# Import Tariffs and Global Sourcing

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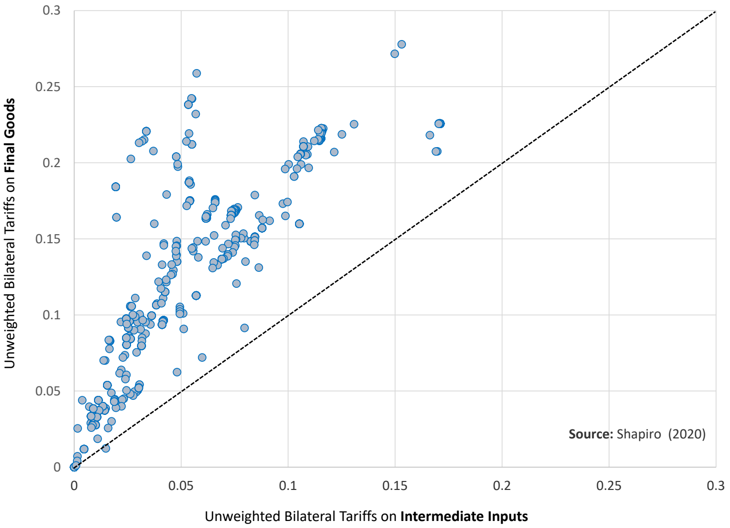
July 12, 2021

Preliminary!

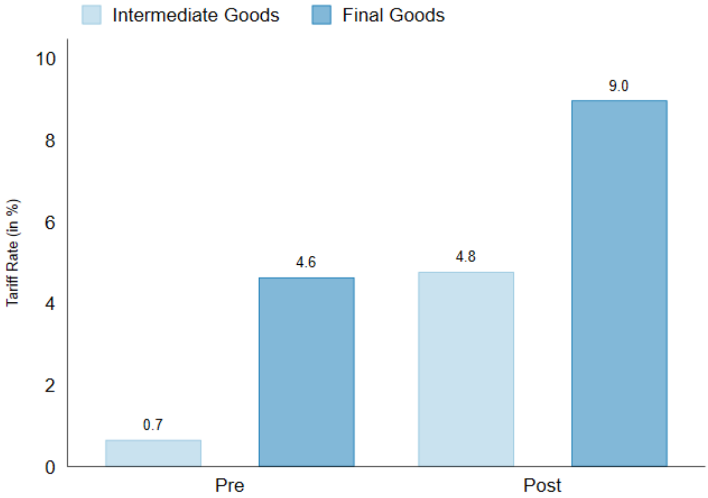
# Motivation

- Historically, tariffs tend to be higher for downstream goods (i.e., **tariff escalation**)
- Significant unilateral tariff increases during recent trade conflicts
- 60 percent of new US tariffs targeted intermediate inputs (Bown and Zhang, 2019)
- Stated objective was to ‘bring manufacturing back to America’
- Early empirical work suggests these intermediate-good tariffs harmed US manufacturing firms and workers (Flaaen and Pierce, 2019; Handley, Kamal, and Monarch, 2020)
  - Is this just a short-run effect?

# Tariff Escalation



# Tariff Escalation in the US Pre and Post Trade War



# Is Tariff Escalation An Optimal Policy?

- Neoclassical theory does not provide a simple rationale for tariff escalation
  - Theoretically, no sharp insights from traditional work with homogenous goods: Ruffin (1969), Casas (1973), Das (1983)
- Modern Ricardian models with CRS stress the optimality of common tariffs across sectors, regardless of demand elasticities: Costinot et al. (2015), Beshkar and Lashkaripour (2020)
- If anything, second-best optimal import tariff features tariff 'de-escalation' because import tariffs on inputs mimic downstream export taxes (Beshkar and Lashkaripour, 2020)
- Empirically, 'upstreamness' and inverse export supply elasticities are weakly *positively* correlated

# Our Contribution

- This Paper: We explore optimal tariffs for final goods vs inputs in an environment with IRS, monopolistic competition, and product differentiation (Krugman, Venables, Ossa)

- Some considerations ...
  - Are relocation effects more beneficial in the upstream or downstream sector?
  - How do tariffs upstream affect production relocation downstream, and vice versa?
  - How do these tariffs affect relative wages?
  - How do these tariffs interact with domestic distortions?

