Online Appendix A: Analytical Appendix

When Tariffs Disturb Global Supply Chains
(Not for Publication)

by

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Section 1 Introduction

This appendix provides proofs and derivations for the Propositions and analytical expressions in the main text. Section numbers in the appendix correspond to those in the main text. We also derive the analytical expressions used in the calibration exercise.

Section 2 Foreign Sourcing with Search and Bargaining

We start from the bargaining game, which determines the payment to a supplier with inverse match productivity a for one unit of the intermediate input. The Nash bargaining solution solves

$$\rho\left(a\right) = \arg\max_{q}\left(qm - wam\right)^{1-\beta}\left[\mu_{\rho}\left(\bar{a}\right)m + \frac{f}{G\left(\bar{a}\right)} - qm\right]^{\beta}.$$

The first-order condition for the maximization on the right-hand side yields

$$\frac{1-\beta}{\rho\left(a\right) - wa} = \frac{\beta}{\mu_{\rho}\left(\bar{a}\right) + \frac{f}{mG\left(\bar{a}\right)} - \rho\left(a\right)}$$

and therefore

$$\rho\left(a\right) = \beta wa + \left(1-\beta\right)\mu_{\rho}\left(\bar{a}\right) + \left(1-\beta\right)\frac{f}{mG\left(\bar{a}\right)}.$$

Taking the conditional mean of both sides of this equation for $a \le \bar{a}$, we have

$$\mu_{\rho}\left(\bar{a}\right) = w\mu_{a}\left(\bar{a}\right) + \frac{1-\beta}{\beta}\frac{f}{mG\left(\bar{a}\right)}. \tag{A.1}$$

Substituting this result back into the $\rho\left(a\right)$ function then gives

$$\rho\left(a\right) = \beta wa + \left(1-\beta\right)w\mu_{a}\left(\bar{a}\right) + \frac{1-\beta}{\beta}\frac{f}{mG\left(\bar{a}\right)}, \tag{A.2}$$

which is equation (4) in the main text. Next we use (5), the first-order condition for $\bar{a}$. This states

$$mw\mu_{a}'\left(\bar{a}\right) = \frac{fg\left(\bar{a}\right)}{\beta G\left(\bar{a}\right)^{2}}. \tag{A.3}$$

Note, however, that

$$\mu_{a}\left(\bar{a}\right) = \frac{1}{G\left(\bar{a}\right)}\int_{0}^{\bar{a}} ag(a)da$$

and therefore

$$\mu_{a}'\left(\bar{a}\right)G\left(\bar{a}\right) = g\left(\bar{a}\right)\left[\bar{a} - \mu_{a}\left(\bar{a}\right)\right]. \tag{A.4}$$

Substituting this into (A.3), we obtain

$$w\left[\bar{a} - \mu_{a}\left(\bar{a}\right)\right] = \frac{f}{\beta mG\left(\bar{a}\right)}. \tag{A.5}$$

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Substituting (A.5) into (A.2) then yields equation (6),

$$\rho(a) = \beta w \left[a - \mu_a(\bar{a}) \right] + \beta w \mu_a(\bar{a}) + (1 - \beta) w \bar{a}$$
$$= \beta w a + (1 - \beta) w \bar{a}.$$

We next use the demand equation (3), the pricing equation (7), and (A.1) to compute operating profits. These profits are

$$\pi_o = x(p - c) - \frac{1 - \beta}{\beta} \frac{f}{G(\bar{a})} - f_o,$$

where

$$p = \frac{\sigma}{\sigma - 1} c,$$

$$x = X \left(\frac{p}{P} \right)^{-\sigma} = X P^\sigma \left(\frac{\sigma}{\sigma - 1} c \right)^{-\sigma}, \tag{A.6}$$

and the aggregate cost of m units of the intermediate input is

$$w \mu_a(\bar{a}) m + \frac{1 - \beta}{\beta} \frac{f}{G(\bar{a})}.$$

Therefore,

$$\pi_o = X P^\sigma \frac{(\sigma - 1)^{\sigma - 1}}{\sigma^\sigma} c^{1 - \sigma} - \frac{1 - \beta}{\beta} \frac{f}{G(\bar{a})} - f_o, \tag{A.7}$$

where

$$c = c \left[w \mu_a(\bar{a}) \right],$$

as stated in equation (8). By Shephard's Lemma, m is given by

$$m = X P^\sigma \frac{(\sigma - 1)^\sigma}{\sigma^\sigma} c^{-\sigma} c'. \tag{A.8}$$

A firm chooses $\bar{a}$ to maximize profits net of search costs, taking P and X as given. That is,

$$\bar{a} = \arg\max_a X P^\sigma \frac{(\sigma - 1)^{\sigma - 1}}{\sigma^\sigma} c \left[w \mu_a(a) \right]^{1 - \sigma} - \frac{1 - \beta}{\beta} \frac{f}{G(a)} - \frac{f}{G(a)} - f_o$$

$$= \arg\max_a X P^\sigma \frac{(\sigma - 1)^{\sigma - 1}}{\sigma^\sigma} c \left[w \mu_a(a) \right]^{1 - \sigma} - \frac{f}{\beta G(a)} - f_o.$$

For an interior solution, the first-order condition is

$$-X P^\sigma \frac{(\sigma - 1)^\sigma}{\sigma^\sigma} c \left[w \mu_a(\bar{a}) \right]^{-\sigma} c' \left[w \mu_a(\bar{a}) \right] w \mu_a'(\bar{a}) + \frac{f g(\bar{a})}{\beta G(\bar{a})^2} = 0,$$

which is the same as (5) in view of (A.8). Using Assumptions 1 and 2, this condition can be written

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as

$$-\alpha X P^{\sigma} \frac{(\sigma-1)^{\sigma}}{\sigma^{\sigma}} \left(w\frac{\theta}{\theta+1}\bar{a}\right)^{-\alpha(\sigma-1)-1} \left(w\frac{\theta}{\theta+1}\right) + \theta\frac{f}{\beta\bar{a}^{\theta+1}} = 0.$$

Therefore the second-order condition for profit maximization is satisfied at the optimal choice of $\bar{a}$ if and only if $\theta > \alpha(\sigma-1)$, as stipulated in Assumption 3. This first-order condition can be expressed as

$$\bar{a}^{\theta-\alpha(\sigma-1)} X P^{\sigma} = \frac{\theta f}{\alpha\beta} \left(\frac{w\theta}{\theta+1}\right)^{\alpha(\sigma-1)} \left(\frac{\sigma}{\sigma-1}\right)^{\sigma}. \tag{A.9}$$

Substituting this expression into (A.7) yields

$$\pi_o - \frac{f}{G(\bar{a})} = \frac{\theta-\alpha(\sigma-1)}{\beta\alpha(\sigma-1)} f\bar{a}^{-\theta} - f_o.$$

The free entry condition is

$$\pi_o - \frac{f}{G(\bar{a})} = f_e,$$

which, together with the previous equation, yields equation (10):

$$\bar{a}^{\theta} = \frac{f}{f_o+f_e} \frac{\theta-\alpha(\sigma-1)}{\beta\alpha(\sigma-1)}. \tag{A.10}$$

The solution to this cutoff is interior if and only if

$$\frac{f}{f_o+f_e} \frac{\theta-\alpha(\sigma-1)}{\beta\alpha(\sigma-1)} < 1.$$

Substituting (A.10) and $X P^{\sigma} = P^{\sigma-\varepsilon}$ into (A.9) provides a solution for P. And substituting this equation into

$$P = \frac{\sigma}{\sigma-1} \left(w\frac{\theta}{\theta+1}\bar{a}\right)^{\alpha} n^{-\frac{1}{\sigma-1}} \tag{A.11}$$

provides a solution for n. Note that

$$\hat{n} = (\sigma-1)\left(\alpha\widehat{\bar{a}} - \hat{P}\right),$$

where a hat over a variable represents a proportional rate of change, e.g., $\hat{y} = dy/y$. For an increase in the search cost f we have, from (A.9),

$$\hat{P} = \frac{\hat{f} - [\theta-\alpha(\sigma-1)]\widehat{\bar{a}}}{\sigma-\varepsilon}$$

and from (A.10),

$$\widehat{\bar{a}} = \frac{1}{\theta}\hat{f}.$$

Therefore,

$$\hat{P} = \frac{\alpha(\sigma-1)}{\theta(\sigma-\varepsilon)}\hat{f},$$

$$\hat{n} = \frac{\alpha(\sigma-1)}{\theta}\frac{1-\varepsilon}{\sigma-\varepsilon}\hat{f}.$$

These results are summarized in

Lemma A.1 *Suppose Assumptions 1-3 hold and*

$$\frac{f}{f_o + f_e}\frac{\theta - \alpha(\sigma-1)}{\beta\alpha(\sigma-1)} < 1.$$

Then lower search costs f lead to a lower cutoff $\bar{a}$ and a lower price index P. They also generate more variety n for $\sigma > \varepsilon > 1$.

Section 3 Unanticipated Tariffs

Section 3.1 Small Tariffs

In this case, the ex-factory price paid to a foreign supplier with inverse match productivity a is $\rho(a,\tau)$, which is the solution to

$$\rho(a,\tau) = \arg\max_q \left[\tau\mu_\rho[\bar{a}(\tau),\tau] + \frac{f}{m(\tau)G[\bar{a}(\tau)]} - \tau q\right]^\beta (q - wa)^{1-\beta}.$$

This f.o.b. price excludes the tariff levy. The first-order condition for this maximization problem is

$$\frac{1-\beta}{\rho(a,\tau) - wa} = \frac{\beta}{\mu_\rho[\bar{a}(\tau),\tau] + \frac{f}{\tau m(\tau)G[\bar{a}(\tau)]} - \rho(a,\tau)},$$

which yields

$$\rho(a,\tau) = \beta wa + (1-\beta)\mu_\rho[\bar{a}(\tau),\tau] + (1-\beta)\frac{f}{\tau m(\tau)G[\bar{a}(\tau)]}. \tag{A.12}$$

Taking conditional expectations on both sides of this equation for $a \leq \bar{a}(\tau)$, we find

$$\mu_\rho[\bar{a}(\tau),\tau] = w\mu_a[\bar{a}(\tau)] + \frac{1-\beta}{\beta}\frac{f}{\tau m(\tau)G[\bar{a}(\tau)]}. \tag{A.13}$$

Next, substituting this expression into (A.12), we obtain

$$\rho(a,\tau) = \beta wa + (1-\beta)w\mu_a[\bar{a}(\tau)] + \frac{1-\beta}{\beta}\frac{f}{\tau m(\tau)G[\bar{a}(\tau)]}, \tag{A.14}$$

which is equation (11) in the main text. As explained in the text, using the optimal search cutoff $\bar{a}(\tau)$ yields

$$w\{\bar{a}(\tau) - \mu_a[\bar{a}(\tau)]\} = \frac{f}{\beta\tau m(\tau)G[\bar{a}(\tau)]}. \tag{A.15}$$

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Now substitute this equation into (A.14) to obtain

$$\rho(a, \tau) = \beta w a + (1 - \beta) w \bar{a}(\tau).$$ (A.16)

Next note that it is cheaper to sources inputs from the original supplier a whenever

$$\tau \rho(a, \tau) \leq \tau \mu_\rho[\bar{a}(\tau), \tau] + \frac{f}{m(\tau) G[\bar{a}(\tau)]}.$$

Using (A.13) and (A.15), the right-hand side of this inequality equals $\tau w_A \bar{a}(\tau)$. Therefore this inequality can be expressed as

$$a \leq \bar{a}(\tau).$$

From this result, we have

Lemma A.2 *For a given $\bar{a}(\tau)$ the cost minimizing cutoff a_c is*

$$a_c = \min\{\bar{a}(\tau), \bar{a}\}.$$

As explained in the main text, the marginal cost of m is given by equation (15),

$$\phi^\tau = \beta \frac{G(a_c)}{G(\bar{a})} \tau w \mu_a(a_c) + \left[1 - \beta \frac{G(a_c)}{G(\bar{a})}\right] \tau w \mu_a(\bar{a}^\tau)$$

and then optimal (mark-up) pricing implies

$$p^\tau = \frac{\sigma}{\sigma - 1} c(\phi^\tau).$$

Using Assumption 2 and Lemma A.2, the marginal cost can be expressed as

$$\phi^\tau = \begin{cases} \frac{\theta}{\theta+1} \tau w \bar{a}^\tau & \text{for } \bar{a}^\tau < \bar{a} \\ \beta \frac{\theta}{\theta+1} \tau w \bar{a} + (1 - \beta) \frac{\theta}{\theta+1} \tau w \bar{a}^\tau & \text{for } \bar{a}^\tau > \bar{a} \end{cases}.$$ (A.17)

This is the MM curve in Figure 2.

