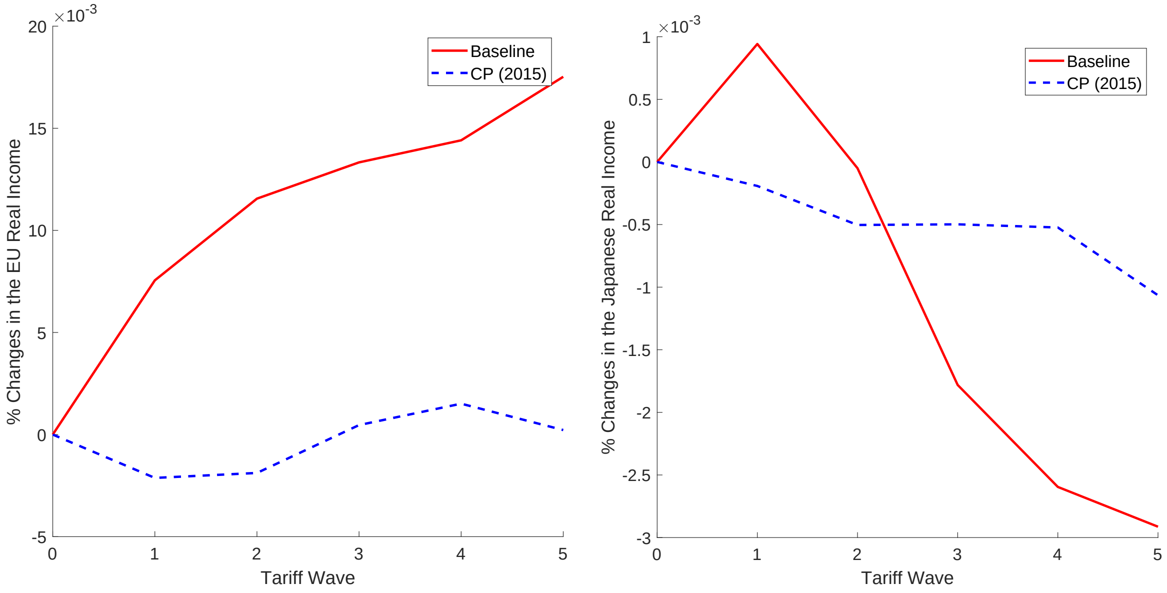


(b) U.S.

Figure 10: The Impacts of “Made in China 2025” on Service Sectors



(a) U.S. (b) China

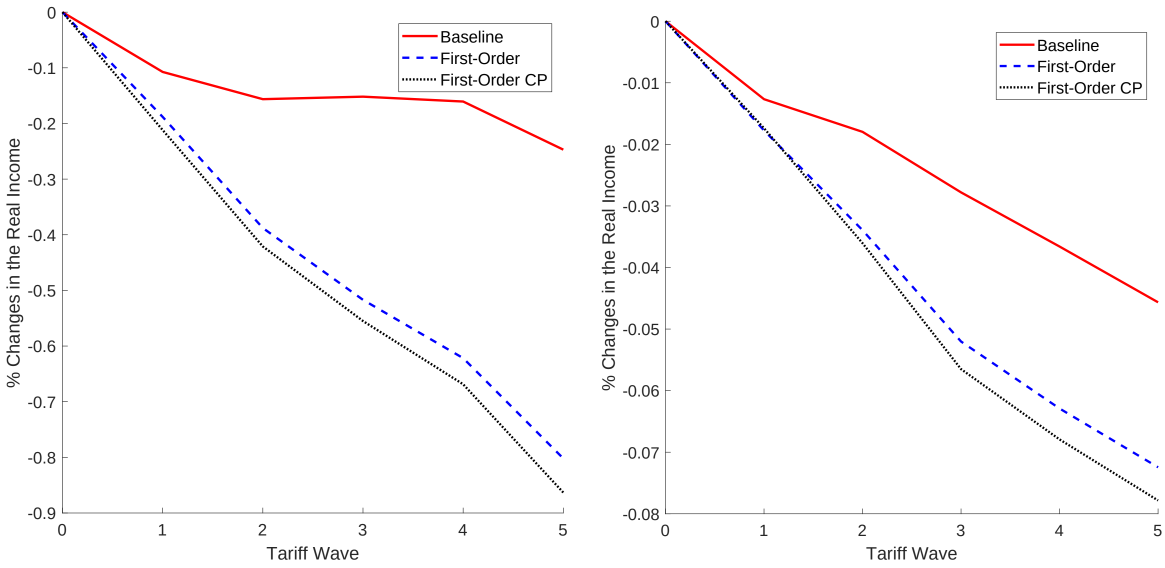


(c) EU (d) Japan

Figure 11: Welfare Effects of Trade Wars: Nonlinearity

Table 3: Trump Tariffs (Wave 1) and “Made-in-China 2025”: Alternative Calibration following Bartelme et al. (2019)

