When Tariffs Disrupt Global Supply Chains

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Motivation

- Intermediate inputs comprise as much as $2/3^{rds}$ of world trade
  - Some inputs purchased on anonymous world markets
  - Many transactions take place within global supply chains
- Distinctive features of global supply chains (WDR 2020)
  - Made possible by fragmentation of production processes
  - Impose non-trivial search costs
  - Require matching of compatible partners
  - Often involve relationship-specific investments
  - Often governed by incomplete contracts with frequent renegotiation
  - Typically observe many durable relationships ("stickiness")

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  - Typically observe many durable relationships ("stickiness")
- Burgeoning literature on supply chains addresses:
  - Participation; Geography of international sourcing; Implications for productivity and market structure; Persistence and significance of sparse firm-to-firm networks
  - Little on how trade policy might impact/reorganize global supply chains

Trade Policy vis-à-vis Intermediate Goods

- Pre 2018, trade barriers notably escalated
  - MFN tariffs in G20 countries 70-75% higher on final goods than on intermediates (Bown and Crowley, 2018)
  - We calculate: US average applied tariffs 2010-2017 on consumption goods more than 4x as high as on intermediates
  - Wtd-average applied tariff on intermediate goods only 0.9% in 2017

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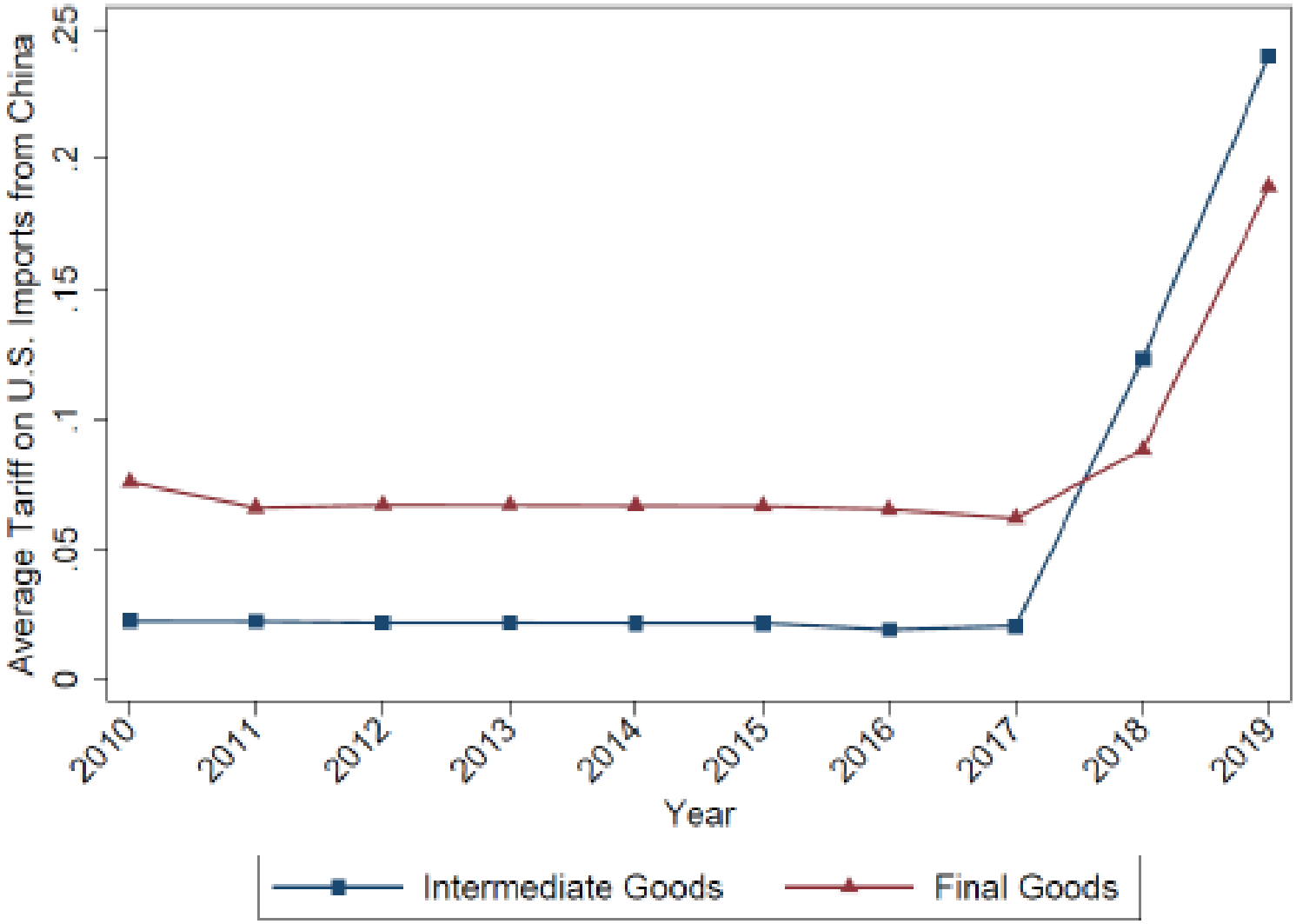
- History changes course: The Trump tariffs
  - By September 2018, 82% of intermediates from China covered, but only 29% of consumer goods (Bown)
  - Under Phase One deal, 93% of intermediates covered by special tariffs (Bown)
  - We calculate average applied tariffs on imports of consumer goods and intermediate goods from China:

Average Tariffs Applied by US to Imports from China



Supply Chain Disruption?

- Anecdotes from business press
  - Shift from China to Vietnam, Thailand, Indonesia, Malaysia
  - Variety of industries: electronics, furniture, hand luggage, auto parts
  - Variety of large firms: Samsonite, Cisco Systems, Macy's, Ingersoll-Rand

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- Diff-in-Diff Evidence of Supply Chain Disruption (à la Amiti et al.)
  - Monthly customs data for imports of intermediate goods at HTS10-country-of-origin level, January 2016 - October 2019, with product fixed effects

	Imports from China (1)	Imports from 13 LCCs (2)
Log Difference in Tariffs	-1.609**	0.441*
	(0.212)	(0.224)
R Squared	0.85	0.84
Obs	110132	110132

Goals of Paper

- Develop model of relational supply chains with many of the defining features described by *World Development Report* (2020).
- Study sourcing patterns, price and welfare effects of discriminatory unanticipated tariff shocks
  - Small tariffs: do not alter ideal location for search
  - Large tariffs: ideal location shifts to another country that is free from tariffs, or to home country (reshoring)
- Complement Ornelas and Turner (2008, 2012), Ornelas, Turner and Bickwit (2021) and Antràs and Staiger (2012) on hold up problems with customized inputs; our paper focuses instead on costly search and renegotiation

Foreign Sourcing with Search and Bargaining

Model Outline

- Two sectors
  - Homogeneous good, produced competitively with CRS
  - Differentiated products, monopolistic competition, relational supply chains
- Technology for differentiated products
  - Combines labor and composite intermediate good, Cobb Douglas
  - Composite requires continuum of inputs in fixed proportions
  - Inputs imported from cheapest source, or produced at home
- Search and Bargaining
  - A final producer pays to search for supplier of each input
  - Each supplier has match-specific productivity
  - Buyer can negotiate a short-term contract or resume search
- Long-run Equilibrium: Zero profits in anticipation of free trade

