ECO862 - International Trade
Lecture 3: GFTs Static Models & the Trade Elasticity

Outline

- Armington Model (Static Models)
- Gains from trade (global)
- Pattern of Trade
- Trade Costs and Tastes
- Trade Response: Empirics

Static Trade Models

- Gains from trade (i.e. Δ integration) depend on level of trade & trade response to policy Δ
- Thus, gains depend on level of tariffs and Δ in tariffs or trade costs
  - Gains smaller from Δtariffs as no resources freed up
  - Gains larger to trade costs with positive tariffs - distorted economy.
  - Broad confusion about how gains depend on size of trade response (trade elasticity).
  - Key question: do trade costs respond to tariffs or vice versa? How costly is it to reduce trade costs?
- Key takeaway: Trade elasticity & trade share sufficient to measure aggregate gains regardless of micro margins because free entry relates changes in scale and production to change in trade from change in trade barriers.

Armington 1969

- Two symmetric countries: Home and Foreign
  - Easily generalized to n countries & asymmetries.
- Specialized in imperfect substitutes by source of production (nat'l product differentiation)
- CES preferences - love of variety
- Exogenous labor
- Same technology, *a*
- Trade barriers: iceberg costs, $\xi \geq 1$, & tariffs, $\tau \geq 1$

Consumer's problem

$$
\begin{aligned}
U &= \max C = \left[c_H^{\frac{\gamma-1}{\gamma}} + c_F^{\frac{\gamma-1}{\gamma}} \right]^{\frac{\gamma}{\gamma-1}}, \\
st &: P_H c_H + \tau P_F c_F = WL + T
\end{aligned}
$$

where $\tau \geq 1$ is tariff rebated lump sum, $T = (\tau - 1) P_F c_F$.

$$
c_H = \left(\frac{P_H}{P} \right)^{-\gamma} C, \; c_F = \left(\frac{\tau P_F}{P} \right)^{-\gamma} C
$$

$$
P = \left(P_H^{1-\gamma} + \tau^{1-\gamma} P_F^{1-\gamma} \right)^{\frac{1}{1-\gamma}}
$$

Technology

$$
\begin{aligned}
y &= aL = c_H + \xi c_H^* \\
y^* &= a^* L^* = \xi c_F + c_F^*
\end{aligned}
$$

$\xi \geq 1$ is an iceberg cost (melts in transit)With perfect competition, $P_H = W/A$, $P_F = \xi W^*/A^*$.

Gravity Equation

Aggregate expenditures on imports in home

$$\tau P_F c_F = (\tau\xi)^{1-\gamma} W^{*1-\gamma} P^{\gamma} C A^{*\gamma-1}$$

Expenditures on home goods

$$P_H c_H = W^{1-\gamma} P^{\gamma} C A^{\gamma-1}$$

Let λ be the domestic expenditure share

$$\lambda = \frac{P_H c_H}{\tau P_F c_F + P_H c_H}$$

Ratio of expenditures is then

$$g_x = \frac{1-\lambda}{\lambda} = \frac{(\xi\tau)^{1-\gamma} W^{*1-\gamma} A^{*\gamma-1}}{W^{1-\gamma} A^{\gamma-1}}$$

Trade and Armington elasticity

- Trade elasticity = $\frac{\partial \log g_x}{\partial \log(\xi\tau)} = \frac{\partial \log \frac{1-\lambda}{\lambda}}{\partial \log(\xi\tau)} = 1 - \gamma$

- Partial - only thing that changes (relative wages constant).

- Doesn't matter if change is from tariff or trade cost (global or unilateral).

- Armington elasticity is γ.

- Tight link between Trade & Armington elasticities
  - Armington relates Δ relative prices to Δrelative trade flows. $\frac{\partial \log \frac{1-\lambda}{\lambda}}{\partial \log\left(\frac{W^*/A^*}{W/A}\right)} = 1 - \gamma$
  - Trade elasticity includes response of trade to $\Delta' s$ in relative prices & Δ in relative prices to trade costs.