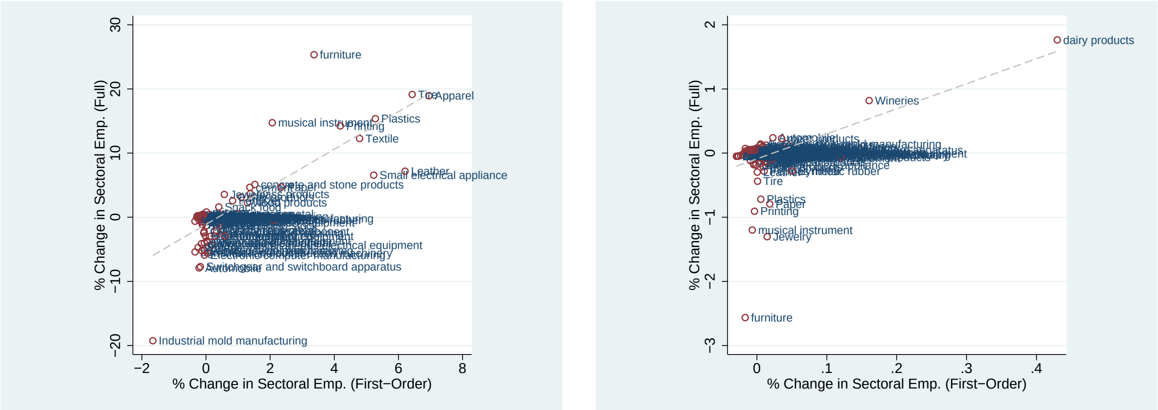
	China							
%Δ in:	Welfare	Real Wage	Final Goods		Scale		Intermediates	
			Goods	Services	Goods	Services	Goods	Services
Trump Wave 1	-0.035	-0.030	-0.003	-0.001	-0.018	0.000	0.005	-0.013
MIC 2025	-0.003	3.127	-0.006	0.009	0.920	0.000	-3.168	0.868
Both	-0.018	3.094	-0.012	0.008	0.912	0.000	-3.173	0.854
MIC under Trump Wave 1	0.018	3.126	-0.009	0.009	0.930	0.000	-3.177	0.868
Trump Wave 1 under MIC	-0.015	-0.032	-0.006	-0.001	-0.008	0.000	-0.004	-0.013
	U.S.							
%Δ in:	Welfare	Real Wage	Final Goods		Scale		Intermediates	
			Goods	Services	Goods	Services	Goods	Services
Trump Wave 1	-0.158	-0.157	-0.077	0.010	0.026	0.000	-0.059	-0.057
MIC 2025	0.087	0.084	0.472	-0.005	-2.225	0.000	1.795	0.047
Both	-0.318	-0.340	-0.120	0.006	-0.298	0.000	0.181	-0.110
MIC under Trump Wave 1	-0.160	-0.183	-0.043	-0.004	-0.324	0.000	0.240	-0.053
Trump Wave 1 under MIC	-0.405	-0.424	-0.590	0.011	1.972	0.000	-1.586	-0.156



(a) U.S.

(b) China

Figure 12: Welfare Effects of Trade Wars: Baseline vs First-Order Approximation



(a) U.S. (b) China

Figure 13: Changes in Sectoral Employment under US-China Trade Wars (Wave 5): Baseline Model vs First-Order Approximation

Appendix A Theory

A.1 Equilibrium in Relative Changes

Changes in unit costs can be expressed as

$$\hat{c}_i^j = \frac{1}{\left(\hat{L}_i^j\right)^{\psi_j}} \left[\tilde{\beta}_i^j \left(\hat{w}_i\right)^{1-\rho_j^L} + \left(1-\tilde{\beta}_i^j\right)\left(\hat{P}_i^{Mj}\right)^{1-\rho_j^L}\right]^{\frac{1}{1-\rho_j^L}}, \tag{A.1}$$

where

$$\hat{P}_i^{Mj} := \left(\sum_{g\in G_i^j} \chi_i^{gj} \left[\sum_{s\in g} \tilde{\gamma}_i^{sj} \left(\hat{P}_i^s\right)^{1-\eta_i^{gj}}\right]^{\frac{1-\mu_i^j}{1-\eta_i^{gj}}}\right)^{\frac{1}{1-\mu_i^j}}. \tag{A.2}$$