Preferences and Demand

Quasi-linear, constant elasticity, CES:

$$\Omega(X, Y) = Y + U(X)$$

$$U(X) = \begin{cases} \frac{\varepsilon}{\varepsilon - 1}\left(X^{\frac{\varepsilon-1}{\varepsilon}} - 1\right) & \text{for } \varepsilon \neq 1 \\ \log X & \text{for } \varepsilon = 1 \end{cases}.$$

$$X = \left[\int_0^n x(\omega)^{\frac{\sigma-1}{\sigma}}\, d\omega\right]^{\frac{\sigma}{\sigma-1}}, \sigma > 1,$$

$$\sigma > \varepsilon$$

which implies that demand for each brand is increasing in price index, P

Production

- Linear production of homogeneous good (or numeraire):

$$Y = \ell_Y$$

- Cobb-Douglas production of differentiated varieties:

$$x = z(\ell, m)$$

or

$$c(\phi) = \phi^{\alpha}$$

where ϕ is marginal cost of m

Search

- Symmetry across firms and inputs: All producers initially search in minimum wage country A
- At cost F, take draw from $G(\cdot)$ for input ω
  - Learn inverse match productivity a: can produce ω at unit cost wa
  - Negotiate short-term contract or pay F again and take another draw
- For simplicity: Assume no time between draws
- Optimal strategy: Reservation stopping rule $\bar{a}$ for each input

Search cost: $S(\bar{a}) = F + [1 - G(\bar{a})] S(\bar{a}) \Rightarrow$

$$S(\bar{a}) = \frac{F}{G(\bar{a})}$$

Bargaining

- Nash bargaining over per-unit price, with weights β and $1-\beta$
- "Nash-in-Nash": bargain separately with suppliers, take m as given
- Outside options:
  - For buyer: Resume search, find alternative supplier with expected price $\mu_\rho(\bar{a})$ at expected flow cost $f/G(\bar{a})$
  - For supplier: Zero

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  - For supplier: Zero
- Total cost of m units of intermediates (including search cost):

$$C(m) = w\mu_a(\bar{a})m + \frac{f}{\beta G(\bar{a})}$$

- Perceived marginal cost:

$$\phi = w\mu_a(\bar{a}) \Rightarrow \ MC < AC$$

Free-Trade Equilibrium

- Optimal search trade-off:

$$\bar{a} = \arg\min_{a} mw\mu_a(a) + \frac{f}{\beta G(a)}$$

- $\bar{a}$ is decreasing in mw:
  - greater stake in search outcome $\Rightarrow$ more intensive search

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- Input price after substitution of optimal search in Nash bargain:

$$\rho(a) = \beta w a + (1-\beta) w\bar{a}$$

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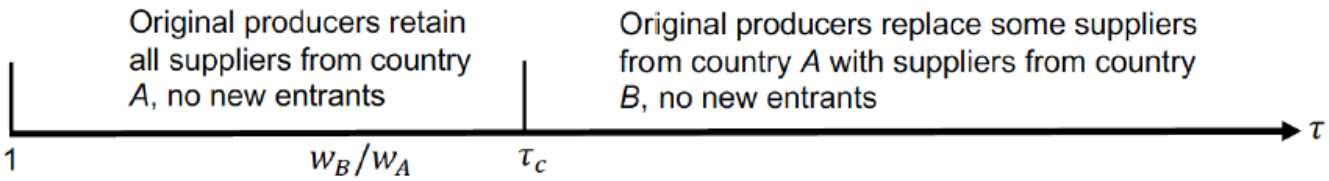
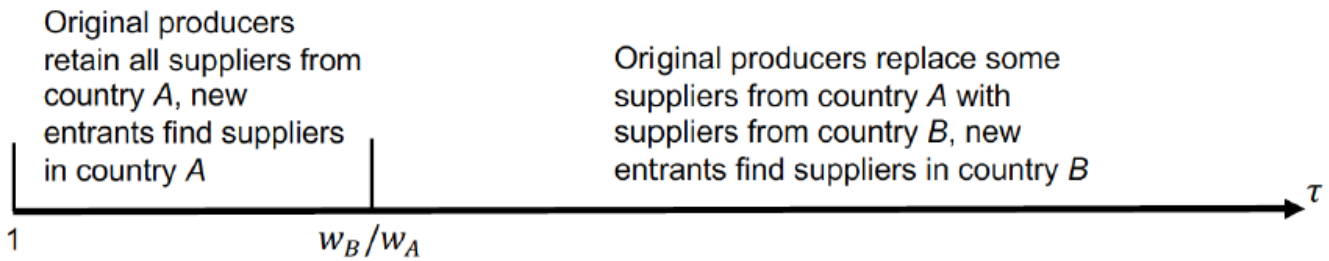
- Start tariff analysis from zero-profit equilibrium
  - Ad valorem tariff t on imports from country A, $\tau \equiv 1 + t$
  - Unanticipated: n pre-determined in expectation of $\tau = 1$