- Study second- and first-best policies in economies with and without domestic distortions

- Main result: First and second-best trade policies feature tariff escalation *largely* because raising input costs hurts downstream producers both in both the short and the 'long run'

# Related Literature

- **Optimal tariffs**
  - Gros (1985); Bagwell and Staiger (1999, 2001), Venables (1987), Ossa (2011), Costinot et al. (2015); Costinot et al. (2020); Beshkar and Lashkaripour (2020)
- **Trade policy with input trade**
  - Neoclassical theory: Ruffin (1969); Casas (1973); Das (1983); Blanchard, Bown, and Johnson (2021); Beshkar and Lashkaripour (2021)
  - Political Economy: Cadot et al. (2004), Gawande et al. (2012)
  - Scale Economies: Krugman and Venables (2005); Caliendo et al. (2021); Lashkaripour and Lugovskyy (2021)
  - Other approaches: Antràs and Staiger (2012); Ornelas and Turner (2008, 2012), Grossman and Helpman (2020); Liu (2019)
- **Effects of recent trade war**
  - Amiti, Redding, and Weinstein (2019); Fajgelbaum et al. (2020); Flaaen and Pierce (2020); Handley, Kamal, and Monarch (2020)

# Outline of Talk

1. Closed-economy model
2. Open economy with final-good and input tariffs
3. Quantification of final-good versus input tariff effects

# Closed Economy: Krugman'80 with Input and Final-Good Sectors

- Two sectors: final-good and intermediate input sectors
- Consumers have CES preferences over final-good varieties (elasticity $\sigma$)

$$U = \left( \int_0^{M^d} q^d(\omega)^{\frac{\sigma-1}{\sigma}} \, d\omega \right)^{\frac{\sigma}{\sigma-1}}, \tag{1}$$

- Final goods production uses labor and a bundle of inputs to cover fixed & marginal costs
  - Production is Cobb-Douglas in inputs and labor, (labor share $\alpha$)

$$f^d + x^d(\omega) = A^d \ell^d(\omega)^\alpha Q^u(\omega)^{1-\alpha}, \qquad \omega \in [0, M^d], \tag{2}$$

- Intermediate input sector uses labor to cover fixed & marginal costs
  - Bundle of inputs is CES (elasticity $\theta$)

$$f^u + x^u(\varpi) = A^u \ell^u(\varpi), \qquad \varpi \in [0, M^u], \tag{3}$$

- Both sectors features monopolistic competition and free entry, as in Krugman (1980)

# Closed Economy: Market Equilibrium versus First Best

- Aggregate decentralized market allocation of labor to the upstream sector is given by

$$M^u \ell^u = (1-\alpha)L,$$

- Social planner allocates a larger share of labor to that upstream sector

$$(M^u \ell^u)^* = \frac{\theta}{\theta-\alpha}(1-\alpha)L > (1-\alpha)L.$$

- Although too much labor allocated downstream, there is still too little entry downstream because there are too few input varieties

$$\left(M^d\right)^* = \left(\frac{\theta-1}{\theta-\alpha}\right)^{\alpha} \left(\frac{\theta}{\theta-\alpha}\right)^{\frac{\theta(1-\alpha)}{\theta-1}} M^d > M^d$$

# Closed Economy: Results

Proposition 1. In the decentralized equilibrium, firm-level output is at its socially optimal level in both sectors, but the market equilibrium features too little entry into both the downstream and upstream sectors unless $\alpha = 1$ (so the upstream sector is shut down) or $\alpha = 0$ (i.e., when the downstream sector does not use labor directly in production).

Proposition 2. The social planner can restore efficiency in the market equilibrium by subsidizing upstream production at a rate $(s^u)^* = 1/\theta$.