Gains from Trade

From budget constraint

$$PC = WL + T$$

Normalizing $W = 1$ and $L = 1$ yields

$$C = \frac{1 + T}{P}$$

With algebra find price level as a function of trade

$$P = a^{-1} \left(1 + \frac{1 - \lambda}{\lambda}\right)^{\frac{1}{1-\gamma}} = A^{-1} \cdot \lambda^{\frac{1}{\gamma-1}}$$

Notice foreign productivity absent - summarized by λ (domestic expenditure share)

Prices and trade barriers

Price effect depends on Δ in tariffs*trade costs

$$\ln \frac{P\left((\tau\xi)_1\right)}{P\left((\tau\xi)_0\right)} = \frac{1}{1-\gamma} \ln \frac{\lambda_1}{\lambda_0} \rightarrow \hat{P} = -\frac{\hat{\lambda}}{\gamma - 1}$$

Suppose we go from autarky to 50 percent trade

Given trade elasticity ranges from $(2, 11)$ we find $\hat{P} = -\frac{\ln(0.5)}{\gamma-1}$ ranges from $(0.693, 0.0693)$

Of course, these are for very different changes in trade costs (**key point**).

For a given change in trade barriers the effects are larger the more substitutable goods are!
Can you derive relationship between trade barriers and GFT?

Gains from Trade with tariffs

Gains from trade depends on tariff revenue

Assuming symmetry, from market clearing condition

$$y = c_H + \xi c_H^* = \left[P_H^{-\gamma} + \xi \left(\tau P_F \right)^{-\gamma} \right] P^{\gamma - 1} PC$$

Substitute $P_F = P_F^* \xi$ let $E = PC$, and $\zeta = \xi^{\gamma-1} \tau^{\gamma}$

$$y = \left[P_H^{-\gamma} + \zeta^{-1} P_F^{*-\gamma} \right] P^{\gamma-1} E$$

Notice that

$$P^{1-\gamma} = \left[P_H^{1-\gamma} + \tau \zeta^{-1} P_F^{*1-\gamma} \right]$$

Gains from Trade with tariffs

Assuming symmetry A=A* yields

$$P^{1-\gamma} = p_H^{1-\gamma}\left[1+\tau\zeta^{-1}\right]$$

which then yields

$$y = \frac{P_H^{-\gamma}\left[1+\xi^{1-\gamma}\tau^{-\gamma}\right]}{P_H^{1-\gamma}\left[1+\xi^{1-\gamma}\tau^{1-\gamma}\right]}E = \frac{\left[1+\zeta^{-1}\right]}{P_H\left[1+\tau\zeta^{-1}\right]}E = \frac{E}{P_H S}$$

where

$$S = \left(1+\tau\zeta^{-1}\right)/\left(1+\zeta^{-1}\right) = \frac{(1+g_x)\,\tau}{\tau+g_x}$$

** Tariff creates a wedge between expenditures & producer revenue ($\ln S$).

Gains from Trade with Tariffs

Rearranging market clearing conditions

$$C = \frac{P_H S y}{P}$$

Given $y = a$, $P_H = w/a$, & $w = 1$

$$C = \frac{S}{P}$$

and

$$\hat{C} = \hat{S} - \hat{P}$$

Two effects: trade on prices and trade on distortion

Gains from Trade with Tariffs

Recall $S = \frac{(1+g_x)\tau}{\tau+g_x}$. How does $\hat{S}$ change with tariffs?

$$\begin{aligned}
\widehat{S} &= \widehat{\tau} + \frac{g_X}{1+g_X}\widehat{g}_X - \frac{1}{\tau+g_X}\left(\tau\widehat{\tau} + g_X\widehat{g}_X\right) \\
&= \frac{1}{\gamma-1}\left[\frac{\gamma S}{\tau} - (\gamma-1)\right]\widehat{\lambda}
\end{aligned}$$

Suppose $\tau = 1$ then $S = 1$ and

$$\widehat{C} = \frac{\widehat{\lambda}}{\gamma-1} - \hat{P} = \frac{\widehat{\lambda}}{\gamma-1} - \frac{\widehat{\lambda}}{\gamma-1} = 0.$$