We next derive the NN curve, using the first-order condition for $\bar{a}^\tau$ in (A.15), Shephard's Lemma $m^\tau = x^\tau c'(\phi^\tau)$, the expression for the demand for variety ω in (A.6), and the expression for the price index, $P^\tau = p^\tau (n^\tau)^{-1/(\sigma-1)}$. This expression of the price index assumes that all firms, new and old, charge the same price p^τ, which we verify below. First, in the Pareto case (A.15) becomes

$$w \bar{a}(\tau)^{\theta+1} = \frac{f(\theta + 1)}{\beta \tau m(\tau)}.$$ (A.18)

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Second,

$$m^\tau = X^\tau \left(\frac{p^\tau}{P^\tau}\right)^{-\sigma} c'\left(\phi^\tau\right) \tag{A.19}$$

$$= X^\tau \left(n^\tau\right)^{-\frac{\sigma}{\sigma-1}} c'\left(\phi^\tau\right) = \left(P^\tau\right)^{-\varepsilon} \left(n^\tau\right)^{-\frac{\sigma}{\sigma-1}} c'\left(\phi^\tau\right)$$

$$= \left(p^\tau\right)^{-\varepsilon} \left(n^\tau\right)^{-\frac{\sigma-\varepsilon}{\sigma-1}} c'\left(\phi^\tau\right)$$

Combining these equations, we obtain

$$\frac{(\theta+1)f}{w\beta\left(\bar{a}^\tau\right)^{\theta+1}} = \tau\left(n^\tau\right)^{-\frac{\sigma-\varepsilon}{\sigma-1}} \left(p^\tau\right)^{-\varepsilon} c'\left(\phi^\tau\right) \ ,$$

which is equation (18) in the main text. Using $p^\tau = c\left(\phi^\tau\right)\sigma/\left(\sigma-1\right)$ and $c\left(\phi^\tau\right) = \left(\phi^\tau\right)^\alpha$, this equation becomes

$$\frac{(\theta+1)f}{w\beta\left(\bar{a}^\tau\right)^{\theta+1}} = \tau\left(n^\tau\right)^{-\frac{\sigma-\varepsilon}{\sigma-1}} \left(\frac{\sigma}{\sigma-1}\right)^{-\varepsilon} \alpha\left(\phi^\tau\right)^{\alpha(1-\varepsilon)-1} \ . \tag{A.20}$$

This implies that the NN curve is higher the greater is the tariff rate and that all along this curve,

$$\hat{\phi}^\tau = \frac{\theta+1}{1-\alpha\left(1-\varepsilon\right)}\widehat{\bar{a}}^\tau.$$

The denominator is positive for all $\varepsilon > 0$, and since $\varepsilon < \sigma$ and $\theta > \alpha\left(\sigma-1\right)$, $\theta+1 > 1+\alpha\left(\varepsilon-1\right)$. Therefore the elasticity of the NN curve is larger than one. The upward shift of the curve in response to a rise in τ satisfies

$$\hat{\phi}^\tau = \frac{1}{1-\alpha\left(1-\varepsilon\right)}\hat{\tau}.$$

Therefore, ϕ^τ rises proportionately less for $\varepsilon > 1$. As a result, the marginal cost ϕ^τ rises, holding constant the number of firms.

We show at the end of this section that the NN curve is steeper than the MM curve for general distribution functions (i.e., not necessarily Pareto), as long as the choice of $\bar{a}$ that maximizes profits satisfies the second-order condition. In this event the above comparative static results also hold.

Next, consider the incentives for new firms to enter. For $\varepsilon > 1$, equations (16), (17) and (18) imply

$$\hat{\phi}^\tau = \frac{\theta+1-\gamma^\tau}{\theta+1-\gamma^\tau-\gamma^\tau\alpha\left(\varepsilon-1\right)}\hat{\tau} \tag{A.21}$$

and

$$\widehat{\bar{a}}^\tau = \frac{\alpha\left(\varepsilon-1\right)}{\theta+1-\gamma^\tau-\gamma^\tau\alpha\left(\varepsilon-1\right)}\hat{\tau}, \tag{A.22}$$

where

$$\gamma^\tau = \frac{(1-\beta)\bar{a}^\tau}{\beta\bar{a}+(1-\beta)\bar{a}^\tau}.$$

Using (A.7) and (A.17), the objective function of a potential entrant is

$$\pi\left(\tau\right) = \max_{a} P\left(\tau\right)^{\sigma-\varepsilon} \frac{\left(\sigma-1\right)^{\sigma-1}}{\sigma^{\sigma}} \left[\tau w \mu_a\left(a\right)\right]^{\alpha(1-\sigma)} - \frac{f}{\beta G\left(a\right)} - f_o - f_e.$$

Therefore $\pi'\left(\tau\right) > 0$ if and only if $P\left(\tau\right)^{\sigma-\varepsilon} \tau^{\alpha(1-\sigma)}$ is rising in τ. However, using (A.21) and $\theta > \alpha\left(\sigma-1\right)$ we obtain

$$\begin{aligned}
\frac{\left(\sigma-\varepsilon\right)\hat{P}^{\tau} - \alpha\left(\sigma-1\right)\hat{\tau}}{\alpha\hat{\tau}} &= \frac{\left(\sigma-\varepsilon\right)\hat{\phi}^{\tau} - \left(\sigma-1\right)\hat{\tau}}{\hat{\tau}} \\
&= \frac{\left(\theta+1-\gamma^{\tau}\right)\left(\sigma-\varepsilon\right)}{\theta+1-\gamma^{\tau}-\gamma^{\tau}\alpha\left(\varepsilon-1\right)} - \left(\sigma-1\right) \\
&< \frac{\left[\alpha\left(\sigma-1\right)+1-\gamma^{\tau}\right]\left(\sigma-\varepsilon\right)}{\alpha\left(\sigma-1\right)+1-\gamma^{\tau}-\gamma^{\tau}\alpha\left(\varepsilon-1\right)} - \left(\sigma-1\right) \\
&= -\frac{\left(1-\gamma^{\tau}\right)\left(\varepsilon-1\right)\left[\alpha\left(\sigma-1\right)+1\right]}{\alpha\left(\sigma-1\right)+1-\gamma^{\tau}-\gamma^{\tau}\alpha\left(\varepsilon-1\right)} < 0.
\end{aligned}$$

It follows that potential entrants face negative profits for all small tariff levels. Therefore, we have

Lemma A.3 *Suppose Assumptions 1-3 hold and $\sigma > \varepsilon > 1$. Then for small tariffs there is no entry of new final-good producers and prospective profits of potential entrants decline with the tariff rate.*

General Productivity Distribution and Cost Function

We now show that the NN curve is steeper than the MM curve for a general productivity distribution and cost function as long as the second-order condition for the choice of $\bar{a}$ is satisfied. We consider the case of a small tariff, so that the outside option is to search in country A. In this case

$$p^{\tau} = \frac{\sigma}{\sigma-1} c\left(\phi^{\tau}\right), \tag{A.23}$$

$$P^{\tau} = \frac{\sigma}{\sigma-1} c\left(\phi^{\tau}\right) n^{\frac{1}{1-\sigma}}, \tag{A.24}$$

$$x^{\tau} = \left(P^{\tau}\right)^{\sigma-\varepsilon} \left[\frac{\sigma}{\sigma-1} c\left(\phi^{\tau}\right)\right]^{-\sigma}, \tag{A.25}$$

$$m^{\tau} = \left(P^{\tau}\right)^{\sigma-\varepsilon} \frac{\left(\sigma-1\right)^{\sigma}}{\sigma^{\sigma}} c\left(\phi^{\tau}\right)^{-\sigma} c'\left(\phi^{\tau}\right). \tag{A.26}$$

These equations also apply to the case $\tau = 0$, i.e., the initial equilibrium. In the initial equilibrium $\phi = w\mu_a\left(\bar{a}\right)$ and operating profits are (see (A.7))

$$\pi_o = \left(P\right)^{\sigma-\varepsilon} \frac{\left(\sigma-1\right)^{\sigma-1}}{\sigma^{\sigma}} c\left[w\mu_a\left(\bar{a}\right)\right]^{1-\sigma} - \frac{1-\beta}{\beta} \frac{f}{G\left(\bar{a}\right)} - f_o.$$

The choice of $\bar{a}$ maximizes operating profits minus search costs, $f/G(\bar{a})$, which yields the first-order condition

$$-(P^\tau)^{\sigma-\varepsilon} \frac{(\sigma-1)^\sigma}{\sigma^\sigma} c \left[w\mu_a(\bar{a}^\tau)\right]^{-\sigma} c'\left[w\mu_a(\bar{a}^\tau)\right] w\mu'_a(\bar{a}^\tau) + \frac{1}{\beta}\frac{fg(\bar{a}^\tau)}{G(\bar{a}^\tau)^2} = 0.$$

Since

$$\mu_a(\bar{a}) = \frac{1}{G(\bar{a})}\int_0^{\bar{a}} a g(a)\,da,$$

$$\mu'_a(\bar{a}) = \frac{g(\bar{a})}{G(\bar{a})}\left[\bar{a}^\tau - \mu_a(\bar{a}^\tau)\right],$$

this first-order condition can be expressed as

$$-(P)^{\sigma-\varepsilon} \frac{(\sigma-1)^\sigma}{\sigma^\sigma} c \left[w\mu_a(\bar{a})\right]^{-\sigma} c'\left[w\mu_a(\bar{a})\right] w\left[\bar{a} - \mu_a(\bar{a})\right] + \frac{1}{\beta}\frac{f}{G(\bar{a})} = 0.$$

It follows that the second-order condition requires

$$\left\{G(\bar{a})\, c\left[w\mu_a(\bar{a})\right]^{-\sigma} c'\left[w\mu_a(\bar{a})\right]\left[\bar{a} - \mu_a(\bar{a})\right]\right\}' > 0. \tag{A.27}$$

With a Pareto distribution and a Cob-Douglas (C-D) production function this holds if and only if

$$\left\{(\bar{a})^\theta\,(\bar{a})^{-\alpha\sigma}\,(\bar{a})^{\alpha-1}\,\bar{a}\right\}' > 0,$$

which is satisfied if and only if $\theta > \alpha(\sigma-1)$. With C-D and a general distribution function, the second-order condition requires

$$\left\{G(\bar{a})\,\mu_a(\bar{a})^{-\alpha(\sigma-1)-1}\left[\bar{a} - \mu_a(\bar{a})\right]\right\}' > 0.$$

Now consider the MM curve. It is represented by

$$\phi^\tau = \beta\frac{G(a_c)}{G(\bar{a})}\tau w\mu_a(a_c) + \left[1 - \beta\frac{G(a_c)}{G(\bar{a})}\right]\tau w\mu_a(\bar{a}^\tau),$$

where

$$a_c = \min\left\{\bar{a}^\tau, \bar{a}\right\}.$$

Therefore

$$\phi^\tau = \begin{cases} \tau w\mu_a(\bar{a}^\tau) & \text{for } \bar{a}^\tau \le \bar{a} \\ \tau w\beta\mu_a(\bar{a}) + \tau w(1-\beta)\mu_a(\bar{a}^\tau) & \text{for } \bar{a}^\tau \ge \bar{a} \end{cases}. \tag{A.28}$$

It is an increasing curve with a break in the slope at $\bar{a}^\tau = \bar{a}$, where the right-hand side slope is flatter than the left-hand side slope. The left-hand side slope equals $\tau w\mu'_a(\bar{a})$.

We next derive the NN curve, using the first-order condition (12) in the paper,

$$\tau w \left[\bar{a}^\tau - \mu_a \left(\bar{a}^\tau \right) \right] G \left(\bar{a}^\tau \right) = \frac{f}{\beta m^\tau}.$$

Using (A.24) and (A.26) above, this yields

$$\tau G \left(\bar{a}^\tau \right) c \left(\phi^\tau \right)^{-\varepsilon} c' \left(\phi^\tau \right) \left[\bar{a}^\tau - \mu_a \left(\bar{a}^\tau \right) \right] = \frac{f \sigma^\varepsilon}{w \beta n^{\frac{\sigma - \varepsilon}{1-\sigma}} \left(\sigma - 1 \right)^\varepsilon}. \tag{A.29}$$

With C-D and Pareto this is

$$\tau w \frac{\left(\bar{a}^\tau \right)^{\theta+1}}{\theta + 1} = \frac{f}{\beta n^{\frac{\sigma - \varepsilon}{1-\sigma}} \frac{(\sigma-1)^\varepsilon}{\sigma^\varepsilon} \alpha \left(\phi^\tau \right)^{-\alpha(\varepsilon-1)-1}},$$

which is what we have in the paper.