Isomorphism: Framework with external economies of scale and perfect competition

$$\begin{aligned} x^u &= A^u \ell^u (L^u)^{\gamma^u} \\ x^d &= A^d \left(\ell^d\right)^{\alpha} (q^u)^{1-\alpha} \left(\left(L^d\right)^{\alpha} (Q^u)^{1-\alpha}\right)^{\gamma^d}, \end{aligned}$$

Model with external economies of scales is isomorphic to our model if $\gamma^u = 1/(\theta - 1)$. Upstream subsidy $(s^u)^* = \gamma^u/(1+\gamma^u)$ restores efficiency

# Open Economy: Allow for Trade in Both Sectors

- Two-country model with international trade in both final goods and inputs
- Trade is costly due to the presence of iceberg trade costs and import tariffs
  - $\tau^d$ and $\tau^u$ are iceberg trade costs applied to final goods and to inputs
  - $t_i^d$ and $t_i^u$ the tariffs set by country $i$ on imports of final goods and intermediate inputs
- Intuition from special case with $\alpha = 0$ and no tariff revenue (no domestic distortion)
- Intuition from first-order approximation around zero-tariff equilibrium
- Quantitative evaluation of optimal tariffs under second- and first-best policies

# A Special Case à la Ossa (2011)

- Assume $\alpha = 0$ and that $t_i^d$ and $t_i^u$ are unilateral trade barriers set by Home that generate no tax revenue
- Setting home wage as numéraire, we have $U_H = 1/P_H^d$ and:

$$\left(P_H^d\right)^{\sigma-1} = \frac{\Upsilon}{L_H} \frac{\left(P_H^u\right)^{\sigma} - \left(\tau^d\right)^{1-\sigma} \left(P_F^u\right)^{\sigma}}{1 - \left(1 + t_H^d\right)^{1-\sigma} \left(\tau^d\right)^{2(1-\sigma)}} \quad (4)$$

$$\left(P_F^d\right)^{\sigma-1} = \frac{\Upsilon}{w_F L_F} \frac{\left(P_F^u\right)^{\sigma} - \left(\tau^d \left(1 + t_H^d\right)\right)^{1-\sigma} \left(P_H^u\right)^{\sigma}}{1 - \left(1 + t_H^d\right)^{1-\sigma} \left(\tau^d\right)^{2(1-\sigma)}} \quad (5)$$

- Holding constant the input price indices $P_H^u$ and $P_F^u$, $\left(P_H^d\right)^{\sigma-1}$ is decreasing in $t_H^d$
- Direct effect of final-good tariff: it raises $M_H^d$, thus reducing $P_H^d$, thereby *increasing* Home welfare (Ossa, 2011)

# A Special Case à la Ossa (2011)

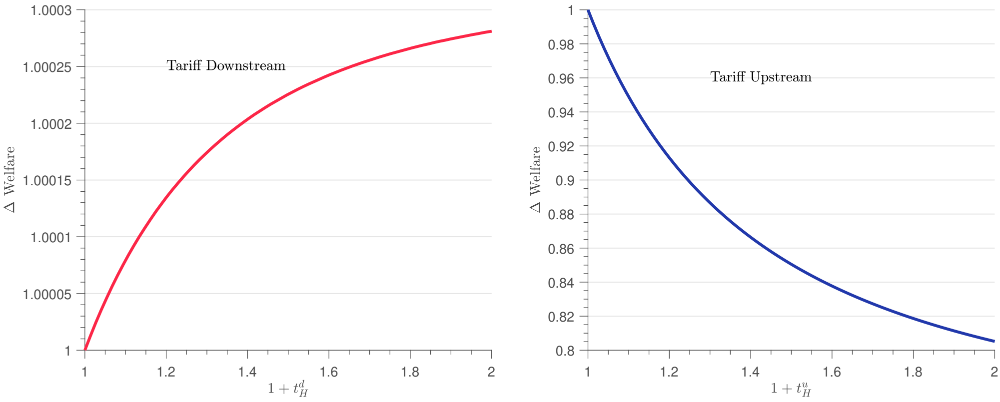
- But input price indices are endogenous. They are determined by:

$$P_H^u = \frac{\theta}{(\theta - 1) A^u} \left[ M_H^u + M_F^u \left( \left(1 + t_i^u\right) \tau^u w_F \right)^{1-\theta} \right]^{\frac{1}{1-\theta}} \quad (6)$$