Changes in trade share:

$$\hat{\pi}_{in}^j = \frac{\left[\hat{c}_i^j \widehat{1+t_{in}^j}\,\widehat{1+e_{in}^j}\right]^{-\theta_j}}{\left(\hat{P}_n^j\right)^{-\theta_j}}. \tag{A.3}$$

Changes in price indices:

$$\hat{P}_n^j = \left[\sum_{i=1}^{N} \pi_{in}^j \left[\hat{c}_i^j \widehat{1+t_{in}^j}\,\widehat{1+e_{in}^j}\right]^{-\theta_j}\right]^{\frac{1}{-\theta_j}}. \tag{A.4}$$

Changes in sectoral wage incomes:

$$\hat{w}_i \hat{L}_i^j w_i L_i^j = \frac{\tilde{\beta}_i^j \left(\hat{w}_i\right)^{1-\rho_j^L}}{\tilde{\beta}_i^j \left(\hat{w}_i\right)^{1-\rho_j^L} + \left(1-\tilde{\beta}_i^j\right)\left(\hat{P}_i^{Mj}\right)^{1-\rho_j^L}} \sum_{n=1}^{N} \frac{\hat{\pi}_{in}^j \hat{X}_n^j X_{in}^j}{\left(1+\left(t_{in}^j\right)'\right)\left(1+\left(e_{in}^j\right)'\right)}. \tag{A.5}$$

Changes in sectoral labor allocation satisfy:

$$\sum_{j=1}^{J} \hat{L}_i^j L_i^j = L_i. \tag{A.6}$$

Changes in the total income:

$$\hat{Y}_i Y_i = \hat{w}_i w_i L_i + \sum_{j=1}^{J}\sum_{n=1}^{N} \frac{\left(e_{in}^j\right)'}{1+\left(e_{in}^j\right)'}\left(X_{in}^j\right)' + \sum_{j=1}^{J}\sum_{k=1}^{N} \frac{\left(t_{ki}^j\right)'}{\left(1+\left(t_{ki}^j\right)'\right)\left(1+\left(e_{ki}^j\right)'\right)}\left(X_{ki}^j\right)'. \tag{A.7}$$

Changes in sectoral expenditure:

$$\hat{X}_i^j X_i^j = \frac{\tilde{\alpha}_i^j \left(\hat{P}_i^j\right)^{1-\rho_C}}{\sum_{s=1}^{J} \tilde{\alpha}_i^s \left(\hat{P}_i^s\right)^{1-\rho_C}} \hat{Y}_i Y_i + \sum_{s=1}^{J} \frac{\tilde{\gamma}_i^{js}\left(\hat{P}_i^j\right)^{1-\eta_i^{gs}}}{\sum_{j'\in g} \tilde{\gamma}_i^{j's}\left(\hat{P}_i^{j'}\right)^{1-\eta_i^{gs}}} \frac{\chi_i^{gs}\left[\sum_{j'\in g}\tilde{\gamma}_i^{j's}\left(\hat{P}_i^{j'}\right)^{1-\eta_i^{gs}}\right]^{\frac{1-\mu_i^s}{1-\eta_i^{gs}}}}{\sum_{g'\in G_i^s}\chi_i^{g's}\left[\sum_{j'\in g'}\tilde{\gamma}_i^{j's}\left(\hat{P}_i^{j'}\right)^{1-\eta_i^{g's}}\right]^{\frac{1-\mu_i^s}{1-\eta_i^{g's}}}}$$

$$\times \frac{\left(1-\tilde{\beta}_i^s\right)\left(\hat{P}_i^{Ms}\right)^{1-\rho_s^L}}{\tilde{\beta}_i^s\left(\hat{w}_i^j\right)^{1-\rho_s^L} + \left(1-\tilde{\beta}_i^s\right)\left(\hat{P}_i^{Ms}\right)^{1-\rho_s^L}} \sum_{n=1}^{N} \frac{\left(X_{in}^s\right)'}{\left(1+\left(t_{in}^s\right)'\right)\left(1+\left(e_{in}^s\right)'\right)}. \tag{A.8}$$