The slope of the MM curve to the left of $\bar{a}^\tau = \bar{a}$, i.e., evaluated at $\tau = 1$, equals $w \mu'_a \left(\bar{a} \right)$ (see (A.28)). From (A.29), the slope of the NN curve evaluated at $\bar{a}^\tau = \bar{a}$, i.e., at $\tau = 1$, equals

$$s_{NN} = - \frac{\left\{ G \left(\bar{a} \right) \left[\bar{a} - \mu_a \left(\bar{a} \right) \right] \right\}' c \left(\phi \right)^{-\varepsilon} c' \left(\phi \right)}{\left[c \left(\phi \right)^{-\varepsilon} c' \left(\phi \right) \right]' G \left(\bar{a} \right) \left[\bar{a} - \mu_a \left(\bar{a} \right) \right]} \tag{A.30}$$

However, the second-order condition (A.27) implies

$$\left\{ G \left(\bar{a} \right) \left[\bar{a} - \mu_a \left(\bar{a} \right) \right] \right\}' c \left(\phi \right)^{-\varepsilon} c' \left(\phi \right) + \left[c \left(\phi \right)^{-\varepsilon} c' \left(\phi \right) \right]' G \left(\bar{a} \right) \left[\bar{a} - \mu_a \left(\bar{a} \right) \right] w \mu'_a \left(\bar{a} \right) > 0,$$

or, using (A.30),

$$\left\{ G \left(\bar{a} \right) \left[\bar{a} - \mu_a \left(\bar{a} \right) \right] \right\}' c \left(\phi \right)^{-\varepsilon} c' \left(\phi \right) \left[1 - \frac{w \mu'_a \left(\bar{a} \right)}{s_{MM}} \right] > 0.$$

Since $\left\{ G \left(\bar{a} \right) \left[\bar{a} - \mu_a \left(\bar{a} \right) \right] \right\}' c \left(\phi \right)^{-\varepsilon} c' \left(\phi \right) > 0$, this yields $w \mu'_a \left(\bar{a} \right) < s_{NN}$. That is, the NN curve is steeper than the MM curve at this point.

Next consider the upward shift in each one of the curves at $\bar{a}^\tau = \bar{a}$ in response to and increase in τ. The MM curve shifts proportionately to τ. The NN curve shifts less than proportionately if and only if the elasticity of $c \left(\phi \right)^{-\varepsilon} c' \left(\phi \right)$, which is negative, is smaller than -1 ($c'' < 0$ due to concavity of the cost function). In the C-D case this elasticity is $-\alpha \left(\varepsilon - 1 \right) - 1 < 1$ and an increase in τ leads to $\bar{a}^\tau > \bar{a}$, as argued in the paper. This is true more generally, for cost functions whose elasticity of $c \left(\phi \right)^{-\varepsilon} c' \left(\phi \right)$ is smaller than -1.

Section 3.2 Large Tariffs

In this section, the outside option for buyers is to search for new suppliers in country B. The outside option is the same when a buyer bargains with a supplier in country A as when it bargains with one in country B. Since there are no tariffs on inputs purchased in country B, the bargaining

game with a supplier in country B yields

$$\rho_B(b,\tau) = \arg\max_q \left[qm(\tau) - w_B bm(\tau)\right]^{1-\beta} \left[w_B\mu_b\left[\bar{b}(\tau)\right]m(\tau) + \frac{f}{\beta G\left[\bar{b}(\tau)\right]} - qm(\tau)\right]^{\beta}.$$

The first-order condition for this problem is

$$\frac{1-\beta}{\rho_B(b,\tau) - w_B b} = \frac{\beta}{w_B\mu_b\left[\bar{b}(\tau)\right] + \frac{f}{\beta m(\tau)G[\bar{b}(\tau)]} - \rho_B(b,\tau)},$$

and therefore

$$\rho_B(b,\tau) = \beta w_B b + (1-\beta)w_B\mu_b\left[\bar{b}(\tau)\right] + (1-\beta)\frac{f}{\beta m(\tau)G\left[\bar{b}(\tau)\right]}. \tag{A.31}$$

Taking the conditional mean of both sides of this equation for $b \le \bar{b}(\tau)$, yields

$$\mu_{\rho_B}\left[\bar{b}(\tau)\right] = w_B\mu_b\left[\bar{b}(\tau)\right] + \frac{1-\beta}{\beta}\frac{f}{m(\tau)G\left[\bar{b}(\tau)\right]}. \tag{A.32}$$

Now use the first-order condition for $\bar{b}(\tau)$ that minimizes costs,

$$w_B\left\{\bar{b}(\tau) - \mu_b\left[\bar{b}(\tau)\right]\right\} = \frac{f}{\beta m(\tau)G\left[\bar{b}(\tau)\right]}, \tag{A.33}$$

to obtain

$$\rho_B(b,\tau) = \beta w_B b + (1-\beta)w_B\bar{b}(\tau). \tag{A.34}$$

Note that this cost of inputs depends on the tariff only through $\bar{b}(\tau)$ and it is the same for the original producers and new entrants.

Bargaining with suppliers in country A yields

$$\rho_A(a,\tau) = \arg\max_q \left[qm(\tau) - w_A am(\tau)\right]^{1-\beta} \left[w_B\mu_b\left[\bar{b}(\tau)\right]m(\tau) + \frac{f}{\beta G\left[\bar{b}(\tau)\right]} - \tau qm(\tau)\right]^{\beta}.$$

The first-order condition for this problem is

$$\frac{1-\beta}{\rho_A(a,\tau) - w_A a} = \frac{\beta\tau}{w_B\mu_b\left[\bar{b}(\tau)\right] + \frac{f}{\beta m(\tau)G[\bar{b}(\tau)]} - \tau\rho_A(a,\tau)}$$

and therefore

$$\tau\rho_A(a,\tau) = \beta\tau w_A a + (1-\beta)w_B\mu_b\left[\bar{b}(\tau)\right] + (1-\beta)\frac{f}{\beta m(\tau)G\left[\bar{b}(\tau)\right]}. \tag{A.35}$$

Substituting (A.32) and (A.33) into this equation we obtain

$$\rho_A(a, \tau) = \beta w_A a + (1 - \beta) w_B \frac{\bar{b}(\tau)}{\tau}. \tag{A.36}$$

This negotiated price depends on τ through the ratio $\bar{b}(\tau)/\tau$. In these circumstances, it is cheaper to source an input a from country A if

$$\tau \rho_A(a, \tau) \leq \mu_{\rho_B}\left[\bar{b}(\tau)\right] + \frac{f}{m(\tau) G\left[\bar{b}(\tau)\right]}.$$

Using (A.32) and (A.33), the right-hand side of this inequality equals $w_B \bar{b}(\tau)$. Therefore this inequality can be expressed as

$$\tau w_A a \leq w_B \bar{b}(\tau).$$

From this result we have

Lemma A.4 *For given $\bar{b}(\tau)$, the cost minimizing cutoff a_B is*

$$a_B = \min\left\{\frac{w_B \bar{b}(\tau)}{\tau w_A}, \bar{a}\right\}. \tag{A.37}$$

Now consider the perceived marginal cost of the composite intermediate good for one of the original producers. From (A.31), we see that the average marginal cost of sourcing from country B is $w_B \mu_b\left[\bar{b}(\tau)\right]$, while from (A.35) we see that the average marginal cost of sourcing from country A is $\beta \tau w_A \mu_a(a_B) + (1 - \beta) w_B \mu_b\left[\bar{b}(\tau)\right]$. Since an incumbent firm sources a fraction $G(a_B)/G(\bar{a})$ of its inputs from country A and the remaining fraction $1 - G(a_B)/G(\bar{a})$ from country B, its marginal cost of the intermediate input is

$$\phi^\tau = \frac{G(a_B)}{G(\bar{a})}\left[\beta \tau w_A \mu_a(a_B) + (1 - \beta) w_B \mu_b(\bar{b}^\tau)\right] + \left[1 - \frac{G(a_B)}{G(\bar{a})}\right] w_B \mu_b(\bar{b}^\tau)$$

$$= \beta \frac{G(a_B)}{G(\bar{a})} \tau w_A \mu_a(a_B) + \left[1 - \beta \frac{G(a_B)}{G(\bar{a})}\right] w_B \mu_b(\bar{b}^\tau),$$

where we have replace the function $\bar{b}(\tau)$ with the value of $\bar{b}$ at the tariff level τ, $\bar{b}^\tau$. Using (A.37) and properties of the Pareto distribution yields the equation for the MM curve,

$$\phi^\tau = \begin{cases} \frac{\theta}{\theta+1} w_B \bar{b}^\tau & \text{for } \bar{b}^\tau < \tau w_A \bar{a}/w_B \\ \frac{\theta}{\theta+1}\left[\beta \tau w_A \bar{a} + (1 - \beta) w_B \bar{b}^\tau\right] & \text{for } \bar{b}^\tau > \tau w_A \bar{a}/w_B \end{cases}. \tag{A.38}$$

New entrants (if any exist) search for suppliers only in country B. Equation (A.32) implies that an entrant's marginal cost is

$$\phi^\tau_{new} = w_B \mu_b(\bar{b}^\tau) = \frac{\theta}{\theta+1} w_B \bar{b}^\tau. \tag{A.39}$$

For the tariff level $\tau = w_B/w_A$, the equilibrium values are $\bar{b}^\tau = \bar{a}$ and $\phi^\tau_{new} = \phi^\tau = \tau\phi = \frac{\theta}{\theta+1}w_B\bar{a}$.

We next derive the equation for the NN curve. We have (A.33). As we explained in the previous section, when all the firms are identical, m^τ, the volume of imported intermediate goods, is given by (see (A.19))

$$m^\tau = (p^\tau)^{-\varepsilon} (n^\tau)^{-\frac{\sigma-\varepsilon}{\sigma-1}} c'(\phi^\tau) \tag{A.40}$$

$$= \left[\frac{\sigma}{\sigma-1} c(\phi^\tau) \right]^{-\varepsilon} (n^\tau)^{-\frac{\sigma-\varepsilon}{\sigma-1}} c'(\phi^\tau)$$

$$= \alpha \left(\frac{\sigma}{\sigma-1} \right)^{-\varepsilon} (n^\tau)^{-\frac{\sigma-\varepsilon}{\sigma-1}} (\phi^\tau)^{\alpha(1-\varepsilon)-1} ,$$

where $n^\tau = n$ in the elastic case. Since higher tariffs do not raise profits when $\varepsilon > 1$, there is no entry of new firms. Substituting the expression for m^τ into (A.33) yields

$$\frac{(\theta+1)f}{w_B\beta(\bar{b}^\tau)^{\theta+1}} = n^{-\frac{\sigma-\varepsilon}{\sigma-1}} \left(\frac{\sigma}{\sigma-1} \right)^{-\varepsilon} \alpha(\phi^\tau)^{\alpha(1-\varepsilon)-1} , \tag{A.41}$$

which is the NN curve. It follows that the elasticity of the NN curve in this case is $(\theta+1)/[1-\alpha(1-\varepsilon)]$, which is larger than one under Assumption 3 for all $\varepsilon < \sigma$. From (A.38), the slope of the MM curve is smaller than one and therefore NN is steeper at the intersection point of the two curves, as drawn in Figure 3.

Now consider the response of ϕ^τ and $\bar{b}^\tau$ to tariff changes. First suppose that τ is such that $\bar{b}^\tau < \tau w_A\bar{a}/w_B$. In this case, there is sourcing from both countries and (A.38) and (A.41) imply that neither ϕ^τ nor $\bar{b}^\tau$ change as long as tariffs remain in the region with $\bar{b}^\tau < \tau w_A\bar{a}/w_B$. In contrast, consider an increase in the tariff when $\bar{b}^\tau > \tau w_A\bar{a}/w_B$. Then (A.38) and (A.41) imply

$$\hat{\phi}^\tau = \gamma_B \widehat{\bar{b}}^\tau + (1-\gamma_B)\hat{\tau},$$

$$(\theta+1)\widehat{\bar{b}}^\tau = [1+\alpha(\varepsilon-1)]\hat{\phi}^\tau,$$

where

$$\gamma_B = \frac{(1-\beta)w_B\bar{b}^\tau}{\beta\tau w_A\bar{a} + (1-\beta)w_B\bar{b}^\tau}.$$

Therefore,

$$\hat{\phi}^\tau = \frac{(\theta+1)(1-\gamma_B)}{\theta+1-\gamma_B-\gamma_B\alpha(\varepsilon-1)}\hat{\tau}, \tag{A.42}$$

$$\widehat{\bar{b}}^\tau = \frac{[1-\alpha(1-\varepsilon)](1-\gamma_B)}{\theta+1-\gamma_B-\gamma_B\alpha(\varepsilon-1)}\hat{\tau}. \tag{A.43}$$

The numerators and the denominators of both equations are positive, implying that higher tariffs raise the cutoff and the marginal costs of intermediate inputs. Moreover, note from (A.43) that

$$\widehat{\bar{b}}^\tau - \hat{\tau} = -\frac{(1-\gamma_B)[\theta-\alpha(\varepsilon-1)]}{\theta+1-\gamma_B-\gamma_B\alpha(\varepsilon-1)}\hat{\tau}.$$

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The denominator on the right-hand side of this equation is positive. The numerator is negative under Assumption 3, because $\sigma > \varepsilon$. We conclude that the ratio $\bar{b}^\tau / \tau$ is declining with the tariff level.