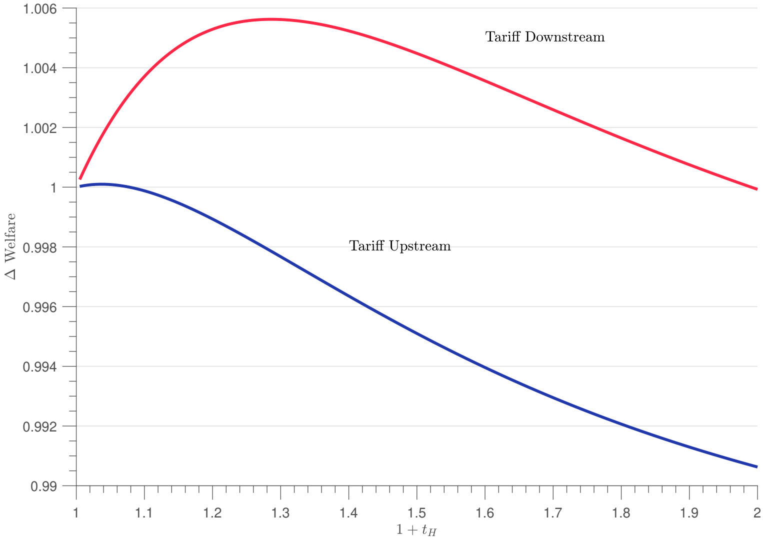
$$P_F^u = \frac{\theta}{(\theta - 1) A^u} \left[ M_F^u \left( w_F \right)^{1-\theta} + M_H^u \left( \tau^u \right)^{1-\theta} \right]^{\frac{1}{1-\theta}} . \quad (7)$$

- Shaped by location of input producers ($M_i^u$), input tariffs $t_i^u$ and by relative foreign wage $w_F$ (pinned down in GE)
- But with $\alpha = 0$, $M_i^u = \bar{M}_i^u$ (no domestic distortion)
- Direct effect of input tariff: it raises $P_H^u$, and thus $P_H^d$, thereby *reducing* Home welfare
- There are indirect effects of $t_i^d$ and $t_i^u$ via relative wages, but do not overturn direct effects

# Effect of Import Trade Barriers with No Tariff Revenue



# Effect of Unilateral Import Tariffs



# Decomposing Change in Welfare

$$
\begin{aligned}
\frac{dU_H}{U_H} = \quad & -\left(b_H^H \Omega_{F,H} + b_F^H\left(\Omega_{F,F}+\alpha\right)\right)\frac{dw_F}{w_F} && \leftarrow \text{Relative wage effects} \\
& + \left(\frac{b_H^H \Omega_{H,H} + b_F^H \Omega_{H,F}}{\theta - 1}\right)\frac{dM_H^u}{M_H^u} && \leftarrow \text{Relocation of upstream firms to home} \\
& + \left(\frac{b_H^H \Omega_{F,H} + b_F^H \Omega_{F,F}}{\theta - 1}\right)\frac{dM_F^u}{M_F^u} && \leftarrow \text{Relocation of upstream firms to foreign} \\
\text{Relocation of downstream firms to home} \rightarrow \quad & + \left(\frac{b_H^H}{\sigma - 1}\right)\frac{dM_H^d}{M_H^d} \\
\text{Relocation of downstream firms to foreign} \rightarrow \quad & + \left(\frac{b_F^H}{\sigma - 1}\right)\frac{dM_F^d}{M_F^d} \\
\text{Input tariff re-exported to foreign} \rightarrow \quad & + \left(\lambda_H^d - b_H^H\right)\Omega_{F,H}(dt)\mathbb{I}_{\{t=t^u\}}
\end{aligned}
$$

$b_i^j$: share of $j$ income spent on $i$ varieties

$\Omega_{i,j}$: share of $j$ final-good revenue spent on $i$ input varieties

$\lambda_i^d$: ratio of domestic final-good revenue to income in $i$

▸ Derivations

# Parameterization

- Four alternative ways of estimating $\theta$ and $\sigma$
  1. Symmetric case: $\theta = \sigma = 4$
  2. Response in trade flows to US-China trade war ($\theta = 3.35$, $\sigma = 4.08$)
  3. Mark-ups ($\theta = 4.43$, $\sigma = 6.44$)
  4. Scale economies from Bartelme et al. (2019) ($\theta = 8.52$, $\sigma = 8.41$)
- $1 - \alpha = 0.45$ (from WIOD)
- Relative population size from CEPII
- Calibrate trade costs and productivities to best fit moments that appear in the exact hat algebra equations