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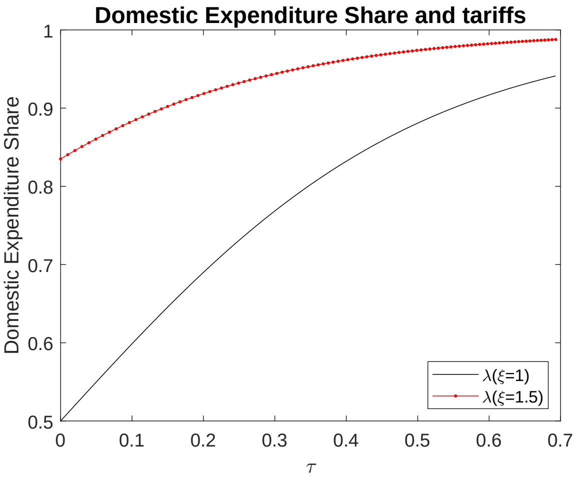
No cost to marginal increase in tariffs!

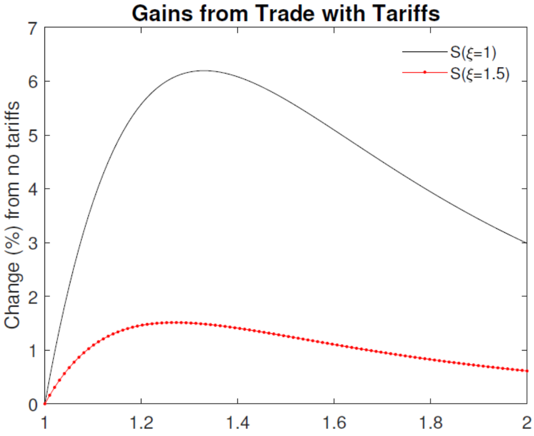
Gains from Trade with Tariffs - Numbers

Consider how trade depends on τ, ξ when $\gamma = 5$



Gains from Trade with Tariffs - Numbers

Consider how tariff distortion (S) depends on τ when $\gamma = 5$



Gains from Trade with Tariffs - Numbers

Consider 3 ways of reducing $\lambda_0 = 0.947$ to $\lambda_1 = 0.808$

γ	τ_0	ξ_0	τ_1	ξ_1	λ_0	S_0	$\hat{\lambda}$	$-\hat{P}$	$\hat{S}$	$\hat{C}$
5	1	**1.778**	1	**4/3**	0.947	1	-15.8	3.96	0	3.96
5										
5										

- Direct resource gain of $(\xi_1 - \xi_0)(1 - \lambda_0) \approx 2.4$

Gains from Trade with Tariffs - Numbers

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5	1	1.778	1	4/3	0.947	1	-15.8	3.96	0	3.96
5	**4/3**	4/3	**1**	4/3	0.947	1.0238	-15.8	3.96	-2.3	1.65
5										

- Large gain in case 1 vs 2 from resource gain of $(\xi_1 - \xi_0)(1 - \lambda_0)$

Gains from Trade with Tariffs - Numbers

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5	1	1.778	1	4/3	0.947	1	-15.8	3.96	0	3.96
5	4/3	4/3	1	4/3	0.947	1.0238	-15.8	3.96	-2.3	1.65
5	*4/3*	**4/3**	*4/3*	**1**	0.947	1.0238	-15.8	3.96	3.9	7.86

- Large gain in case 1 vs 2 from resource gain of $(\xi_1 - \xi_0)(1 - \lambda_0)$
- Larger gain in case 3 vs 1 because producer distortion reduced
- Note: changes in technology aren't free (Panama Canal) & should be netted out.
- Gains are about 1) Direct resource savings or 2) reallocation given resources, but do not consider how resources are accumulated (need dynamic model).