As shown in the text, for $\tau \in (w_B/w_A, \tau_c)$ we have $\bar{b}^\tau > \tau w_A \bar{a}/w_B$, where τ_c is the tariff level at which $\tau_c w_A \bar{a} = w_B \bar{b}(\tau_c)$. For tariffs in this range, a higher tariff raises both ϕ^τ and $\bar{b}^\tau$ according to (A.42) and (A.43). In contrast, ϕ^τ and $\bar{b}^\tau$ are invariant to the tariff rate for all $\tau > \tau_c$. In this range, $a_B = w_B \bar{b}(\tau_c)/\tau w_A$ and $\bar{b}^\tau = \bar{b}(\tau_c)$, so we can express the weighted average of the foreign cost of the inputs using (A.34) and (A.36) as

$$\rho^\tau = \frac{G(a_B)}{G(\bar{a})}\left[\beta w_A \mu_a(a_B) + (1-\beta) w_B \frac{\bar{b}^\tau}{\tau}\right] + \left[1 - \frac{G(a_B)}{G(\bar{a})}\right]\left[\beta w_B \mu_b(\bar{b}^\tau) + (1-\beta) w_B \bar{b}^\tau\right]$$

$$= \left(\frac{\tau_c}{\tau}\right)^\theta \frac{\theta + 1 - \beta}{\theta + 1} \frac{w_B \bar{b}^\tau}{\tau} + \left[\left\{1 - \left(\frac{\tau_c}{\tau}\right)^\theta\right\}\right]\frac{\theta + 1 - \beta}{\theta + 1} w_B \bar{b}^\tau.$$

The second line reveals the offsetting effects on the terms of trade: ρ^τ declines as a result of the decline in prices paid to suppliers in country A, but it rises with reallocation of supply from country A to country B, because net-of-tariff costs are higher in country B. The combined impact can be seen by rewriting the equation for ρ^τ as

$$\rho^\tau = \left\{1 - \frac{\tau - 1}{\tau}\left(\frac{\tau_c}{\tau}\right)^\theta\right\}\frac{\theta + 1 - \beta}{\theta + 1} w_B \bar{b}^\tau. \tag{A.44}$$

From this, we obtain

Lemma A.5 *Suppose $\varepsilon > 1$. Then for $\tau > \tau_c$, higher tariffs generate better terms of trade if and only if*

$$\tau < \frac{\theta + 1}{\theta}.$$

Finally, we derive an equation for τ_c. From (A.5) we have

$$\frac{1}{\theta + 1} w_A \bar{a} = \frac{f}{\beta m \bar{a}^\theta},$$

where m is the volume of intermediates in the free-trade equilibrium, before any tariff is imposed. From (A.33) we have

$$\frac{1}{\theta + 1} w_B \bar{b}(\tau_c) = \frac{f}{\beta m(\tau_c)\bar{b}(\tau_c)^\theta}$$

when the tariff is τ_c. Therefore,

$$\frac{w_B \bar{b}(\tau_c)^{\theta+1}}{w_A \bar{a}^{\theta+1}} = \frac{m}{m(\tau_c)}.$$

However, from (A.40),

$$m = \alpha\left(\frac{\sigma}{\sigma - 1}\right)^{-\varepsilon} n^{-\frac{\sigma - \varepsilon}{\sigma - 1}}\left(\frac{\theta}{\theta + 1} w_A \bar{a}\right)^{\alpha(1-\varepsilon)-1},$$

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$$m\left(\tau_c\right) = \alpha \left(\frac{\sigma}{\sigma - 1}\right)^{-\varepsilon} n^{-\frac{\sigma - \varepsilon}{\sigma - 1}} \phi\left(\tau_c\right)^{\alpha(1-\varepsilon)-1}.$$

However, (A.38) implies that,

$$\phi\left(\tau_c\right) = \frac{\theta}{\theta + 1} w_B \bar{b}\left(\tau_c\right) = \frac{\theta}{\theta + 1} \tau_c w_A \bar{a}$$

and therefore,

$$\frac{w_B \bar{b}\left(\tau_c\right)^{\theta+1}}{w_A \bar{a}^{\theta+1}} = \left(\frac{w_A}{w_B}\right)^{\theta} \left(\tau_c\right)^{\theta+1} = \frac{m}{m\left(\tau_c\right)} = \frac{1}{\left(\tau_c\right)^{\alpha(1-\varepsilon)-1}}.$$

It follows that,

$$\tau_c = \left(\frac{w_B}{w_A}\right)^{\frac{\theta}{\theta - \alpha(\varepsilon-1)}}. \tag{A.45}$$

Since $\tau_c w_A \bar{a} = w_B \bar{b}\left(\tau_c\right)$, this implies

$$\bar{b}\left(\tau_c\right) = \left(\frac{w_B}{w_A}\right)^{\frac{\alpha(\varepsilon-1)}{\theta - \alpha(\varepsilon-1)}} \bar{a}. \tag{A.46}$$

We now consider tariffs that are large enough to induce exit. We denote by τ_{ex} the tariff rate at which the operating profits net of new search costs equal zero. To avoid taxonomy, we assume that $\tau_{ex} > \tau_c$; that profits drop to zero at a tariff rate that is high enough to induce surviving firms to switch suppliers from country A to country B.

For tariffs above τ_c the suppliers in country A that are replaced with suppliers from country B are all those with inverse productivity $a \in (a_B, \bar{a}]$, where

$$a_B = \frac{w_B \bar{b}^\tau}{\tau w_A} < \bar{a} \quad \text{for } \tau > \tau_c. \tag{A.47}$$

For these tariffs, the perceive marginal cost ϕ^τ and search cutoff $\bar{b}^\tau$ satisfy

$$\phi^\tau = \frac{\theta}{\theta + 1} w_B \bar{b}^\tau \tag{A.48}$$

and

$$\frac{(\theta + 1) f}{w_B \beta \left(\bar{b}^\tau\right)^{\theta+1}} = (n^\tau)^{-\frac{\sigma - \varepsilon}{\sigma - 1}} \left(\frac{\sigma}{\sigma - 1}\right)^{-\varepsilon} \alpha \left(\phi^\tau\right)^{\alpha(1-\varepsilon)-1}, \tag{A.49}$$

respectively. It follows, as we have already noted, that perceived marginal cost and the search cutoff are independent of the tariff rate for $\tau \in [\tau_c, \tau_{ex}]$ and that $n^\tau = n$ for all tariffs in this range.

We can write operating profits net of new search costs for the representative firm as a function of the number of active firms, n^τ, as follows:

$$\pi_{ex}^\tau = (P^\tau)^{\sigma - \varepsilon} \frac{(\sigma - 1)^{\sigma-1}}{\sigma^\sigma} \left(\phi^\tau\right)^{\alpha(1-\sigma)} - \frac{(1 - \beta) f}{\beta \left(\bar{b}^\tau\right)^\theta} - \left[1 - \left(\frac{w_B \bar{b}^\tau}{\tau w_A \bar{a}}\right)^\theta\right] \frac{f}{\left(\bar{b}^\tau\right)^\theta} - f_o. \tag{A.50}$$

The first term on the right-hand side represents revenue minus labor costs minus the variable costs of intermediate input. The second term represents payments to suppliers of intermediate inputs that do not depend on m^τ; these are the fixed payments that result from bargaining in the shadow of an outside option to search for a new supplier in country B. These fixed payments apply to all inputs, regardless of their source, because the outside option always involves search in country B when the tariff rate is large. The third term represents the new search costs incurred as a result of actual searches in country B to replace original suppliers in country A. These costs apply to the fraction of inputs with $a \in (a_B, \bar{a}]$ that are replaced after the tariff is introduced. Using (A.47), this fractions is $1 - \left(w_B \bar{b}^\tau / \tau w_A \bar{a} \right)^\theta$.

Note that

$$P^\tau = \frac{\sigma}{\sigma - 1} (\phi^\tau)^\alpha (n^\tau)^{-\frac{1}{\sigma - 1}} . \tag{A.51}$$

It is apparent from (A.50) and (A.51) that, as long as the number of firms remains unchanged, and therefore ϕ^τ and $\bar{b}^\tau$ also do not change, operating profits net of new search costs decline with the tariff. Although revenues net of input costs are independent of the tariff rate, higher tariffs generate greater trade diversion to country B and thus greater expense on new searches. The critical tariff rate τ_{ex} that is large enough to induce exit is determined implicitly by

$$\pi_{ex}^\tau = (P_c^\tau)^{\sigma - \varepsilon} \frac{(\sigma - 1)^{\sigma - 1}}{\sigma^\sigma} (\phi_c^\tau)^{\alpha(1-\sigma)} - \frac{(1 - \beta) f}{\beta \left(\bar{b}_c^\tau \right)^\theta} - \left[1 - \left(\frac{w_B \bar{b}_c^\tau}{\tau_{ex} w_A \bar{a}} \right)^\theta \right] \frac{f}{\left(\bar{b}_c^\tau \right)^\theta} - f_o = 0, \quad \text{(A.52)}$$

where ϕ_c^τ and $\bar{b}_c^\tau$ are the solution to (A.48) and (A.49) for $n^\tau = n$ and

$$P_c^\tau = \frac{\sigma}{\sigma - 1} (\phi_c^\tau)^\alpha \, n^{-\frac{1}{\sigma - 1}} .$$

Now consider the relationship between ϕ^τ and $\bar{b}^\tau$ and the tariff rate for $\tau \geq \tau_{ex}$. Substituting (A.51) into (A.50) yields the zero-profit condition,

$$(n^\tau)^{-\frac{\sigma - \varepsilon}{\sigma - 1}} \frac{(\sigma - 1)^{\varepsilon - 1}}{\sigma^\varepsilon} (\phi^\tau)^{\alpha(1-\varepsilon)} - \frac{(1 - \beta) f}{\beta \left(\bar{b}^\tau \right)^\theta} - \left[1 - \left(\frac{w_B \bar{b}^\tau}{\tau w_A \bar{a}} \right)^\theta \right] \frac{f}{\left(\bar{b}^\tau \right)^\theta} = f_o.$$

Next use (A.48) to rewrite (A.49) as

$$\frac{\theta f}{\beta \left(\bar{b}^\tau \right)^\theta} = (n^\tau)^{-\frac{\sigma - \varepsilon}{\sigma - 1}} \left(\frac{\sigma}{\sigma - 1} \right)^{-\varepsilon} \alpha \, (\phi^\tau)^{\alpha(1-\varepsilon)} . \tag{A.53}$$

These two equations imply

$$\frac{\theta}{\alpha (\sigma - 1)} \frac{f}{\beta \left(\bar{b}^\tau \right)^\theta} - \frac{(1 - \beta) f}{\beta \left(\bar{b}^\tau \right)^\theta} - \left[1 - \left(\frac{w_B \bar{b}^\tau}{\tau w_A \bar{a}} \right)^\theta \right] \frac{f}{\left(\bar{b}^\tau \right)^\theta} = f_o,$$

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or

$$\frac{1}{\beta \left(\bar{b}^\tau\right)^\theta} \left[\frac{\theta}{\alpha \left(\sigma - 1\right)} - 1\right] + \left(\frac{w_B}{\tau w_A \bar{a}}\right)^\theta = \frac{f_o}{f}. \tag{A.54}$$

Assumption 3 ensures that the term in the square bracket is positive, implying that higher tariffs induce more selective search; i.e., lower values of $\bar{b}^\tau$. Moreover,

$$\widehat{\bar{b}^\tau} = -\xi^\tau \hat{\tau}, \quad \xi^\tau = \frac{\beta \alpha \left(\sigma - 1\right)}{\theta - \alpha \left(\sigma - 1\right)} \left(\frac{w_B \bar{b}^\tau}{\tau w_A \bar{a}}\right)^\theta > 0. \tag{A.55}$$

From (A.48), we see that ϕ^τ is proportional to $\bar{b}^\tau$ and therefore

$$\hat{\phi}^\tau = \widehat{\bar{b}^\tau} = -\xi^\tau \hat{\tau}.$$

Then (A.49) implies

$$\frac{\sigma - \varepsilon}{\sigma - 1} \hat{n}^\tau = - \left[\theta - \alpha \left(\varepsilon - 1\right)\right] \xi^\tau \hat{\tau}. \tag{A.56}$$

So the number of firms also declines. We therefore have

Proposition A.1 *Suppose Assumptions 1-3 hold and that $\tau \geq \tau_{ex}$. Then, the larger is the tariff, the smaller is ϕ^τ, $\bar{b}^\tau$, and n^τ.*

This proposition implies that, in the elastic case, the perceived marginal cost is a non-monotonic function of the size of the tariff. For tariffs in the range $\tau \in (1, \tau_c)$ perceived marginal cost rises with the tariff rate, in the range $\tau \in (\tau_c, \tau_{ex})$ it is independent of that rate, and in the range $\tau \geq \tau_{ex}$ it declines with τ. Since $\bar{b}^\tau$ follows the same non-monotonic pattern as ϕ^τ, and m^τ is decreasing in $\bar{b}^\tau$ from the equation that describes the optimal choice of $\bar{b}^\tau$ for a given m^τ, it follows that m^τ is also non-monotonic; it declines initially, remains constant for a range of tariffs, and then rises with τ when $\tau \geq \tau_{ex}$.