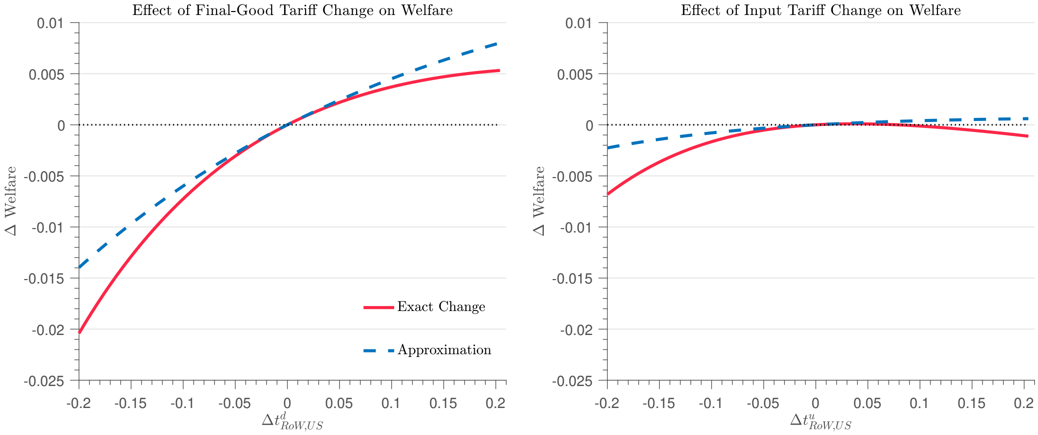
# Calibrated Parameters

| **A.** Calibrated Parameters | |
|---|---|
| Productivity in final-good sector, RoW relative to US, $A^d_{row}$ | 0.3127 |
| Productivity in input sector, RoW relative to US, $A^u_{row}$ | 0.1364 |
| Iceberg cost for final goods from US to RoW, $\tau^d$ | 3.2312 |
| Iceberg cost for inputs from US to RoW, $\tau^u$ | 2.5912 |

| **B.** Moments | Data | Model |
|---|---|---|
| Sales share to US from US in final goods | 0.9431 | 0.9641 |
| Sales share to RoW from RoW in final goods | 0.9884 | 0.9854 |
| Sales share to US from US in intermediate good | 0.8974 | 0.8890 |
| Sales share to RoW from Row in intermediate good | 0.9825 | 0.9778 |
| Expenditure share in US final goods for the US | 0.9603 | 0.9464 |
| Expenditure share in RoW final good for the RoW | 0.9811 | 0.9892 |
| Expenditure share in US int. good for the US | 0.9055 | 0.9207 |
| Expenditure share in RoW int. good for the RoW | 0.9801 | 0.9670 |
| Total US sales (int. goods) to total US expenditure (final goods) | 0.7711 | 0.4665 |
| Total RoW sales (int. goods) to total RoW expenditure (final goods) | 1.2418 | 0.4463 |
| Total US sales (final goods) to total US expenditure (final goods) | 1.0182 | 0.9973 |
| Total RoW sales (final goods) to total RoW expenditure (final goods) | 0.9926 | 0.9993 |
| Total expenditure in final goods by the US relative to RoW | 0.3032 | 0.2850 |

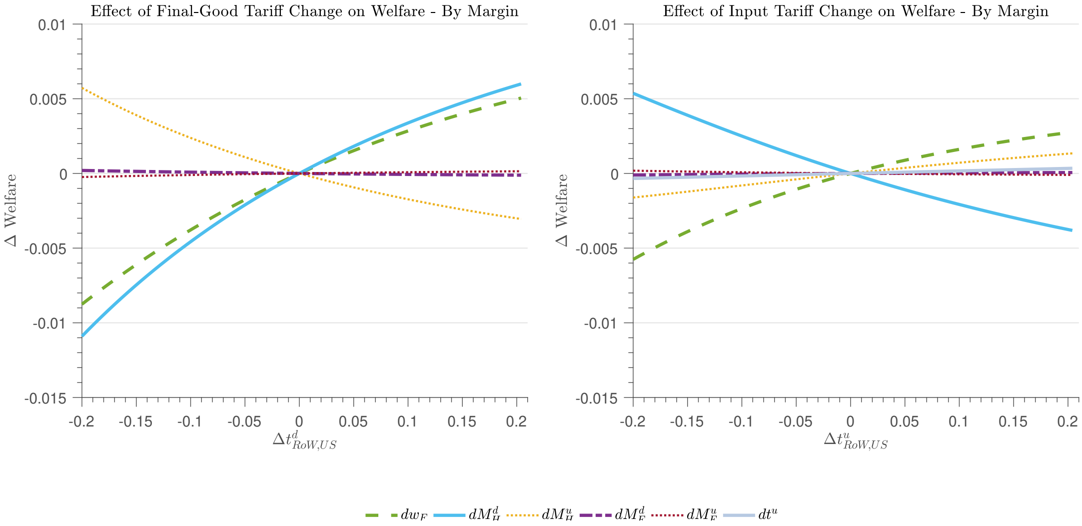
Notes: Panel B presents the targeted moments in the estimation. Column 1 presents moments from the data and column 2 presents their estimated counterparts. Note that in the model, total sales upstream to total expenditure downstream cannot be larger than 1 since the upstream sector is pure value added.