Gains from Trade without Tariffs - Static Models

- Without tariffs, the gains depend on how expenditure share changes.
- The trade elasticity then becomes the key parameter to recover the benefits from integration.
- This is true across a wide class of static models (locally or globally). (Arkolakis et al., 2012; Costinot and Rodríguez-Clare, 2014)
- There is much disagreement about the trade elasticity

Many Countries

- Extend model to include N countries.

$$
\begin{aligned}
U_j &= \max C_j = \left[\nu_{jj}^{\frac{1}{\theta}} c_{jj}^{\frac{\gamma-1}{\gamma}} + \left(\sum_{i=1}^{N} \left(\nu_{ij}^{\frac{1}{\theta}} c_{ij}^{\frac{\theta-1}{\theta}} \right)^{\frac{\theta}{\theta-1}} \right)^{\frac{\gamma-1}{\gamma}} \right]^{\frac{\gamma}{\gamma-1}}, \\
st &: P_{jj} c_{jj} + \sum_{i=1}^{N} \tau_{ij} P_{ij} c_{ij} = W_j L_j + T_j
\end{aligned}
$$

- Taste parameter ν_{ij}, Armington elasticity γ, and elasticity of subst. across foreign sources θ
- Nested nature implies that given some level of imports, X_j

$$
\begin{aligned}
c_{ij} &= \nu_{ji} \left(\tau_{ij} P_{ij} \right)^{-\theta} P_{j,-j}^{\theta-1} X_j \\
X_{ij} &= \nu_{ij} \tau_{ij}^{-\theta} P_{ij}^{1-\theta} P_{j,-j}^{\theta-1} X_j
\end{aligned}
$$

where $\mathrm{P}_{j,-j}$ is the import price deflator.

Many countries (pattern of trade)

Assume each country sets the same export price (why? why not?)

$$P_{ij} = \mu_i \xi_{ij} mc_i$$

then

$$X_{ij} = \nu_{ij} \tau_{ij}^{-\theta} \left(\mu_i \xi_{ij} mc_i\right)^{1-\theta} P_{j,-j}^{\theta-1} X_j$$

Many countries (pattern of trade)

Assume each country sets the same export price (why? why not?)

$$P_{ij} = \mu_i \xi_{ij} mc_i$$

then

$$X_{ij} = \nu_{ij} \tau_{ij}^{-\theta} \left(\mu_i \xi_{ij} mc_i\right)^{1-\theta} P_{j,-j}^{\theta-1} X_j$$

Shipping costs assumed to satisfy triangle inequalityTaking logs yields an estimating equation

$$\begin{aligned} X_{ij} &= \ln \nu_{ij} - \theta \ln \tau_{ij} + (1-\theta) \ln \left(\mu_i \xi_{ij} mc_i\right) + (1-\theta) \ln P_{j,j} + \ln X_j \\ X_{ijt} &= \ln \nu_{ij} - \theta \ln \tau_{ijt} + (1-\theta) \ln \xi_{ijt} + \delta_{jt} + \delta_{it} + \varepsilon_{ijt} \end{aligned}$$

Can estimate with global trade data

Big debate about exporter and importer fe?(How does it relate with development?)

But what is ν_{ij}? Proxy with language, colonial ties,....

Many countries & many products

With many goods g we can do more

$$x_{gjit} = \ln \nu_{gji} - \theta_g \ln \tau_{gjit} + \left(1 - \theta_g\right) \ln \xi_{gjit} + \delta_{gjt} + \delta_{git} + \varepsilon_{gjit}$$

With global trade data we can estimate these

With U.S. data alone, less restrictive supply factors

$$x_{gjit} = \ln \nu_{gji} - \theta_g \ln \tau_{gjit} + \left(1 - \theta_g\right) \ln \xi_{gjit} + \delta_{jt} + \delta_{git} + \varepsilon_{gjit}$$

Note we're allowing for θ, to be good-specific.