Sourcing Patterns



Elastic demand: $\varepsilon > 1$



Inelastic demand: $\varepsilon < 1$

- Small tariff: $\tau < w_B / w_A$

Renegotiation in Enduring Relationships (Small Tariff)

- Start with "small tariff": $\tau < w_B / w_A$
  - Actual and threatened searches remain in A
- Renegotiated price:

$$\rho(a, \tau) = \beta w a + (1 - \beta) w \bar{a}(\tau)$$

  - $\rho \downarrow$ if credible threat of more intensive search
  - $\rho \uparrow$ if threatend search is less discerning
- Optimal choice of $\bar{a}$: decreasing in $\tau m(\tau)$
  - Input prices rise iff $\bar{a}(\tau) > \bar{a}$
  - Input prices rise iff $\tau m(\tau) < m$ (smaller stake)
  - $\tau m(\tau) < m$ iff $\varepsilon > 1$
- These are TOT effects of tariff due to shared surplus

Replacing Unproductive Suppliers (Small Tariff)

- Producers might choose to terminate some relationships and recommence search for these inputs
- When, if ever, do firms replace some of their initial suppliers?
  - If $\varepsilon > 1$, $\bar{a}(\tau) > \bar{a} \Rightarrow$ no replacement of any suppliers by original producers
  - If $\varepsilon < 1$, $\bar{a}(\tau) < \bar{a}$ at original n
    - But profitability rises, because direct effect of input tariff offset by favorable effect on competition through $P \uparrow$
    - Tariff induces entry: $n \uparrow$
    - Entry reduces stake in search by original producers; entry continues until $\tau m^{\tau} = m(1)$
    - In equilibrium, $\bar{a}(\tau) = \bar{a}(1) \Rightarrow$ no replacement of any suppliers by original producers

Welfare Effects of Small Tariffs: Elastic Demand

- No new searches, no entry, so no new capital costs
- Tariff payments by firm accrue as tariff revenue
- So

$$V(\tau) = U(X^\tau) - n\rho^\tau m^\tau - n\ell^\tau$$

- Differentiating:

$$\frac{1}{n}\frac{dV^\tau}{d\tau} = \left(\frac{\sigma}{\sigma-1} - 1\right)\frac{d\ell^\tau}{d\tau} + \left(\frac{\sigma}{\sigma-1}\phi^\tau - \rho^\tau\right)\frac{dm^\tau}{d\tau} - m^\tau\frac{d\rho^\tau}{d\tau}$$

- Labor demand declines, m declines, terms of trade deteriorate
- Possibility of welfare enhancing tariff due to middle term ($\phi^\tau < \rho^\tau$), but plausible parameter values suggest not.