# Approximation Works Well for Small Changes




- Negative welfare effects for large range of input tariffs

# Channels of Tariffs' Welfare Effects Differ by Good Type



# Optimal Tariffs

- Next, calculate optimal tariffs when ...
  1. Only import tariffs are available
  2. Import tariffs and an upstream (input) production subsidy is available
  3. Additionally, an export tax for downstream goods is available (sufficient to achieve First Best)
- Lerner symmetry implies that (gross) tariff levels are only pinned down up to a scalar
- But 'tariff escalation wedge' $(1 + t_i^d)/(1 + t_i^u)$ is *independent* of normalization
- A downstream production subsidy is a redundant instrument

# Optimal Import Tariffs Exhibit Tariff Escalation

| | **A.** Tariff & Tax Instruments | | | | | **B.** Welfare | |
|---|---|---|---|---|---|---|---|
| | $t_H^d$ | $t_H^u$ | $v_H^u$ | $s_H^u$ | $\frac{1+t_H^d}{1+t_H^u}$ | $U_{US}$ | $U_{RoW}$ |
| Zero Tariff Equilibrium | | | | | | 0.031565 | 0.14148 |
| Optimal Import Tariff | 0.4025 | 0.2142 | | | 1.155 | 0.031810 | 0.140823 |
| Optimal Import Tariffs & Production Subsidy | 0.6225 | 0.2222 | | 0.2334 | 1.3275 | 0.032251 | 0.140827 |
| Optimal Trade & Tax Policies | 0.3367 | 0.0033 | -0.2507 | 0.2500 | 1.3322 | 0.032317 | 0.140784 |

# Robustness to Different Parameter Values

- Tariff escalation is robust to wide range of parameter values

| | $\theta = 3.35$ $\sigma = 4.08$ | $\theta = 4.43$ $\sigma = 6.44$ | $\theta = 8.52$ $\sigma = 8.41$ | $\theta = 2.5$ $\sigma = 4$ | $\theta = 5.5$ $\sigma = 4$ | $\alpha = 0.75$ | $\alpha = 0.25$ | $\alpha = 0$ |
|---|---|---|---|---|---|---|---|---|
| **A.** Optimal Import Tariff | | | | | | | | |
| $t^d$ | 0.3791 | 0.2245 | 0.1617 | 0.3648 | 0.3877 | 0.3377 | 0.4511 | 0.4770 |
| $t^u$ | 0.2380 | 0.1755 | 0.0911 | 0.3010 | 0.1514 | 0.2314 | 0.1457 | 0.0788 |
| $\frac{1+t^d}{1+t^u}$ | 1.1139 | 1.0417 | 1.0647 | 1.0490 | 1.2052 | 1.0864 | 1.2666 | 1.3691 |