Some concerns

- Demand shocks
- Endogeneity (tariffs, trade costs, marginal cost)
- Zeros (trade matrix is sparse)
- Time aggregation (more sparse at high frequency. Why?)
- Product aggregation (global datasets more aggregate than tariff line)
- Dynamics (anticipation, temporary, delayed effects)

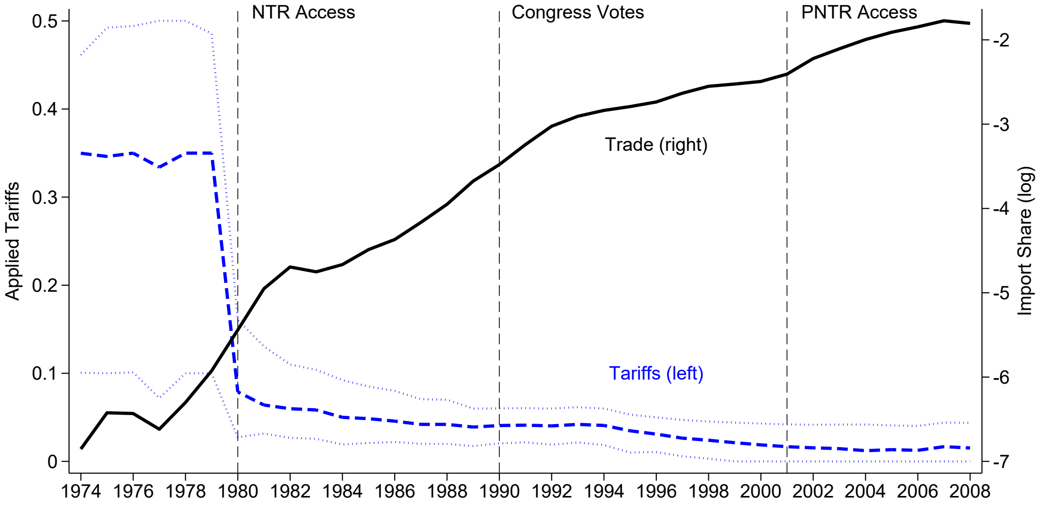
The trade elasticity

- Is the key object of interest in models
- Wide disagreement about its value owing to methods, episodes, ...
- Head and Mayer, 2014; Hillberry and Hummels, 2013; Bajzik et al., 2020 are good reviews.
- Typical range is 5-10 but there is no notion of horizon
- Conventional view is SR is lower than LR, but gap is unknown.
- A challenge is data and history.

Some evidence from U.S. China integration and disintegration

- Two changes in tariffs (1980, 2018).
  - In 1980, China went from NNTR to MFN schedule (Alessandria et al., 2021)
  - In 2018, China was moved from MFN to TW schedule (Alessandria et al., 2023b)

Tariffs and Trade with China



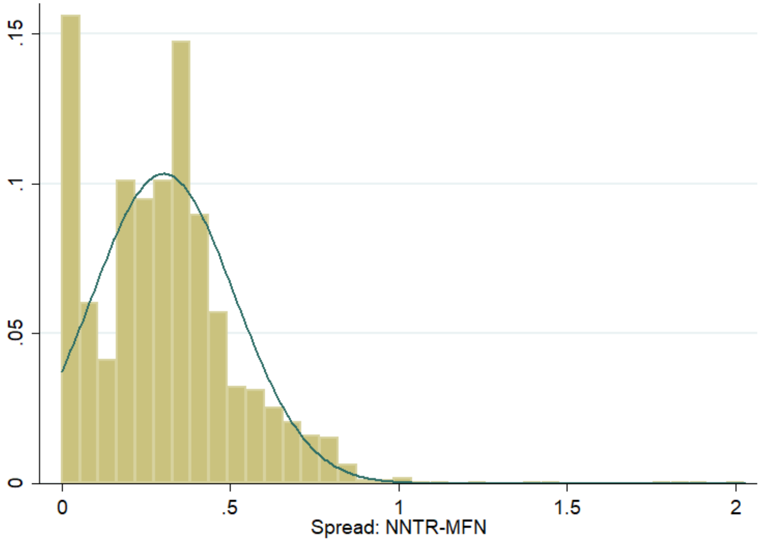
Some evidence from U.S. China integration and disintegration