Larger Tariffs

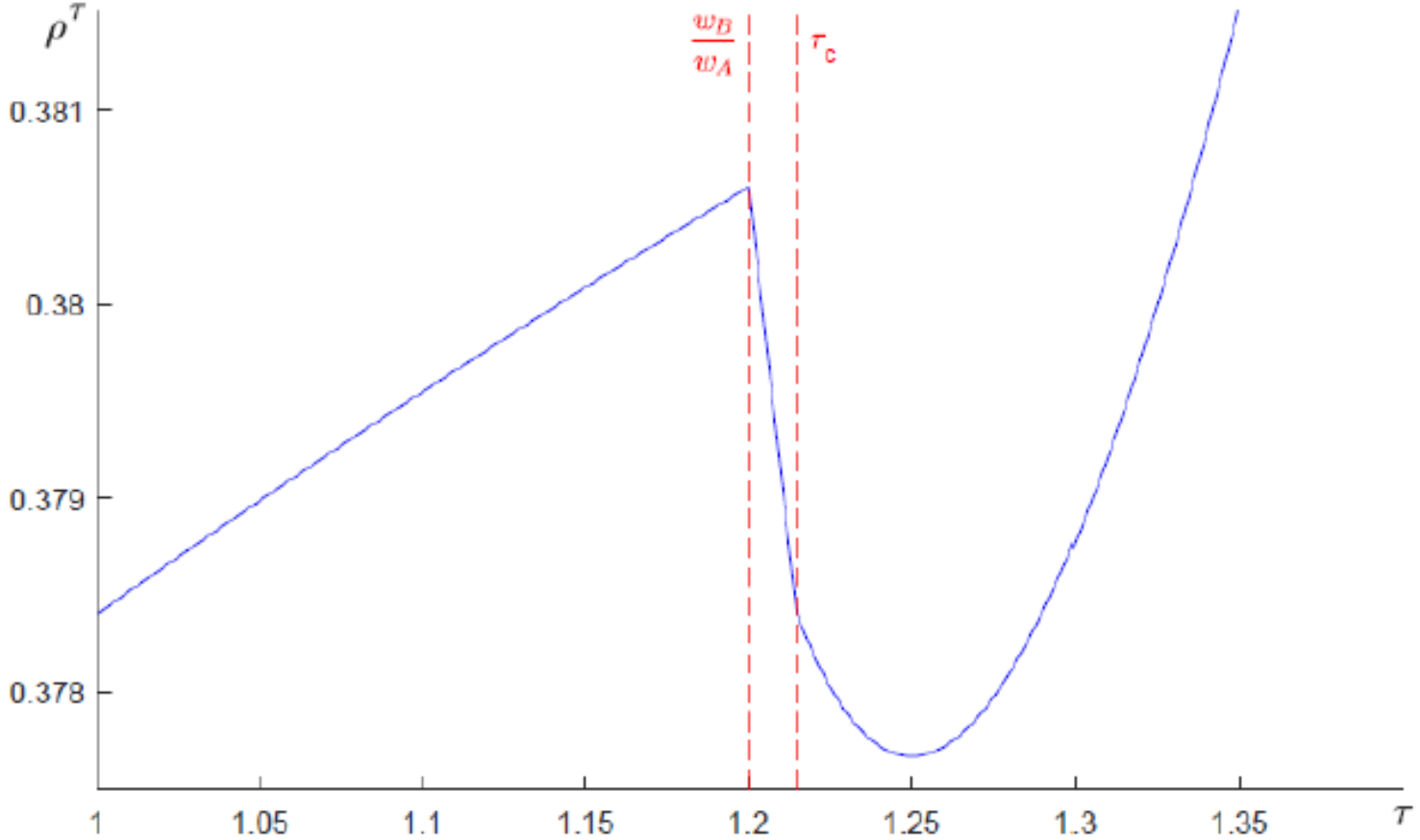
- Suppose $w_B < \tau w_A$
  - Country B could be foreign country exempt from tariff (e.g., Vietnam)
  - Country B could be the home country
- New searches (if any) and threatened searches take place in B
- Renegotiation with original suppliers: Suppliers share burden of tariff!
  - Consistent with Amiti et al. (2020)
  - Partial Effect: TOT improve!
- Reorganization of supply chains:
  - With $\varepsilon > 1$
    - $\tau < \tau_c \Rightarrow$ no replacement (room to bargain)
    - $\tau > \tau_c \Rightarrow$ replace range of least productive suppliers
  - With $\varepsilon < 1$, replace range of least productive suppliers
  - Replacement $\Rightarrow$ Vinerian trade diversion, harms TOT