# Robustness to Trade and Tax Policies

- Tariff escalation is robust to various tax policies

| | $\theta = 3.35$<br>$\sigma = 4.08$ | $\theta = 4.43$<br>$\sigma = 6.44$ | $\theta = 8.52$<br>$\sigma = 8.41$ | $\theta = 2.5$<br>$\sigma = 4$ | $\theta = 5.5$<br>$\sigma = 4$ | $\alpha = 0.75$ | $\alpha = 0.25$ | $\alpha = 0$ |
|---|---|---|---|---|---|---|---|---|
| **B.** Optimal Import Tariffs & Production Subsidy | | | | | | | | |
| $t^d$ | 0.6290 | 0.3486 | 0.2026 | 8034 | 0.5062 | 0.5238 | 0.5411 | 0.4769 |
| $t^u$ | 0.2330 | 0.1488 | 0.0714 | 0.3524 | 0.1340 | 0.1299 | 0.1726 | 0.0788 |
| $s^u$ | 0.2798 | 0.1994 | 0.0899 | 0.3835 | 0.1640 | 0.2306 | 0.2336 | 0 |
| $\frac{1+t^d}{1+t^u}$ | 1.3211 | 1.1739 | 1.1225 | 1.3335 | 1.3283 | 1.3486 | 1.3142 | 1.3691 |
| **C.** Optimal Trade & Tax Policies | | | | | | | | |
| $t^d$ | 0.3295 | 0.1868 | 0.1375 | 0.3381 | 0.3388 | 0.3440 | 0.3377 | 0.3518 |
| $t^u$ | 0.0034 | 0.0028 | 0.0015 | 0.0029 | 0.0032 | 0.0030 | 0.0036 | 0.0027 |
| $v^u$ | -0.3001 | -0.2270 | -0.1183 | -0.426 | -0.1822 | -0.2560 | -0.2506 | -0.2624 |
| $s^u$ | 0.2985 | 0.2261 | 0.1185 | 0.4000 | 0.1818 | 0.2500 | 0.2500 | 0 |
| $\frac{1+t^d}{1+t^u}$ | 1.3250 | 1.1835 | 1.1358 | 1.3342 | 1.3345 | 1.3400 | 1.3329 | 1.3482 |

# Counterfactuals: Effects of Trump Tariffs and Retaliation

Here: Use estimates for $\theta$ and $\sigma$ from response in trade flows to tariffs ($\theta = 3.35$, $\sigma = 4.08$)

| | **A.** RoW tariff at 2017 level | | | **B.** RoW tariff at 2019 level | | |
|---|---|---|---|---|---|---|
| | $U_{US}$ | $U_{RoW}$ | $\frac{U_{US}}{U_{US,2017}}$ | $U_{US}$ | $U_{RoW}$ | $\frac{U_{US}}{U_{US,2017}}$ |
| US tariffs - 2017 level | 0.028422 | 0.131439 | | | | |
| US tariffs - 2019 level | 0.028479 | 0.131301 | 1.0020 | 0.028436 | 0.131329 | 1.0005 |
| 2019 US tariff only Downstream | 0.028459 | 0.131367 | 1.0013 | 0.028416 | 0.131396 | 0.9998 |
| 2019 US tariff only Upstream | 0.028437 | 0.131377 | 1.0005 | 0.028395 | 0.131406 | 0.9991 |
| Counterfactual Tariff only Downstream | 0.028488 | 0.131293 | 1.0023 | 0.028444 | 0.131322 | 1.0008 |
| Counterfactual Tariff only Upstream | 0.028443 | 0.131333 | 1.0007 | 0.028401 | 0.131360 | 0.9993 |
| Optimal US Import Tariffs | 0.028612 | 0.130663 | 1.0067 | 0.028566 | 0.130683 | 1.0051 |
| Optimal US Tax Policy | 0.029312 | 0.130611 | 1.0313 | 0.029264 | 0.130631 | 1.0296 |

Tax Levels

# Conclusions

- We provide a rationale for tariff escalation – a prevalent feature of real-world tariffs
- Relatively low input tariffs are not explained by a second-best correction to a domestic distortion
- Instead, input tariffs are less beneficial because they increase the price of intermediate inputs for final-good producers
  - This raises domestic downstream firms' costs
  - Induces a relocation of downstream firms abroad

# Derivations for the welfare approximation

$$\frac{dU_H}{U_H} = \left[ -\frac{dP_H}{P_H} + \frac{dR_H}{w_H L_H} \right], \tag{8}$$

$$\frac{dR_H}{w_H L_H} = b_F^H \times dt_H^d + \lambda_H^d \times \Omega_{F,H} \times dt_H^u, \tag{9}$$

$$\frac{dP_H}{P_H} = b_H^H \times \left( \frac{1}{1-\sigma} \frac{dM_H^d}{M_H^d} + \frac{dp_{H,H}^d}{p_{H,H}^d} \right) + b_F^H \times \left( \frac{dM_F^d}{M_F^d} \frac{1}{1-\sigma} + \frac{dp_{F,H}^d}{p_{F,H}^d} + dt_H^d \right) \tag{10}$$