Changes in aggregate price indices:

$$\hat{P}_n = \left[\sum_{j=1}^{J} \tilde{\alpha}_n^j \left(\hat{P}_n^j\right)^{1-\rho_C}\right]^{\frac{1}{1-\rho_C}}. \tag{A.9}$$

A.2 Proof to Proposition 3

Totally differentiating Equation (15) results in

$$d\log P_j = -\frac{1}{\theta_j} d\log T_j - \psi_j d\log L_j + (1-\tilde{\beta}_j)\sum_{s=1}^{J}\delta_{sj} d\log P_s, \tag{A.10}$$

or in matrix form,

$$[\mathbf{I}-\mathbf{\Sigma}]\, d\log \mathbf{P} = \left(-d\log \tilde{\mathbf{T}} - \mathbf{\Psi} d\log \mathbf{L}\right). \tag{A.11}$$

Totally differentiating Equation (14) results in

$$\begin{aligned}
\frac{1}{\tilde{\beta}_j}\frac{L_j}{L} d\log L_j = {} & (1-\rho_C)\,\tilde{\alpha}_j \left[d\log P_j - \sum_{j'=1}^{J} \tilde{\alpha}_{j'} d\log P_{j'}\right] + \sum_{s=1}^{J}\left(1-\tilde{\beta}_s\right)\delta_{js}\frac{1}{\tilde{\beta}_s}\frac{L_s}{L} d\log L_s \\
& + \sum_{s=1}^{J}\left(1-\tilde{\beta}_s\right)\frac{1}{\tilde{\beta}_s}\frac{L_s}{L}(1-\mu_s)\,\delta_{js}\left[d\log P_j - \sum_{j'=1}^{J}\delta_{j's} d\log P_{j'}\right] \\
& + \sum_{s=1}^{J}\left(1-\tilde{\beta}_s\right)\frac{1}{\tilde{\beta}_s}\frac{L_s}{L}\left(1-\rho_s^L\right)\delta_{js}\sum_{j'=1}^{J}\delta_{j's} d\log P_{j'} \\
& - \frac{1}{\tilde{\beta}_j}\frac{L_j}{L}\left(1-\tilde{\beta}_j\right)\left(1-\rho_j^L\right)\sum_{j'=1}^{J}\delta_{j'j} d\log P_{j'}.
\end{aligned} \tag{A.12}$$

or in matrix form,

$$[\mathbf{\Lambda}-\mathbf{\Sigma}'\mathbf{\Lambda}]\, d\log \mathbf{L} = (\mathbf{S}-\mathbf{\Omega})\, d\log \mathbf{P}. \tag{A.13}$$

Therefore, we have

$$d\log \mathbf{P} = -\left[\mathbf{I} + (\mathbf{I}-\mathbf{\Sigma})^{-1}\mathbf{\Psi}\left(\mathbf{\Lambda}-\mathbf{\Sigma}'\mathbf{\Lambda}\right)^{-1}(\mathbf{S}-\mathbf{\Omega})\right]^{-1}[\mathbf{I}-\mathbf{\Sigma}]^{-1} d\log \tilde{\mathbf{T}}. \tag{A.14}$$

Notice that in this economy the welfare $W = 1/P$. Therefore, we have desired results.

Appendix B Quantification

B.1 Trade Elasticities and Scale Economies

B.2 Elasticities of Substitution across Input Sectors

Table B.1: Trade Elasticities and Scale Economies from Lashkaripour & Lugovskyy (2017)