Effect of Tariffs on TOT

Elastic Demand

$\sigma = 5, \theta = 4, \varepsilon = 1.5, \alpha = \beta = 0.5$

$w_A = 0.5, w_B = 0.6$



Welfare Effects of Tariffs

Elastic Demand, B is Foreign Country

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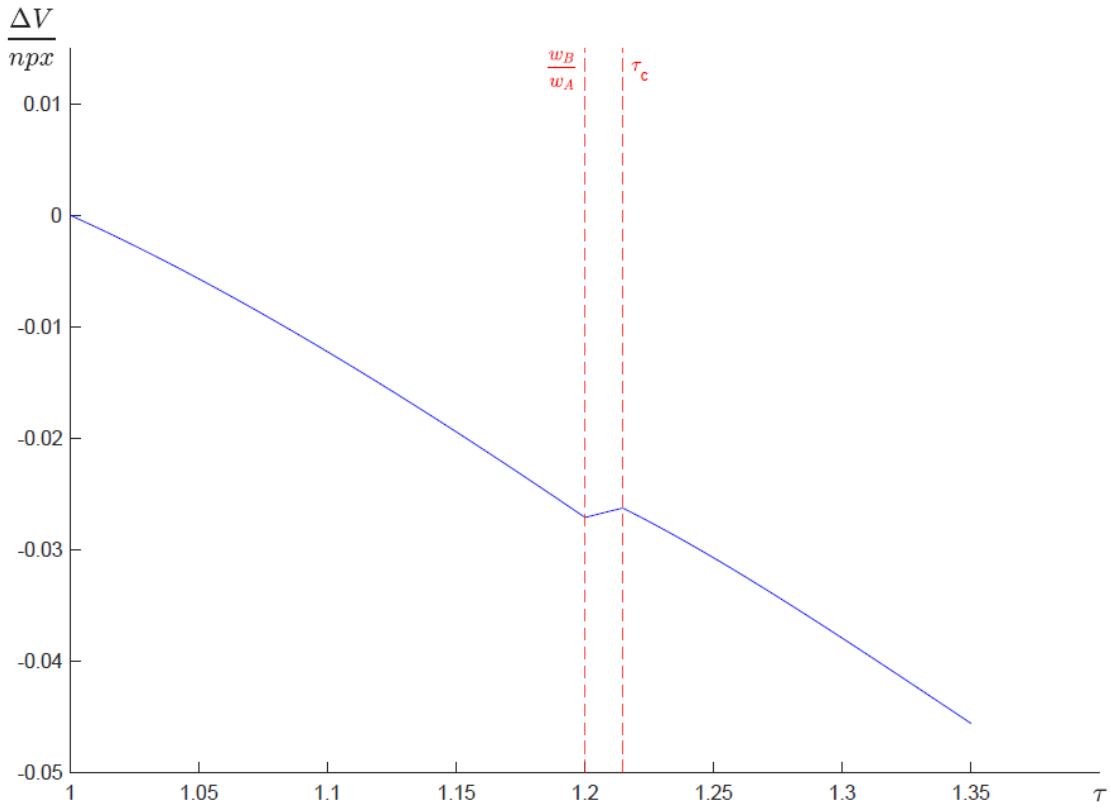