Next use (A.51) and (A.53) to obtain

$$\left(P^\tau\right)^{\sigma - \varepsilon} = \frac{\theta f}{\alpha \beta \left(\bar{b}^\tau\right)^\theta} \left(\frac{\sigma}{\sigma - 1}\right)^\sigma \left(\phi^\tau\right)^{\alpha \left(\sigma - 1\right)}.$$

Substituting (A.49) into this equation yields

$$\left(P^\tau\right)^{\sigma - \varepsilon} = \frac{\theta f}{\alpha \beta \left(\bar{b}^\tau\right)^{\theta - \alpha \left(\sigma - 1\right)}} \left(\frac{\sigma}{\sigma - 1}\right)^\sigma \left(\frac{\theta}{\theta + 1} w_B\right)^{\alpha \left(\sigma - 1\right)}. \tag{A.57}$$

Since $\bar{b}^\tau$ declines with the tariff, this implies that the price index is rising with the tariff in the range of large tariffs that induce exit. Moreover, (A.55) implies

$$\hat{P}^\tau = \frac{\theta - \alpha \left(\sigma - 1\right)}{\sigma - \varepsilon} \xi^\tau \hat{\tau}.$$

Evidently, the price index rises with the tariff when $\tau \geq \tau_{ex}$ despite the decline in perceived marginal

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costs, because the variety reducing effect of exit dominates the effect on the price index of falling prices for brands that survive.

We can compute the size of the critical tariff, $\tau_{ex.}$, using (A.54) with $\bar{b}^\tau = \bar{b}_c^\tau$. Substituting (A.45) and (A.46) into (A.54), we find that τ_{ex} satisfies

$$\frac{\theta - \alpha(\sigma - 1)}{\beta\alpha(\sigma - 1)} + \left(\frac{\tau_c}{\tau_{ex}}\right)^\theta = \frac{f_o}{f}\bar{a}^\theta \left(\frac{w_B}{w_A}\right)^{\frac{\theta\alpha(\varepsilon - 1)}{\theta - \alpha(\varepsilon - 1)}}.$$

Now use the solution for $\bar{a}^\theta$ in (A.10) to obtain

$$\left(\frac{\tau_c}{\tau_{ex}}\right)^\theta = \frac{\theta - \alpha(\sigma - 1)}{\beta\alpha(\sigma - 1)} \left[\frac{f_o}{f_o + f_e}\left(\frac{w_B}{w_A}\right)^{\frac{\theta\alpha(\varepsilon - 1)}{\theta - \alpha(\varepsilon - 1)}} - 1\right]. \tag{A.58}$$

Clearly, this implies that, for $\tau_{ex} > \tau_c$, we need the term in the square brackets to be positive and the right-hand side to be smaller than one. These two conditions can be satisfied if and only if

$$\left(\frac{w_A}{w_B}\right)^{\frac{\theta\alpha(\varepsilon - 1)}{\theta - \alpha(\varepsilon - 1)}} < \frac{f_o}{f_o + f_e} < \frac{\theta - (1 - \beta)\alpha(\sigma - 1)}{\theta - \alpha(\sigma - 1)}\left(\frac{w_A}{w_B}\right)^{\frac{\theta\alpha(\varepsilon - 1)}{\theta - \alpha(\varepsilon - 1)}}. \tag{A.59}$$

For every pair of wage rates w_A and w_B such that $w_B > w_A$ there exist fixed operating costs f_o and fixed entry costs f_e that satisfy these inequalities.

Section 4 Welfare Effects of Unanticipated Tariffs

Section 4.1 Increase in a Small Tariff

Consider the welfare effects of small tariffs. We showed in the main text that, apart from a constant, welfare can be expressed as

$$V(\tau) = U(X^\tau) - n^\tau \rho^\tau m^\tau - n^\tau \ell^\tau - n^\tau f\left[\frac{1}{G(a_c)} - \frac{1}{G(\bar{a})}\right].$$

In the elastic case, i.e., $\varepsilon > 1$, $a_c = \bar{a}$ and there are no additional search costs. Moreover, there is no entry, so that $n^\tau = n$. Therefore

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

and

$$\frac{dV}{d\tau} = P^\tau \frac{dX^\tau}{d\tau} - n\frac{d\ell^\tau}{d\tau} - n\rho^\tau \frac{dm^\tau}{d\tau} - nm^\tau \frac{d\rho^\tau}{d\tau}.$$

The CES aggregator implies that

$$X^\tau = n^{\frac{\sigma}{\sigma - 1}} z\left(\ell^\tau, m^\tau\right)$$

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and therefore

$$P^\tau \frac{dX^\tau}{d\tau} = n^{\frac{\sigma}{\sigma-1}} P^\tau \left(z_\ell \frac{d\ell^\tau}{d\tau} + z_m \frac{dm^\tau}{d\tau} \right)$$

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

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

The second line is obtained from the first by noting that the marginal revenue generated by an increase in an input equals the input's marginal cost, which is one for labor and ϕ^τ for intermediate inputs. The third line is obtained from $P = pn^{-\frac{1}{\sigma-1}}$. Using this result, we obtain

$$\frac{dV}{d\tau} = n \frac{1}{\sigma-1} \frac{d\ell^\tau}{d\tau} + n \left(\frac{\sigma}{\sigma-1} \phi^\tau - \rho^\tau \right) \frac{dm^\tau}{d\tau} - nm^\tau \frac{d\rho^\tau}{d\tau}, \tag{A.60}$$

which is equation (28) in the main text.

Next, the assumption of a Cobb-Douglas technology implies

$$\ell^\tau = \frac{1-\alpha}{\alpha} \phi^\tau m^\tau$$

and therefore

$$\frac{1}{\sigma-1} \frac{d\ell^\tau}{d\tau} = \frac{1}{\sigma-1} \frac{1-\alpha}{\alpha} \frac{d(\phi^\tau m^\tau)}{d\tau}.$$

However, spending on intermediate inputs is a fraction α of spending on all inputs,

$$n\phi^\tau m^\tau = \alpha \frac{\sigma-1}{\sigma} P^\tau X^\tau, \tag{A.61}$$

and therefore

$$n \frac{1}{\sigma-1} \frac{d\ell^\tau}{d\tau} = n \frac{1}{\sigma-1} \frac{1-\alpha}{\alpha} \frac{d(\phi^\tau m^\tau)}{d\tau} = \frac{1-\alpha}{\sigma} \frac{d(P^\tau X^\tau)}{d\tau} \tag{A.62}$$

$$= -\frac{1-\alpha}{\tau\sigma} (\varepsilon-1) \alpha \left(\frac{d\phi^\tau}{d\tau} \frac{\tau}{\phi^\tau} \right) P^\tau X^\tau.$$

Using $P^\tau = (\phi^\tau)^\alpha n^{-\frac{1}{\sigma-1}} \sigma/(\sigma-1)$, the last equality is obtained from

$$\frac{d(P^\tau X^\tau)}{d\tau} = \frac{d(P^\tau)^{1-\varepsilon}}{d\tau} = -(\varepsilon-1) \alpha \left(\frac{d\phi^\tau}{d\tau} \frac{\tau}{\phi^\tau} \right) \frac{1}{\tau} P^\tau X^\tau.$$

Therefore, using (A.21),

$$n \frac{1}{\sigma-1} \frac{d\ell^\tau}{d\tau} = -\frac{1-\alpha}{\tau\sigma} (\varepsilon-1) \alpha \frac{\theta+1-\gamma^\tau}{\theta+1-\gamma^\tau-\gamma^\tau\alpha(\varepsilon-1)} P^\tau X^\tau.$$

This gives us the first term in (A.60). Since $\varepsilon > 1$, the tariff reduces employment and this has a

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negative (partial) effect on welfare.

To obtain the second term in (A.60), we again use (A.61) and (A.21), which gives

$$
\begin{aligned}
n\phi^\tau \frac{dm^\tau}{d\tau} &= \frac{\sigma - 1}{\sigma}\alpha\frac{d\left(P^\tau X^\tau\right)}{d\tau} - nm^\tau\frac{d\phi^\tau}{d\tau} \\
&= -\frac{1-\alpha}{\tau\sigma}\left(\varepsilon - 1\right)\alpha\frac{\theta + 1 - \gamma^\tau}{\theta + 1 - \gamma^\tau - \gamma^\tau\alpha\left(\varepsilon - 1\right)}P^\tau X^\tau - \frac{1}{\tau}nm^\tau\phi^\tau\frac{\theta + 1 - \gamma^\tau}{\theta + 1 - \gamma^\tau - \gamma^\tau\alpha\left(\varepsilon - 1\right)} \\
&= -\frac{1}{\tau}\frac{\sigma - 1}{\sigma}\alpha\left[\left(\varepsilon - 1\right)\alpha + 1\right]\frac{\theta + 1 - \gamma^\tau}{\theta + 1 - \gamma^\tau - \gamma^\tau\alpha\left(\varepsilon - 1\right)}P^\tau X^\tau.
\end{aligned}
$$

Now, (14) and (17) imply

$$
\phi^\tau = \tau w\frac{\theta}{\theta + 1}\left[\beta\bar{a} + \left(1 - \beta\right)\bar{a}^\tau\right] \tag{A.63}
$$

and

$$
\rho^\tau = \beta w\frac{\theta}{\theta + 1}\bar{a} + \left(1 - \beta\right)w\bar{a}^\tau. \tag{A.64}
$$

Therefore,

$$
\begin{aligned}
n\left(\frac{\sigma}{\sigma - 1}\phi^\tau - \rho^\tau\right)\frac{dm^\tau}{d\tau} &= \left(\rho^\tau - \frac{\sigma}{\sigma - 1}\phi^\tau\right)\frac{1}{\tau\phi^\tau}\frac{\sigma - 1}{\sigma}\alpha\left[\left(\varepsilon - 1\right)\alpha + 1\right]\frac{\theta + 1 - \gamma^\tau}{\theta + 1 - \gamma^\tau - \gamma^\tau\alpha\left(\varepsilon - 1\right)}P^\tau X^\tau \\
&= \left(\frac{\theta + \gamma^\tau}{\theta} - \frac{\sigma}{\sigma - 1}\tau\right)\frac{1}{\tau^2}\frac{\sigma - 1}{\sigma}\alpha\left[\left(\varepsilon - 1\right)\alpha + 1\right]\frac{\theta + 1 - \gamma^\tau}{\theta + 1 - \gamma^\tau - \gamma^\tau\alpha\left(\varepsilon - 1\right)}P^\tau X^\tau.
\end{aligned}
$$

While the tariff reduces demand for the composite intermediate good, the welfare effect is ambiguous for the reasons discussed in the main text. This component of the welfare effect is positive if and only if

$$
\frac{\theta + \gamma^\tau}{\theta} > \frac{\sigma}{\sigma - 1}\tau.
$$

This is the second term in (A.60).

To obtain the third term in the welfare formula, we use (A.64) and (A.22) to obtain

$$
\begin{aligned}
nm^\tau\frac{d\rho^\tau}{d\tau} &= wnm^\tau\left(1 - \beta\right)\frac{d\bar{a}^\tau}{d\tau} \\
&= \frac{1}{\tau}nm^\tau\left(1 - \beta\right)\frac{\alpha\left(\varepsilon - 1\right)w\bar{a}^\tau}{\theta + 1 - \gamma^\tau - \gamma^\tau\alpha\left(\varepsilon - 1\right)}.
\end{aligned}
$$

Next, (A.61) and (A.63) imply

$$
nm^\tau = \frac{1}{\tau w\frac{\theta}{\theta+1}\left[\beta\bar{a} + \left(1 - \beta\right)\bar{a}^\tau\right]}\frac{\sigma - 1}{\sigma}\alpha P^\tau X^\tau.
$$

Therefore,

$$
nm^\tau\frac{d\rho^\tau}{d\tau} = \frac{1}{\tau^2}\frac{\theta + 1}{\theta}\gamma^\tau\frac{\sigma - 1}{\sigma}\alpha\frac{\alpha\left(\varepsilon - 1\right)}{\theta + 1 - \gamma^\tau - \gamma^\tau\alpha\left(\varepsilon - 1\right)}P^\tau X^\tau.
$$

So, in this case, $d\rho^\tau/d\tau > 0$; i.e., the terms of trade deteriorate.