Industry	Description	Industry in LL (2017)	Trade Elasticity θ_j	Scale ψ_j	MIC2025
1	Agricultural products	Agriculture & Mining	4.584	0.188	
2	Mining	Agriculture & Mining	4.584	0.188	
3	Wood products	Wood	2.376	0.338	
4	Clay products	Wood	2.376	0.338	
5	Glass products	Wood	2.376	0.338	
6	Cement	Wood	2.376	0.338	
7	Concrete & stone products	Wood	2.376	0.338	
8	Mineral & construction machinery	Machinery	2.471	0.315	
9	Steel products	Basic & Fabricated Metals	2.25	0.263	
10	Nonferrous metal	Basic & Fabricated Metals	2.25	0.263	
11	Ferrous metal	Basic & Fabricated Metals	2.25	0.263	
12	Farm machinery	Machinery	2.471	0.315	Y
13	Semiconductor machinery	Electrical & Optical Equipment	0.394	1.367	Y
14	Optical instrument	Electrical & Optical Equipment	0.394	1.367	Y
15	Industrial mold manufacturing	Machinery	2.471	0.315	
16	Material handling equipment	Electrical & Optical Equipment	0.394	1.367	
17	Other engine equipment	Electrical & Optical Equipment	0.394	1.367	
18	Electronic computer manufacturing	Electrical & Optical Equipment	0.394	1.367	Y
19	Communications equipment	Electrical & Optical Equipment	0.394	1.367	Y
20	Audio and video equipment	Electrical & Optical Equipment	0.394	1.367	
21	Other electronic component	Electrical & Optical Equipment	0.394	1.367	
22	Small electrical appliance	Machinery	2.471	0.315	
23	Power, distribution, and transformer	Electrical & Optical Equipment	0.394	1.367	Y
24	Switchgear and switchboard apparatus	Electrical & Optical Equipment	0.394	1.367	
25	Wiring device manufacturing	Electrical & Optical Equipment	0.394	1.367	
26	Other miscellaneous electrical equipment	Electrical & Optical Equipment	0.394	1.367	
27	Automobile	Transport Equipment	0.463	0.575	Y
28	Railroad rolling stock	Transport Equipment	0.463	0.575	Y
29	Ship building and repairing	Transport Equipment	0.463	0.575	Y
30	Aircraft	Transport Equipment	0.463	0.575	Y
31	Furniture	Wood	2.376	0.338	
32	Jewelry	Manufacturing (average)	2.055	0.22	
33	Musical instrument	Manufacturing (average)	2.055	0.22	
34	Dog and cat food manufacturing	Food	2.036	0.423	
35	Corn products	Food	2.036	0.423	
36	Fat products	Food	2.036	0.423	
37	Dairy products	Food	2.036	0.423	
38	Meat products	Food	2.036	0.423	
39	Sugar products	Food	2.036	0.423	
40	Snack food	Food	2.036	0.423	
41	Fish products	Food	2.036	0.423	
42	Vegetable products	Food	2.036	0.423	
43	Soft drink	Food	2.036	0.423	
44	Wineries	Food	2.036	0.423	
45	Tobacco	Food	2.036	0.423	
46	Textile	Textiles, Leather & Footwear	2.418	0.278	
47	Apparel	Textiles, Leather & Footwear	2.418	0.278	
48	Leather	Textiles, Leather & Footwear	2.418	0.278	
49	Paper	Paper	4.765	0.181	
50	Printing	Paper	4.765	0.181	
51	Petroleum refineries	Petroleum	0.328	1.979	
52	Chemical products	Chemicals	2.389	0.36	
53	Fertilizer	Chemicals	2.389	0.36	
54	Pesticide	Chemicals	2.389	0.36	
55	Pharmaceutical	Chemicals	2.389	0.36	Y
56	Paint	Chemicals	2.389	0.36	
57	Soap	Chemicals	2.389	0.36	
58	Plastics	Rubber & Plastic	3.02	0.24	
59	Rubber products	Rubber & Plastic	3.02	0.24	
60	Synthetic rubber	Rubber & Plastic	3.02	0.24	
61	Tire	Rubber & Plastic	3.02	0.24	
62	Machine repairing	Rubber & Plastic	3.02	0.24	
63	Electricity	Nonmanufacturing (average)	3.058	0.27	
64	Water	Nonmanufacturing (average)	3.058	0.27	
65	Recycling	Nonmanufacturing (average)	3.058	0.27	
66	Construction	Misc.	4	0	
67	Automobile sales	Misc.	4	0	
68	Wholesaling	Misc.	4	0	
69	Retailing	Misc.	4	0	
70	Land transportation	Misc.	4	0	
71	Water transportation	Misc.	4	0	
72	Air transportation	Misc.	4	0	
73	Cargo	Misc.	4	0	
74	Post service	Misc.	4	0	
75	Restaurant	Misc.	4	0	
76	Distribution	Misc.	4	0	
77	Movie	Misc.	4	0	
78	Telecommunication	Nonmanufacturing (average)	3.058	0.27	
79	Computer services	Nonmanufacturing (average)	3.058	0.27	
80	Finance	Nonmanufacturing (average)	3.058	0.27	
81	Insurance	Misc.	4	0	
82	Other finance	Misc.	4	0	
83	Real estate	Misc.	4	0	
84	Legal service	Misc.	4	0	
85	Construction engineering	Misc.	4	0	
86	Science	Nonmanufacturing (average)	3.058	0.27	
87	Advertising	Misc.	4	0	
88	Other science	Misc.	4	0	
89	Administrative	Misc.	4	0	
90	Defense	Misc.	4	0	
91	Education	Misc.	4	0	
92	Healthcare	Misc.	4	0	
93	Other service	Misc.	4	0	
94	Household service	Misc.	4	0	
95	Foreign organization	Misc.	4	0	