- Estimate dynamics of substitution from 1980 liberalization

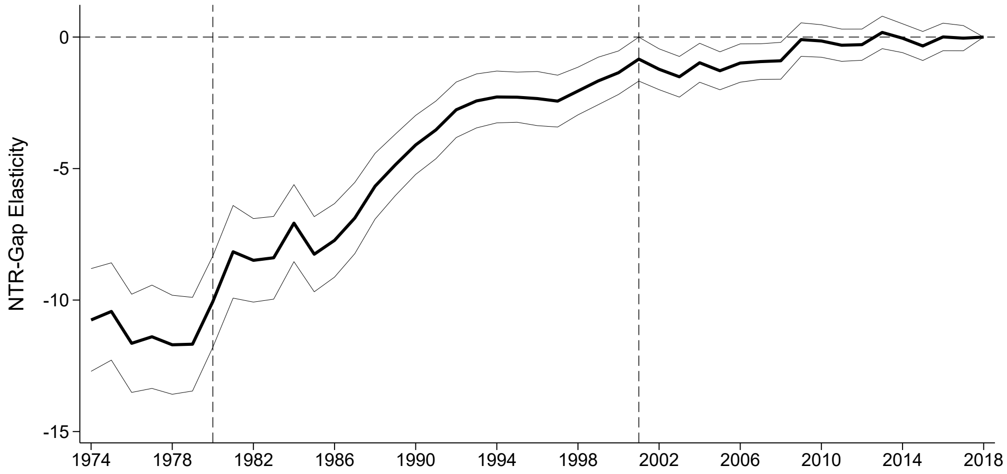
$$\log v_{igt} = \sum_{t=1974}^{2008} \left(\theta_t^{NTR} X_g^{NTR}\right) \mathbb{1}_{\{i=China \wedge t=t'\}} \quad (1)$$

$$+ \delta_{gt} + \delta_{ig} + \delta_{it} + \log c_{igt} + u_{igt},$$

NTR Gap (NNTR - MFN)



Dynamics of trade elasticity (1974-2018)



* Big jump when tariffs changed, continued gradual dynamics. Overall, response ˜10-12.

Some evidence from U.S. China integration and disintegration

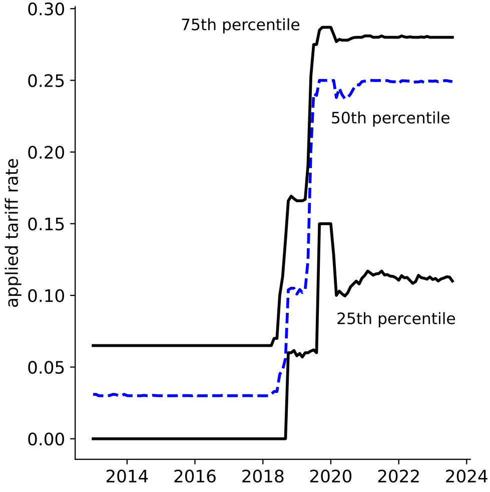
- Two changes in tariffs (1980, 2018).
  - In 1980, China went from NNTR to MFN schedule Alessandria et al., 2021
  - In 2018, China was moved from MFN to TW schedule (Alessandria et al., 2023b)
- Estimate dynamics of substitution from 2018 Trade War

$$\log v_{igt} = \sum_{t=2015}^{2023} \left(\theta_t^{NTR} X_g^{NTR} + \theta_t^{TW} X_g^{TW}\right) \mathbb{1}_{\{i=China \,\wedge\, t=t'\}} \qquad (2)$$

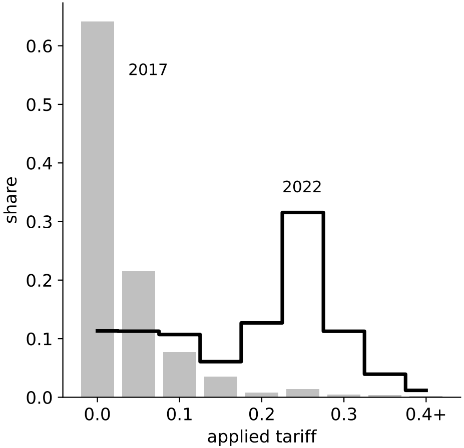
$$+ \delta_{gt} + \delta_{ig} + \delta_{it} + \log c_{igt} + u_{igt},$$