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Combining the three terms in the expression for the change in welfare, we have

$$\frac{\theta + 1 - \gamma^\tau - \gamma^\tau \alpha \left(\varepsilon - 1\right)}{\theta + 1 - \gamma^\tau} \frac{\sigma \tau^2}{\alpha P^\tau X^\tau} \frac{dV}{d\tau} = \tag{A.65}$$

$$- \tau \left(1 - \alpha\right) \left(\varepsilon - 1\right)$$

$$+ \left(\frac{\theta + \gamma^\tau}{\theta} - \frac{\sigma}{\sigma - 1} \tau\right) \left(\sigma - 1\right) \left[\left(\varepsilon - 1\right) \alpha + 1\right]$$

$$- \frac{\theta + 1}{\theta} \left(\sigma - 1\right) \frac{\alpha \left(\varepsilon - 1\right) \gamma^\tau}{\theta + 1 - \gamma^\tau}.$$

A marginal tariff raises welfare if and only if the right-hand side of this equation is positive. Since at free trade $\gamma(1) = 1 - \beta$, it follows that, starting with free trade, a very small tariff reduces welfare if and only if

$$\frac{\theta \varepsilon \left(\theta + \beta\right)}{\theta + \beta - \left(\varepsilon - 1\right) \alpha \left(1 - \beta\right)} > \left(\sigma - 1\right) \left(1 - \beta\right).$$

Next, note that, holding γ^τ constant, the right-hand side of (A.65) is declining in τ. Hence, any positive tariff must reduce welfare if

$$\frac{\theta \varepsilon \left(\theta + 1 - \gamma^\tau\right)}{\theta + 1 - \gamma^\tau - \left(\varepsilon - 1\right) \alpha \gamma^\tau} > \left(\sigma - 1\right) \gamma^\tau \quad \text{for all } \tau \geq 1.$$

Section 4.2 Increase in a Large Tariff

We now examine the welfare effects of tariffs for $\tau > w_B / w_A$. First, consider tariffs in the range $\tau \in \left(w_B / w_A, \tau_c\right)$. In this range, there are no new searches by any of the incumbent producers and country A continues to supply all intermediate inputs. As a result, tariffs are imposed on all imports, generating a revenue of $\left(\tau - 1\right) \rho^\tau m^\tau$. Tariff revenue plus variable profits plus consumer surplus sum to

$$V\left(\tau\right) = T\left(\tau\right) + \Pi\left(\tau\right) + \Gamma\left(\tau\right)$$

$$= \left(\tau - 1\right) \rho^\tau m^\tau + \left[P^\tau X^\tau - \tau \rho^\tau n m^\tau - n \ell^\tau\right] + \left[U\left(X^\tau\right) - P^\tau X^\tau\right]$$

$$= U\left(X^\tau\right) - \rho^\tau n m^\tau - n \ell^\tau.$$

Differentiating this equation gives

$$\frac{1}{n} \frac{dV}{d\tau} = \frac{1}{n} P^\tau \frac{dX^\tau}{d\tau} - \frac{d\ell^\tau}{d\tau} - \rho^\tau \frac{dm^\tau}{d\tau} - m^\tau \frac{d\rho^\tau}{d\tau}$$

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

We have shown that, in this range, $\bar{b}^\tau$ is larger for larger tariffs whereas $\bar{b}^\tau / \tau$ is smaller for larger tariffs. The optimal choice of $\bar{b}^\tau$ for a given m^τ, equation (A.33), therefore implies that m^τ declines with the tariff, while (A.36) implies that ρ^τ declines. For these reasons, the change in the sourcing

of intermediate inputs raises welfare if and only if

$$\frac{\sigma}{\sigma-1}\frac{\phi^\tau}{\rho^\tau} = \tau\frac{\sigma}{\sigma-1}\frac{\frac{\theta}{\theta+1}\left[\beta\tau w_A\bar{a}+(1-\beta)w_B\bar{b}^\tau\right]}{\frac{\theta}{\theta+1}\beta\tau w_A\bar{a}+(1-\beta)w_B\bar{b}^\tau} = \frac{\sigma}{\sigma-1}\frac{\theta\tau}{\theta+\gamma_B} < 1.$$

Meanwhile, better terms of trade always contribute to higher welfare. Finally, since

$$n\ell^\tau = (1-\alpha)\frac{\sigma-1}{\sigma}P^\tau X^\tau$$

and ϕ^τ rises with the tariff level, it follows that $P^\tau X^\tau$ declines with the size of the tariff in the elastic case. As a result, ℓ^τ declines, which reduces welfare, all else the same. Clearly, in this case, a marginal increase in the tariff rate may increase or reduce welfare.

We next consider $\tau > \tau_c$. In this range, $d\ell^\tau/d\tau = dm^\tau/d\tau = dX^\tau/d\tau = dP^\tau/d\tau = 0$, because neither ϕ^τ nor $\bar{b}^\tau$ vary with the size of the tariff. As a result,

$$\frac{dV}{d\tau} = -nm^\tau\frac{d\rho^\tau}{d\tau} - \frac{d\Sigma}{d\tau},$$

where $\Sigma(\tau)$ is the cost of the new searches that take place by incumbent producers. Using (A.33) and $a_B = \frac{w_B\bar{b}(\tau_c)}{\tau w_A}$, the cost of new searches amounts to

$$\Sigma = n\left[1 - \frac{G(a_B)}{G(\bar{a})}\right]\frac{f}{G[\bar{b}(\tau_c)]}$$

$$= nm^t\left[1 - \left(\frac{\tau_c}{\tau}\right)^\theta\right]\frac{\beta}{\theta+1}w_B\bar{b}(\tau_c).$$

Therefore, the variation in the search cost that results from a slightly higher tariff is

$$\frac{d\Sigma}{d\tau} = nm^\tau\frac{\theta}{\tau^{\theta+1}}(\tau_c)^\theta\frac{\beta}{\theta+1}w_B\bar{b}(\tau_c).$$

The terms of trade now are a weighted average of the cost of sourcing from country A and the cost of sourcing from country B,

$$\rho^\tau = \frac{G(a_B)}{G(\bar{a})}\left[\beta w_A\mu_a(a_B) + (1-\beta)w_B\frac{\bar{b}^\tau}{\tau}\right] + \left[1 - \frac{G(a_B)}{G(\bar{a})}\right]w_B\left[\beta\mu_b(\bar{b}^\tau) + (1-\beta)\bar{b}^\tau\right].$$

The first term on the right-hand side represents the fraction of goods sourced from country A, $G(a_B)/G(\bar{a})$, times the average cost of goods sourced from that country, while the second term represents the fraction of goods sourced from country B times the average cost of those inputs.

Using $a_B = \frac{w_B \bar{b}(\tau_c)}{\tau w_A}$ and properties of the Pareto distribution, this equation becomes

$$\rho^\tau = \left(\frac{\tau_c}{\tau}\right)^\theta \frac{\theta + 1 - \beta}{\theta + 1} \frac{w_B \bar{b}(\tau_c)}{\tau} + \left[1 - \left(\frac{\tau_c}{\tau}\right)^\theta\right] \frac{\theta + 1 - \beta}{\theta + 1} w_B \bar{b}(\tau_c)$$

$$= \frac{\theta + 1 - \beta}{\theta + 1} w_B \bar{b}(\tau_c) \left[1 - \frac{\tau - 1}{\tau^{\theta+1}}(\tau_c)^\theta\right],$$

$$\frac{d\rho^\tau}{d\tau} = \frac{\theta(\tau - 1) - 1}{\tau^{\theta+2}}(\tau_c)^\theta \frac{\theta + 1 - \beta}{\theta + 1} w_B \bar{b}(\tau_c)$$

Since the right-hand side of the last equation is negative if and only if

$$\tau < \frac{\theta + 1}{\theta},$$

it follows that the terms of trade improve if $\tau < (\theta + 1)/\theta$ and deteriorate if $\tau > (\theta + 1)/\theta$. Combining terms, we now have

$$\frac{1}{nm^\tau}\frac{dV}{d\tau} = -\frac{d\rho^\tau}{d\tau} - \frac{1}{n^\tau m^\tau}\frac{d\Sigma}{d\tau}$$

$$= w_B \bar{b}(\tau_c) \frac{\theta + 1 - \beta - \theta\tau}{\tau^{\theta+2}}(\tau_c)^\theta.$$

Therefore, welfare rises with the tariff for $\tau > \tau_c$ if and only if

$$\tau < \frac{\theta + 1 - \beta}{\theta}.$$

When the label B denotes the home country, the social cost of inputs is

$$\rho^\tau = \frac{G(a_B)}{G(\bar{a})}\left[\beta w_A \mu_a(a_B) + (1 - \beta)\frac{\bar{b}^\tau}{\tau}\right] + \left[1 - \frac{G(a_B)}{G(\bar{a})}\right] w_B \mu_b(\bar{b}^\tau),$$

where the second term now represents the cost of producing inputs at home. Using properties of the Pareto distribution and $a_B = \frac{w_B \bar{b}(\tau_c)}{\tau w_A}$, we have

$$\rho^\tau = \left(\frac{\tau_c}{\tau}\right)^\theta \frac{\theta + 1 - \beta}{\theta + 1} \frac{w_B \bar{b}(\tau_c)}{\tau} + \left[1 - \left(\frac{\tau_c}{\tau}\right)^\theta\right] \frac{\theta}{\theta + 1} w_B \bar{b}(\tau_c),$$

$$\frac{d\rho^\tau}{d\tau} = -\frac{\theta + 1}{\tau^{\theta+2}}(\tau_c)^\theta \frac{\theta + 1 - \beta}{\theta + 1} w_B \bar{b}(\tau_c) + \frac{\theta}{\tau^{\theta+1}}(\tau_c)^\theta \frac{\theta}{\theta + 1} w_B \bar{b}(\tau_c)$$

$$= \frac{1}{(\theta + 1)\tau^{\theta+2}}(\tau_c)^\theta \left[\tau\theta^2 - (\theta + 1)(\theta + 1 - \beta)\right] w_B \bar{b}(\tau_c).$$

In this case, the resource cost of inputs declines with the tariff if and only if

$$\tau < \frac{(\theta + 1)(\theta + 1 - \beta)}{\theta^2}.$$

The effect of a higher tariff on social welfare can now be expressed as

$$\frac{1}{n^\tau m^\tau}\frac{dV}{d\tau} = -\frac{d\rho^\tau}{d\tau} - \frac{1}{n^\tau m^\tau}\frac{d\Sigma}{d\tau}$$

$$= -\frac{1}{(\theta+1)\,\tau^{\theta+2}}\,(\tau_c)^\theta\left[\tau\theta^2 - (\theta+1)(\theta+1-\beta)\right]w_B\bar{b}\,(\tau_c)$$

$$- \frac{\theta}{\tau^{\theta+1}}\,(\tau_c)^\theta\,\frac{\beta}{\theta+1}w_B\bar{b}\,(\tau_c)$$

$$= w_B\bar{b}\,(\tau_c)\,\frac{-\tau\theta^2 + (\theta+1)(\theta+1-\beta) - \beta\theta\tau}{(\theta+1)\,\tau^{\theta+2}}\,(\tau_c)^\theta\,.$$

Therefore, welfare rises with the tariff if and only if

$$\tau < \frac{(\theta+1)(\theta+1-\beta)}{\theta\,(\theta+\beta)}.$$

Finally, we turn to the welfare effects of tariffs that induce exit. Recall that the welfare components that might vary with the tariff are income from operating profits net of new search costs, tariff revenue, and consumer surplus. However, for $\tau \geq \tau_{ex}$ operating profits net of new search costs are zero, and we are left with tariff revenue and consumer surplus as the welfare components of interest, namely

$$V_{ex}\,(\tau) = T\,(\tau) + \Gamma\,(\tau)\,.$$

Tariffs are collected on imports from country A only and are equal to

$$T\,(\tau) = \frac{G\,(a_B)}{G\,(\bar{a})}\,(\tau-1)\left[\beta w_A\mu_a\,(a_B) + (1-\beta)\frac{w_B\bar{b}^\tau}{\tau}\right]m^\tau.$$

Here, term in the square brackets represents the average ex-factory price paid for inputs from country A, while $G\,(a_B)/G\,(\bar{a})$ represents the fraction of inputs imported from A. Using (A.47), the revenue can be expressed as

$$T\,(\tau) = \frac{\theta+1-\beta}{\theta+1}\left(\frac{1}{w_A\bar{a}}\right)^\theta\left(\frac{w_B\bar{b}^\tau}{\tau}\right)^{\theta+1}(\tau-1)\,m^\tau.$$

In addition, the cost minimizing choice of $\bar{b}^\tau$ for a given m^τ implies

$$w_B\,(\bar{b}^\tau)^{\theta+1} = \frac{f\,(\theta+1)}{\beta m^\tau}$$

and therefore

$$T\,(\tau) = (\theta+1-\beta)\left(\frac{w_B}{w_A\bar{a}}\right)^\theta\frac{f}{\beta}\frac{\tau-1}{\tau^{\theta+1}}.$$

Again using (13), this can be written as

$$T\,(\tau) = \frac{(\theta+1-\beta)\,\alpha\,(\sigma-1)}{\theta-\alpha\,(\sigma-1)}\left(\frac{w_B}{w_A}\right)^\theta(f_o + f_e)\frac{\tau-1}{\tau^{\theta+1}}.$$

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It follows that tariff revenue declines with τ for $\tau > \tau_{ex}$ if and only if $\tau > (\theta + 1)/\theta$. Since the price index unambiguously rises with the size of the tariff, consumer surplus is inversely related to the tariff rate. Therefore, for $\tau > (\theta + 1)/\theta$, higher tariffs in the range where exit occurs must result in lower welfare.