$$\frac{dp_{i,i}^d}{p_{i,i}^d} = \alpha \frac{dw_i}{w_i} + (1-\alpha) \frac{dP_i^u}{P_i^u}, \tag{11}$$

$$(1-\alpha)\frac{dP_i^u}{P_i^u} = \left( \frac{dM_i^u}{M_i^u} \frac{1}{1-\theta} + \frac{dp_{i,i}^u}{p_{i,i}^u} \right) \Omega_{i,i} + \left( \frac{dM_j^u}{M_j^u} \frac{1}{1-\theta} + \frac{dp_{j,i}^u}{p_{j,i}^u} + dt_i^u \right) \Omega_{j,i} \tag{12}$$

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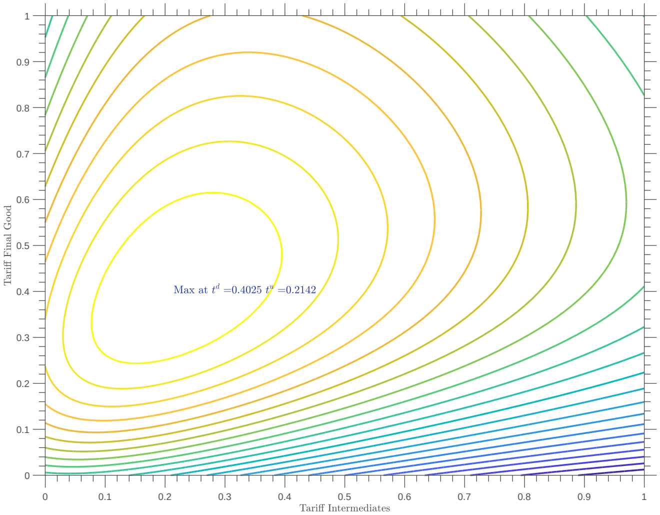
# Key Moments in First-Order Approximation

Statistics around the Zero Tariff Equilibrium

| $\Omega_{H,H}$ | $\Omega_{F,H}$ | $\Omega_{F,F}$ | $\Omega_{H,F}$ | $b_H^H$ | $b_F^H$ | $\lambda_H^d$ |
|---|---|---|---|---|---|---|
| 0.41 | 0.04 | 0.44 | 0.02 | 0.94 | 0.06 | 0.98 |

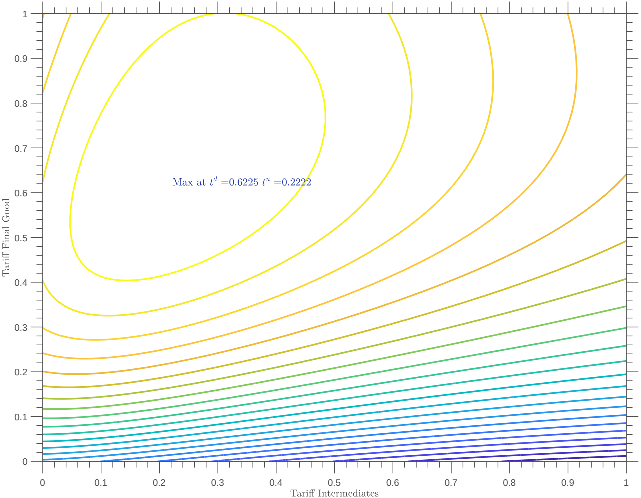
Notes: This table contains summary statistics of the endogenous aggregate variables relevant for the first order approximation around the zero tariff equilibrium.

# Optimal second-best input tariff is lower than the final-good tariff



# Tariff escalation persists with a domestic production subsidy

- We now introduce the closed-economy optimal subsidy $(s^u)^* = 1/\theta$



# Counterfactuals: Level of Taxes

| | **A.** RoW tariff at 2017 level | | | | **B.** RoW tariff at 2019 level | | | |
|---|---|---|---|---|---|---|---|---|
| | $t^d$ | $t^u$ | $\nu^u$ | $s^u$ | $t^d$ | $t^u$ | $\nu^u$ | $s^u$ |
| Optimal US Import Tariffs | 0.4175 | 0.2715 | | | 0.4176 | 0.2717 | | |
| Optimal US Tax Policy | 0.3270 | 0.0041 | -0.3023 | 0.2985 | 0.3269 | 0.0040 | -0.3023 | 0.2985 |

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