Figure: Welfare Effects of Unanticipated Tariffs: Elastic Demand

Welfare Effects of Tariffs

Inelastic Demand, B is Foreign Country

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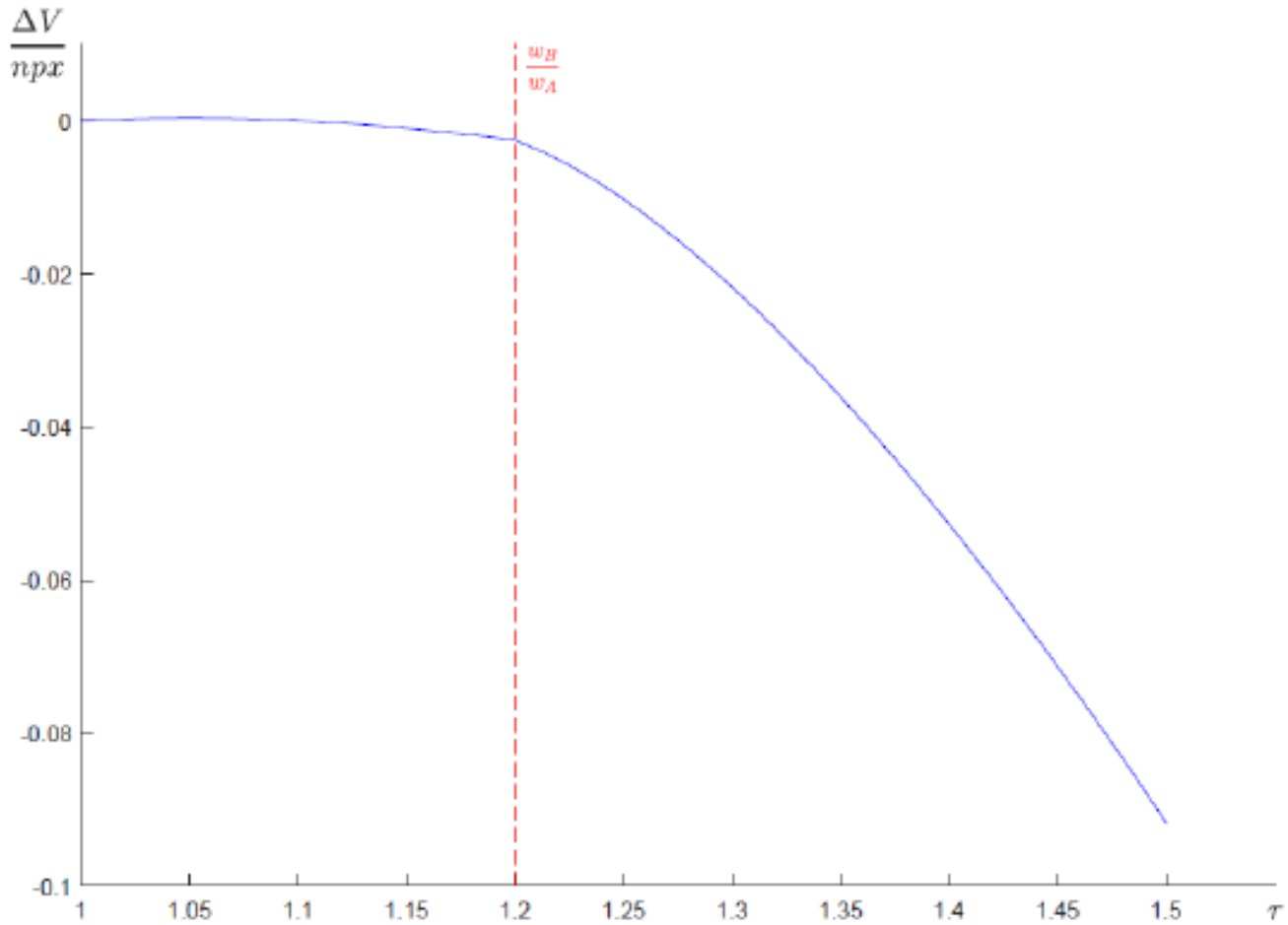
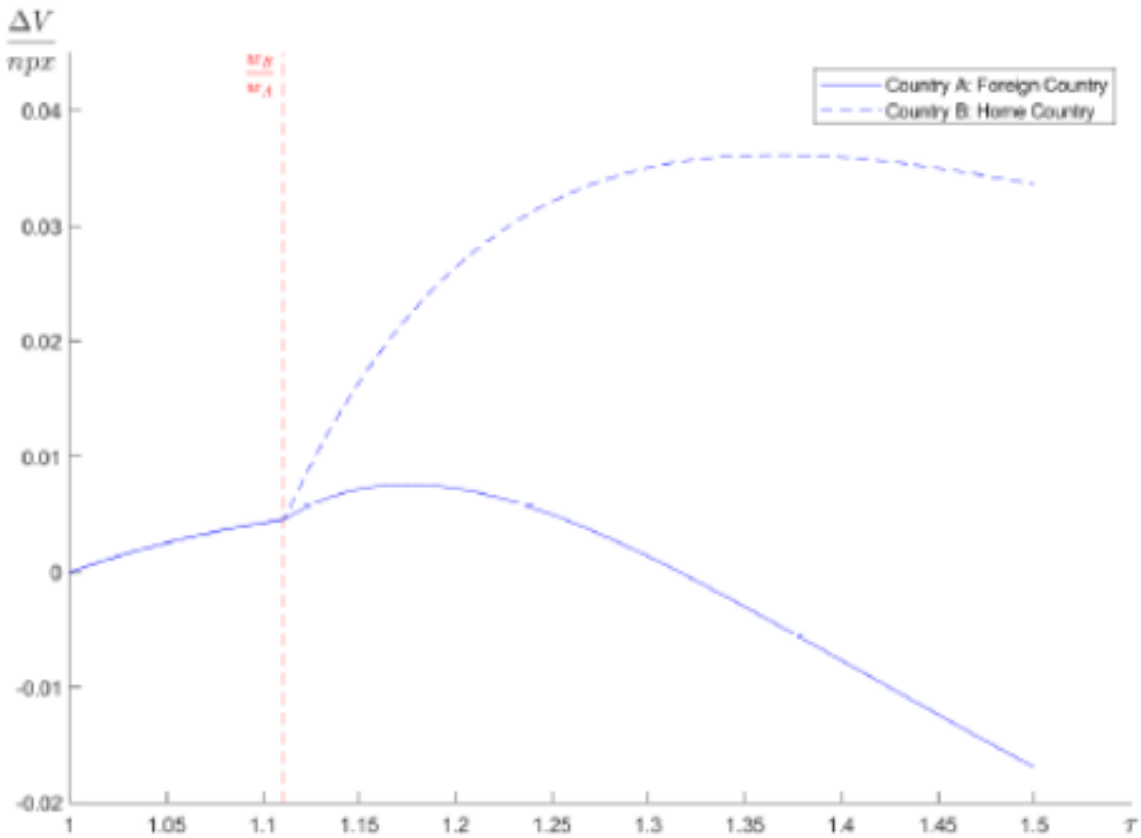


Welfare Effects of Tariffs

Inelastic Demand, Weak Bargaining Position

$\sigma = 5, \theta = 4, \varepsilon = 0.3, \alpha = \beta = 0.3$

$w_A = 0.9, w_B = 1$



Conclusions

- New mechanisms for tariffs to affect prices and welfare:
  - Price negotiations conducted in shadow of renewed search. Input prices rise (fall) if incentive for search reduced (intensified)
  - Bargaining drives a wedge between marginal cost of inputs as perceived by final-good producers and their true social cost — due to independent bargaining with myriad suppliers
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  - Large tariffs can generate Vinerian trade diversion; part of the cost "hidden" in extra search costs
- Elements missing from analysis:
  - Heterogeneous suppliers with comparative advantage in different inputs – which could explain multi-country sourcing
  - Time for search: slow adjustment (major complication)
  - Investment in customization of inputs that generates hold-up problems, as in Ornelas and Turner (2008) and Antràs and Staiger (2012)