Section 5 Application to the Trump Tariffs

In this section we first show that our measure of welfare change relative to initial spending on differentiated products does not depend on the fixed costs (f_o, f_e, f). To this end we note that in all equilibria

$$p = \frac{\sigma}{\sigma - 1} c = \frac{\sigma}{\sigma - 1} \phi^\alpha,$$

$$X = P^{-\varepsilon},$$

and therefore

$$x = X \left(\frac{p}{P}\right)^{-\sigma} = P^{\sigma - \varepsilon} \left(\frac{\sigma}{\sigma - 1} \phi^\alpha\right)^{-\sigma}. \tag{A.66}$$

In the initial equilibrium, (A.9)-(A.11) provide a solution to $\bar{a}$, P and n. To emphasize the dependence on f, f_o and f_e, we express these equations as

$$\bar{a} = B_a \left(\frac{f}{f_o + f_e}\right)^{1/\theta}, \tag{A.67}$$

$$P = B_P \left(f_o + f_e\right)^{\frac{1}{\sigma - \varepsilon}} \bar{a}^{\frac{\alpha(\sigma - 1)}{\sigma - \varepsilon}}, \tag{A.68}$$

$$n^{\frac{1}{\sigma - 1}} = B_n \left(f_o + f_e\right)^{-\frac{1}{\sigma - \varepsilon}} \bar{a}^{-\frac{\alpha(\varepsilon - 1)}{\sigma - \varepsilon}}, \tag{A.69}$$

where B_j, $j = a, P, n$ include neither f nor f_o or f_e. We also have from (A.16) and (A.17)

$$\phi = \frac{\theta}{\theta + 1} w\bar{a}, \tag{A.70}$$

$$\rho = \left[\beta \frac{\theta}{\theta + 1} + (1 - \beta)\right] w\bar{a}. \tag{A.71}$$

Equation (A.68) implies

$$pxn = PX = P^{1 - \varepsilon} = B_P^{1 - \varepsilon} \left(f_o + f_e\right)^{\frac{1 - \varepsilon}{\sigma - \varepsilon}} \bar{a}^{\frac{\alpha(\sigma - 1)(1 - \varepsilon)}{\sigma - \varepsilon}}. \tag{A.72}$$

Together with (A.69), it implies,

$$px = B_P^{1 - \varepsilon} B_n^{1 - \sigma} \left(f_o + f_e\right). \tag{A.73}$$

That is, px is proportional to $(f_o + f_e)$ and independent of the search cost f. This implies that ℓ

is also proportional to $(f_o + f_e)$ and independent of the search cost f, i.e.,

$$\ell = B_\ell (f_o + f_e),$$

where B_ℓ is independent of f, f_o or f_e

Next, (A.8), (A.68) and (A.70) yield

$$m = \alpha P^{\sigma - \varepsilon} \left(\frac{\sigma - 1}{\sigma} \right)^\sigma \phi^{\alpha(1-\sigma)-1}$$

$$= B_m (f_o + f_e) \bar{a}^{-1},$$

where B_m is independent of f, f_o or f_e. Therefore, using (A.71),

$$\rho m = B_{\rho m} (f_o + f_e),$$

where $B_{\rho m}$ is independent of f, f_o or f_e.

Welfare is

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

Therefore, using $X = P^{-\varepsilon}$,

$$V + \frac{\varepsilon}{\varepsilon - 1} = \frac{\varepsilon}{\varepsilon - 1} X^{\frac{\varepsilon-1}{\varepsilon}} - \rho m n - n\ell \tag{A.74}$$

$$= \frac{\varepsilon}{\varepsilon - 1} P^{1-\varepsilon} - \rho m n - n\ell$$

$$= \frac{\varepsilon}{\varepsilon - 1} p x n - \rho m n - n\ell.$$

It follows that

$$\frac{V + \frac{\varepsilon}{\varepsilon-1}}{pxn} = \frac{\varepsilon}{\varepsilon - 1} - \frac{B_{\rho m} + B_\ell}{B_P^{1-\varepsilon} B_n^{1-\sigma}},$$

which is independent of f, f_o or f_e.

We now focus on the large tariff case $\tau > \tau_c > w_B/w_A$, which is relevant for the calibration. In this case (A.46) and (A.48) imply

$$\bar{b}^\tau = \bar{b}_c := B_b^\tau \bar{a}, \tag{A.75}$$

$$\phi^\tau = \phi_c := B_\phi^\tau \bar{a}, \tag{A.76}$$

where B_b^τ and B_ϕ^τ are independent of f, f_o or f_e. In other words, ϕ^τ and $\bar{b}^\tau$ are proportional to $\bar{a}$ for all $\tau \geq \tau_c$.

Consider the range $\tau \geq \tau_c$. In this range (A.40), (A.44) and (A.49) imply

$$m^\tau = \alpha \left(\frac{\sigma}{\sigma - 1} \right)^{-\varepsilon} n^{-\frac{\sigma-\varepsilon}{\sigma-1}} (\phi^\tau)^{\alpha(1-\varepsilon)-1} = \frac{(\theta + 1) f}{w_B \beta (\bar{b}^\tau)^{\theta+1}}. \tag{A.77}$$

$$\rho^\tau m^\tau = \alpha \left[1 - \frac{\tau - 1}{\tau} \left(\frac{\tau_c}{\tau} \right)^\theta \right] \frac{\theta + 1 - \beta (\theta + 1) f}{\theta + 1} \frac{}{\beta (\bar{b}^\tau)^\theta}.$$

Using (A.67) and (A.75) then implies

$$\rho^\tau m^\tau = \left[1 - \frac{\tau - 1}{\tau} \left(\frac{\tau_c}{\tau} \right)^\theta \right] B_{\rho m}^\tau (f_o + f_e), \quad \text{for } \tau \geq \tau_c, \tag{A.78}$$

where $B_{\rho m}^\tau$ does not depend on f, f_o or f_e.

First, consider a tariff $\tau = \tau_c$. In this case, there are no new searches by any of the incumbent producers and country A continues to supply all intermediate inputs. As a result, tariffs are imposed on all imports, generating a revenue of $(\tau - 1) \rho^\tau m^\tau$. Tariff revenue plus variable profits plus consumer surplus sum to

$$\begin{aligned}
V^{\tau_c} &= T^{\tau_c} + \Pi^{\tau_c} + \Gamma^{\tau_c} \\
&= (\tau - 1) \rho^{\tau_c} m^{\tau_c} + [P^{\tau_c} X^{\tau_c} - \tau \rho^{\tau_c} n m^{\tau_c} - n \ell^{\tau_c}] + [U(X^{\tau_c}) - P^{\tau_c} X^{\tau_c}] \\
&= U(X^{\tau_c}) - n \rho^{\tau_c} m^{\tau_c} - n \ell^{\tau_c}.
\end{aligned}$$

In this case (A.78) implies

$$\rho^{\tau_c} m^{\tau_c} = \frac{1}{\tau_c} B_{\rho m}^\tau (f_o + f_e).$$

Labor employment is

$$n \ell^{\tau_c} = (1 - \alpha) \frac{\sigma - 1}{\sigma} P^\tau X^\tau = (1 - \alpha) \frac{\sigma - 1}{\sigma} (P^{\tau_c})^{1-\varepsilon}. \tag{A.79}$$

In addition,

$$U(X^{\tau_c}) + \frac{\varepsilon}{\varepsilon - 1} = \frac{\varepsilon}{\varepsilon - 1} (X^{\tau_c})^{\frac{\varepsilon - 1}{\varepsilon}} = \frac{\varepsilon}{\varepsilon - 1} (P^{\tau_c})^{1-\varepsilon}.$$

Also,

$$(P^{\tau_c})^{1-\varepsilon} = p^{\tau_c} x^{\tau_c} n = (P^{\tau_c})^{\sigma - \varepsilon} \left(\frac{\sigma}{\sigma - 1} \phi_c^\alpha \right)^{1-\sigma} n$$

and

$$P^{\tau_c} = \frac{\sigma}{\sigma - 1} \phi_c^\alpha n^{\frac{1}{1-\sigma}}.$$

Therefore, (A.69) and (A.76) yield,

$$(P^{\tau_c})^{1-\varepsilon} = C_P^{\tau_c} (f_o + f_e) n, \tag{A.80}$$

where $C_P^{\tau_c}$ does not vary with f, f_o or f_e. Together with (A.79), the last equation implies that ℓ^{τ_c} is proportional to $(f_o + f_e)$.

Using (A.74) and (A.80), we now have

$$V^{\tau_c} + \frac{\varepsilon}{\varepsilon - 1} = \frac{\varepsilon}{\varepsilon - 1} (f_o + f_e) C_P^{\tau_c} n - \rho^{\tau_c} m^{\tau_c} n - n \ell^{\tau_c}.$$

It follows that

$$\frac{V^{\tau_c} + \frac{\varepsilon}{\varepsilon-1}}{pxn} = \frac{\frac{\varepsilon}{\varepsilon-1}C_P^{\tau_c}\left(f_o + f_e\right) - \rho^{\tau_c}m^{\tau_c} - \ell^{\tau_c}}{px}.$$

Here both the numerator and the denominator of the right-hand side are proportional to $(f_o + f_e)$, and therefore the right-hand side does not depend on f, f_o or f_e.

For $\tau \geq \tau_c$ we have $P = P^{\tau_c}$, $X = X^{\tau_c}$ and $\ell = \ell^{\tau_c}$. There are now search costs, equal to (see Section 4.2 above)

$$\Sigma^\tau = nm^\tau\left[1 - \left(\frac{\tau_c}{\tau}\right)^\theta\right]\frac{\beta}{\theta+1}w_B\bar{b}\left(\tau_c\right).$$

Using (A.67), (A.75) and (A.77) this yields

$$\Sigma^\tau = n\left[1 - \left(\frac{\tau_c}{\tau}\right)^\theta\right]B_\Sigma^\tau\left(f_o + f_e\right),$$

where B_Σ^τ is independent of f, f_o and f_e. We can express the utility at $\tau \geq \tau_c$ as

$$V^\tau + \frac{\varepsilon}{\varepsilon-1} = V^{\tau_c} + \frac{\varepsilon}{\varepsilon-1} - \left(\rho^\tau m^\tau - \rho^{\tau_c}m^{\tau_c}\right)n - n\left[1 - \left(\frac{\tau_c}{\tau}\right)^\theta\right]B_\Sigma^\tau\left(f_o + f_e\right).$$

Now use (A.78) to obtain

$$V^\tau + \frac{\varepsilon}{\varepsilon-1} = V^{\tau_c} + \frac{\varepsilon}{\varepsilon-1} - n\left[\frac{\tau_c-1}{\tau_c} - \frac{\tau-1}{\tau}\left(\frac{\tau_c}{\tau}\right)^\theta\right]B_{\rho m}^\tau\left(f_o + f_e\right) - n\left[1 - \left(\frac{\tau_c}{\tau}\right)^\theta\right]B_\Sigma^\tau\left(f_o + f_e\right).$$

It follows that

$$\frac{V^\tau + \frac{\varepsilon}{\varepsilon-1}}{pxn} = \frac{V^{\tau_c} + \frac{\varepsilon}{\varepsilon-1}}{pxn} - \frac{\frac{\tau_c-1}{\tau_c} - \frac{\tau-1}{\tau}\left(\frac{\tau_c}{\tau}\right)^\theta}{px}B_{\rho m}^\tau\left(f_o + f_e\right) - \frac{1 - \left(\frac{\tau_c}{\tau}\right)^\theta}{px}B_\Sigma^\tau\left(f_o + f_e\right),$$

which is independent of f, f_o and f_e. Finally, this implies that

$$\frac{V^\tau - V}{pxn}$$

is independent of f, f_o and f_e.

Section 5.1: Calibration Equations

In the remaining part of this appendix we describe the equations that are pertinent for the calibration. Condition $\tau > \tau_c$ requires (see (A.45))

$$\tau > \tau_c = \left(\frac{w_B}{w_A}\right)^{\frac{\theta}{\theta-\alpha(\varepsilon-1)}},$$

while condition $\tau_c < \tau < \tau_{ex}$ requires (see (A.59))

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$$\left(\frac{w_A}{w_B}\right)^{\frac{\theta\alpha(\varepsilon-1)}{\theta-\alpha(\varepsilon-1)}} < \frac{f_o}{f_o+f_e} < \frac{\theta-(1-\beta)\alpha(\sigma-1)}{\theta-\alpha(\sigma-1)}\left(\frac{w_A}{w_B}\right)^{\frac{\theta\alpha(\varepsilon-1)}{\theta-\alpha(\varepsilon-1)}},$$

where (see (A.58))

$$\tau_{ex} = \tau_c\left[\frac{\beta\alpha(\sigma-1)}{\theta-\alpha(\sigma-1)}\right]^{\frac{1}{\theta}}\left[\frac{f_o}{f_o+f_e}\left(\frac{w_B}{w_A}\right)^{\frac{\theta\alpha(\varepsilon-1)}{\theta-\alpha(\varepsilon-1)}}-1\right]^{-\frac{1}{\theta}}.$$

Free Trade Equilibrium

We solve for equilibrium sequentially, starting with the reservation productivity (see (A.10)):

$$\bar{a} = \left[\frac{f}{f_o+f_e}\frac{\theta-\alpha(\sigma-1)}{\beta\alpha(\sigma-1)}\right]^{\frac{1}{\theta}}.$$

Expected differentiated variety marginal cost is:

$$\phi = w_A\mu_a(\bar{a}) = w_A\frac{\theta}{\theta+1}\bar{a},$$

$$c(\phi) = \phi^\alpha.$$

Free entry requires

$$\pi_o = f_e + \frac{f}{G(\bar{a})} = f_e + \frac{f}{\bar{a}^\theta},$$

where operating profits, π_o, are (see (A.7))

$$\pi_o = \frac{(\sigma-1)^{\sigma-1}}{\sigma^\sigma}P^{\sigma-\varepsilon}c(\phi)^{(1-\sigma)} - \frac{(1-\beta)f}{\beta\bar{a}^\theta} - f_o,$$

yielding the price index

$$P = \left\{\frac{1}{c(\phi)^{(1-\sigma)}}\frac{\sigma^\sigma}{(\sigma-1)^{\sigma-1}}\left[\pi_o + \frac{(1-\beta)f}{\beta\bar{a}^\theta} + f_o\right]\right\}^{\frac{1}{\sigma-\varepsilon}}.$$