Table B.2: Estimation Results of μ_j

Sector	Sector Name	μ_j	S.E.	# Obs.
111CA	Farms	0.531	0.220	897
113FF	Forestry, fishing, and related activities	0.715	0.212	826
211	Oil and gas extraction	0.688	0.116	822
212	Mining, except oil and gas	0.404	0.104	915
213	Support activities for mining	0.257	0.127	820
22	Utilities	0.611	0.172	894
23	Construction	0.389	0.133	926
321	Wood products	0.931	0.163	976
327	Nonmetallic mineral products	0.774	0.170	913
331	Primary metals	0.731	0.166	900
332	Fabricated metal products	0.704	0.133	915
333	Machinery	0.827	0.142	962
334	Computer and electronic products	0.308	0.178	885
335	Electrical equipment, appliances, and components	0.594	0.185	902
3361MV	Motor vehicles, bodies and trailers, and parts	0.622	0.169	946
3364OT	Other transportation equipment	0.644	0.204	880
337	Furniture and related products	0.512	0.240	900
339	Miscellaneous manufacturing	0.547	0.151	995
311FT	Food and beverage and tobacco products	0.564	0.133	975
313TT	Textile mills and textile product mills	0.893	0.188	919
315AL	Apparel and leather and allied products	0.753	0.216	825
322	Paper products	0.870	0.147	914
323	Printing and related support activities	1.005	0.152	986
324	Petroleum and coal products	1.325	0.256	966
325	Chemical products	0.930	0.129	1000
326	Plastics and rubber products	0.897	0.140	956
42	Wholesale trade	0.542	0.100	1100
441	Motor vehicle and parts dealers	0.312	0.155	1094
445	Food and beverage stores	0.428	0.077	1007
452	General merchandise stores	0.554	0.115	969
4A0	Other retail	0.485	0.113	1089
481	Air transportation	1.114	0.281	798
482	Rail transportation	0.723	0.161	872
483	Water transportation	1.524	0.219	655
484	Truck transportation	0.552	0.183	897
485	Transit and ground passenger transportation	0.169	0.187	744
486	Pipeline transportation	0.559	0.190	885
487OS	Other transportation and support activities	0.633	0.182	1025
493	Warehousing and storage	0.934	0.113	887
511	Publishing industries, except internet (includes software)	0.772	0.120	986
512	Motion picture and sound recording industries	0.395	0.122	951
513	Broadcasting and telecommunications	0.719	0.102	1036
514	Data processing, internet publishing, and other information services	0.481	0.137	973
521CI	Federal Reserve banks, credit intermediation, and related activities	0.324	0.114	903
523	Securities, commodity contracts, and investments	0.269	0.152	857
524	Insurance carriers and related activities	0.465	0.198	879
525	Funds, trusts, and other financial vehicles	0.689	0.148	616
HS	Housing	0.463	0.365	572
ORE	Other real estate	0.900	0.169	859
532RL	Rental and leasing services and lessors of intangible assets	0.550	0.170	960
5411	Legal services	0.754	0.181	877
5415	Computer systems design and related services	0.452	0.123	961
5412OP	Miscellaneous professional, scientific, and technical services	0.782	0.096	1140
55	Management of companies and enterprises	0.534	0.122	1107
561	Administrative and support services	0.739	0.147	1107
562	Waste management and remediation services	0.686	0.120	978
61	Educational services	0.703	0.173	1056
621	Ambulatory health care services	0.760	0.128	1059
622	Hospitals	1.120	0.188	1100
623	Nursing and residential care facilities	0.832	0.128	981
624	Social assistance	0.805	0.168	1031
711AS	Performing arts, spectator sports, museums, and related activities	1.082	0.153	1026
713	Amusements, gambling, and recreation industries	0.420	0.142	1098
721	Accommodation	0.480	0.152	1020
722	Food services and drinking places	0.488	0.087	1040
81	Other services, except government	0.855	0.118	1157
GFGD	Federal general government (defense)	0.579	0.143	958
GFGN	Federal general government (nondefense)	0.771	0.156	1048
GFE	Federal government enterprises	1.018	0.205	925
GSLG	State and local general government	0.579	0.120	1124
GSLE	State and local government enterprises	0.479	0.104	960