U.S. tariffs on Chinese imports (Trade War)

(a) Applied tariff levels

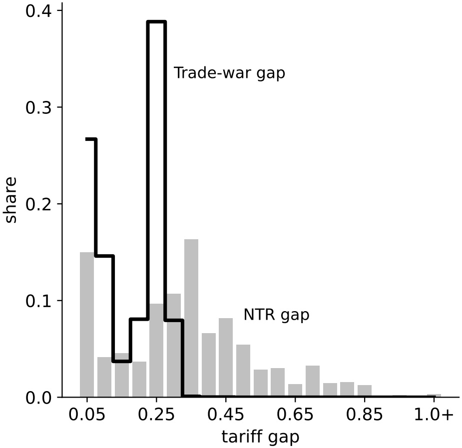


(b) Applied tariff levels

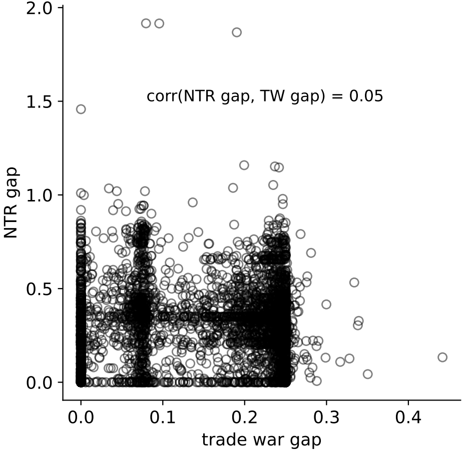


1980 vs 2018

(a) Tariff-gap distributions

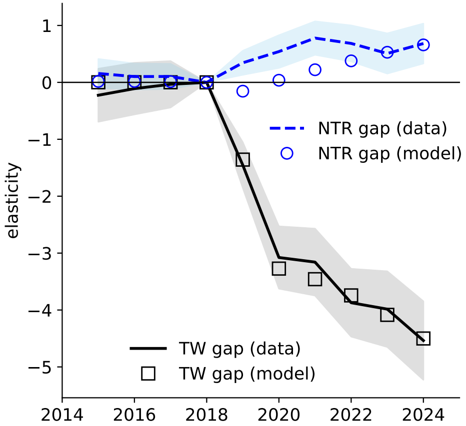


(b) Tariff-gap correlation

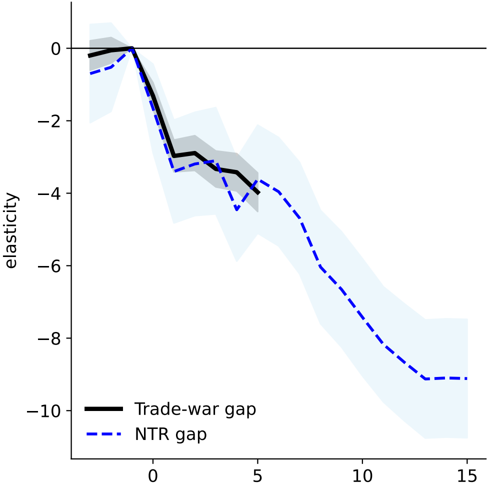


Elasticity of imports from China to the NNTR and trade-war gaps

(a) Elasticities



(b) Liberalization in 1980 vs trade war



Trade and Demand Elasticity

- In Armington model, trade and demand elasticity are the same
- In other static models they can differ, margins of adjustment
- In dynamic models, capture dynamics from destination-specific investments.
- But dynamics of trade elasticity also influenced by trade policy dynamics (Alessandria et al., 2023a)
  - Once and for all surprises (permanent)
  - Once and for anticipated (permanent - anticipated)
  - Phase-ins and Phase-outs (permanent - anticipated)
  - Temporary or uncertain
  - Return to these issues when we have dynamic models
- Have a look at some papers that estimate trade elasticities (Romalis, 2007, Khan and Khederlarian, 2021) or review estimates (Hillberry & Hummels, 2013)

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