Differentiated sector variety prices are

$$p = \frac{\sigma}{\sigma-1}\phi^\alpha,$$

and the price index

$$P = n^{-\frac{1}{\sigma-1}}p$$

yields

$$n = \left(\frac{p}{P}\right)^{\sigma-1}.$$

From the optimal stopping rule (A.3) we have:

$$m = \frac{f(\theta + 1)}{\beta w_A \overline{a}^{\theta+1}}.$$ (A.81)

Employment is (due to the Cobb-Douglas production function):

$$\ell = \frac{1 - \alpha}{\alpha} m\phi.$$

Differentiated sector consumption index is:

$$X = P^{-\varepsilon}.$$

Quantity demanded of individual differentiated sector variety is:

$$x = X \left(\frac{p}{P}\right)^{-\sigma}.$$

Average price of differentiated sector imported intermediate inputs is:

$$\rho = \mu_\rho(\overline{a}) = w_A \overline{a} \left[\beta \frac{\theta}{\theta + 1} + (1 - \beta)\right],$$ (A.82)

where

$$\rho(a) = \beta w_A a + (1 - \beta) w_A \overline{a}.$$

Aggregate value of differentiated sector imports is:

$$M = nm\rho.$$ (A.83)

Expected fixed costs are:

$$f_o + f_e + \frac{f}{\overline{a}^\theta}.$$

Expected variable costs are:

$$\rho m + \ell.$$

Free entry imposes:

$$\pi_o - f_e - \frac{f}{\overline{a}^\theta} = 0.$$

Share of profits in differentiated sector expenditure is:

$$\frac{n\pi_o}{P^{1-\varepsilon}}.$$

Share of imported input costs in differentiated sector expenditure is:

$$\frac{M}{P^{1-\varepsilon}}.$$

Welfare is (see (A.74)):
$$V = \frac{\varepsilon}{\varepsilon - 1} \left(X^{\frac{\varepsilon-1}{\varepsilon}} - 1 \right) - n\rho m - n\ell.$$

Post-Tariff Equilibrium

We have the following system of simultaneous equations for $\overline{b}^\tau$ and ϕ^τ given n (see (A.38) and (A.41)):
$$\phi^\tau = \frac{\theta}{\theta + 1} w_B \overline{b}^\tau,$$

$$\frac{(\theta + 1) f}{w_B \beta \left(\overline{b}^\tau \right)^{\theta+1}} = (n)^{-\frac{\sigma-\varepsilon}{\sigma-1}} \left(\frac{\sigma}{\sigma - 1} \right)^{-\varepsilon} \alpha (\phi^\tau)^{\alpha(1-\varepsilon)-1},$$

where we have used $n^\tau = n$. Substituting the first equation into the second equation, we obtain the following closed-form solution for $\overline{b}^\tau$:

$$\overline{b}^\tau = \left[\frac{(\theta + 1) f}{\alpha\beta} (n)^{\frac{\sigma-\varepsilon}{\sigma-1}} \left(\frac{\sigma}{\sigma - 1} \right)^\varepsilon \left(\frac{\theta}{\theta + 1} \right)^{-\alpha(1-\varepsilon)+1} (w_B)^{-\alpha(1-\varepsilon)} \right]^{\frac{1}{\theta+\alpha(1-\varepsilon)}}.$$

Substituting this solution for $\overline{b}^\tau$ into the first of the two equations above, we recover ϕ^τ:

$$\phi^\tau = \frac{\theta}{\theta + 1} w_B \overline{b}^\tau.$$

We can now solve for the rest of the post-tariff equilibrium sequentially. We start with a_B:

$$a_B = \frac{w_B \overline{b}^\tau}{\tau w_A}. \tag{A.84}$$

Average price of differentiated sector imported intermediate inputs is:

$$\rho^\tau = \left(\frac{a_B}{\overline{a}} \right)^\theta \left[\beta w_A \frac{\theta}{\theta + 1} a_B + (1 - \beta) w_B \frac{\overline{b}^\tau}{\tau} \right] + \left[1 - \left(\frac{a_B}{\overline{a}} \right)^\theta \right] w_B \left[\beta \frac{\theta}{\theta + 1} \overline{b}^\tau + (1 - \beta) \overline{b}^\tau \right].$$

Average price of differentiated sector imported intermediate inputs conditional on sourcing from Country A is:

$$\rho_A^\tau = \beta w_A \frac{\theta}{\theta + 1} a_B + (1 - \beta) w_B \frac{\overline{b}^\tau}{\tau}. \tag{A.85}$$

Average price of differentiated sector imported intermediate inputs conditional on sourcing from Country B is:

$$\rho_B^\tau = \beta w_B \frac{\theta}{\theta + 1} \overline{b}^\tau + (1 - \beta) w_B \overline{b}^\tau. \tag{A.86}$$

Differentiated sector variety prices are:

$$p^\tau = \frac{\sigma}{\sigma - 1} (\phi^\tau)^\alpha.$$

Differentiated sector price index is:
$$P^\tau = n^{-\frac{1}{\sigma-1}} p^\tau.$$

Differentiated sector consumption index is:

$$X^\tau = (P^\tau)^{-\varepsilon}$$

Quantity demanded of individual differentiated sector variety is:

$$x^\tau = X^\tau \left(\frac{p^\tau}{P^\tau}\right)^{-\sigma}.$$

Imports (from optimal stopping rule) of intermediate inputs per product are:

$$m^\tau = \frac{f}{\beta \left(\bar{b}^\tau\right)^\theta w_B} \frac{1}{\left[\bar{b}^\tau - \frac{\theta}{\theta+1}\bar{b}^\tau\right]} = \frac{(\theta+1)f}{\beta \left(\bar{b}^\tau\right)^{\theta+1} w_B}. \tag{A.87}$$

Employment (from Cobb-Douglas production function) is:

$$\ell^\tau = \frac{1-\alpha}{\alpha} \phi^\tau m^\tau, \qquad n\phi^\tau m^\tau = \alpha \frac{\sigma-1}{\sigma} P^\tau X^\tau,$$

$$\Rightarrow \qquad \ell^\tau = (1-\alpha) \frac{\sigma-1}{\sigma} \frac{P^\tau X^\tau}{n}.$$

Aggregate value of imports of intermediate inputs from Country A is:

$$M^A = nm^\tau \left(\frac{a_B}{\bar{a}}\right)^\theta \rho_A^\tau. \tag{A.88}$$

Aggregate value of imports of intermediate input from Country B is:

$$M^B = nm^\tau \left[1 - \left(\frac{a_B}{\bar{a}}\right)^\theta\right] \rho_B^\tau. \tag{A.89}$$

Welfare is:

$$
\begin{aligned}
V^\tau &= \frac{\varepsilon}{\varepsilon-1} \left[(X^\tau)^{\frac{\varepsilon-1}{\varepsilon}} - 1\right] - n\rho^\tau m^\tau - n\ell^\tau - n\left[1 - \frac{G(a_B)}{G(\bar{a})}\right] \frac{f}{G\left(\bar{b}^\tau\right)} \\
&= \frac{\varepsilon}{\varepsilon-1} \left[(X^\tau)^{\frac{\varepsilon-1}{\varepsilon}} - 1\right] - n\rho^\tau m^\tau - n\ell^\tau - n\left[1 - \left(\frac{a_B}{\bar{a}}\right)^\theta\right] \frac{f}{\left(\bar{b}^\tau\right)^\theta}.
\end{aligned}
$$

Import and Price Responses to the Tariff

We now use these relationships from the free trade and tariff equilibria to derive expressions for (i) log changes in imports, (i) log changes in expected input prices from Country A, and (iii) the reallocation of imports towards Country B, in response to the tariff, for the empirically relevant

range of the parameter space in which there is a partial reorganization of supply chains towards Other Asia ($\tau_c < \tau < \tau_{ex}$).

Country A Import Response: Combining equations (A.83), (A.84) and (A.88), the log growth of import values from Country A in response to the tariff is:

$$\log\left(\frac{M_A^\tau}{M_A}\right) = \log\left(\frac{m^\tau}{m}\right) + \log\left(\left(\frac{w_B \bar{b}^\tau}{\tau w_A \bar{a}}\right)^\theta\right) + \log\left(\frac{\rho_A^\tau}{\rho}\right).$$

Using equations (A.81), (A.82), (A.85) and (A.87), we can re-write this expression as follows:

$$\log\left(\frac{M_A^\tau}{M_A}\right) = \log\left(\left(\frac{w_B}{w_A}\right)^\theta \frac{1}{\tau^{\theta+1}}\right). \tag{A.90}$$

which depends on $(\tau, \theta, w_B/w_A)$ alone. We can obtain the elasticity of imports from Country A with respect to the tariff by dividing through by $\log(\tau)$ on both sides of equation (A.90). Therefore, as commonly found for the Pareto distribution, this elasticity depends on the productivity dispersion parameter (θ) rather than the elasticity of substitution between varieties (σ).

Country A Price Response: From equations (A.82), (A.85) and (A.84), the log change in export prices from Country A following the tariff is:

$$\log\left(\frac{\rho_A^\tau}{\rho_A}\right) = \log\left(\frac{w_B \bar{b}^\tau}{\tau w_A \bar{a}}\right). \tag{A.91}$$

For $\tau \geq \tau_c$, we have:

$$a_B = \frac{w_B \bar{b}(\tau_c)}{\tau w_A}, \qquad \bar{b}^\tau = \bar{b}(\tau_c). \tag{A.92}$$

Additionally, τ_c solves:

$$\tau_c w_A \bar{a} = w_B \bar{b}(\tau_c). \tag{A.93}$$

Together these relationships imply:

$$\frac{a_B}{\bar{a}} = \frac{w_B}{w_A} \frac{\bar{b}^\tau}{\bar{a}} \frac{1}{\tau} = \frac{\tau_c}{\tau}.$$

Using this result in equation (A.91), the log change in export prices from Country A following the tariff can be re-written as:

$$\log\left(\frac{\rho_A^\tau}{\rho_A}\right) = \log\left(\frac{\tau_c}{\tau}\right), \tag{A.94}$$

which depends on $(\tau, \theta, w_B/w_A, \alpha, \varepsilon)$ alone, since

$$\tau_c = \left(\frac{w_B}{w_A}\right)^{\frac{\theta}{\theta - \alpha(\varepsilon - 1)}}. \tag{A.95}$$

We can obtain the elasticity of Country A prices with respect to the tariff by dividing through by

$\log(\tau)$ on both sides of equation (A.94).

Import Reallocation from Country A to Country B: From equations (A.83), (A.88) and (A.89), the change in imports from Country B divided by the change in imports from Country A is:

$$\frac{M_B^\tau}{M_A^\tau - M_A} = \frac{\left[1 - \left(\frac{a_B}{\bar{a}}\right)^\theta\right] \frac{\rho_B^\tau}{\rho_A^\tau}}{\left(\frac{a_B}{\bar{a}}\right)^\theta - \frac{m}{m^\tau} \frac{\rho}{\rho_A^\tau}}. \tag{A.96}$$

Using equations (A.81), (A.82), (A.84), (A.85), (A.86) and (A.87), we can rewrite this import reallocation in equation (A.96) as:

$$\frac{M_B^\tau}{M_A^\tau - M_A} = \frac{\left[1 - \left(\frac{a_B}{\bar{a}}\right)^\theta\right] \tau}{\left(\frac{a_B}{\bar{a}}\right)^\theta - \tau \left(\frac{\bar{b}^\tau}{\bar{a}}\right)^\theta}.$$

Using the results in (A.92) and (A.93), we can further re-write this import reallocation as:

$$\frac{M_B^\tau}{M_A^\tau - M_A} = \frac{\left[1 - \left(\frac{\tau_c}{\tau}\right)^\theta\right] \tau}{\left(\frac{\tau_c}{\tau}\right)^\theta - \tau \left(\frac{w_A}{w_B}\tau_c\right)^\theta}, \tag{A.97}$$

which again depends on $(\tau, \theta, w_B/w_A, \alpha, \varepsilon)$ alone, since $\tau_c = \left(\frac{w_B}{w_A}\right)^{\frac{\theta}{\theta - \alpha(\varepsilon-1)}}$.

Parameter Calibration

Productivity Dispersion Parameter (θ): From equations (A.90) and (A.95), we can rewrite the log growth in import values from Country A as:

$$\log\left(\frac{M_A^\tau}{M_A}\right) = \log\left(\tau_c^{\theta - \alpha(\varepsilon-1)} \frac{1}{\tau^{\theta+1}}\right).$$

Using the log change in export prices from Country A from equation (A.94) to substitute for τ_c, we obtain:

$$\log\left(\frac{M_A^\tau}{M_A}\right) = \left(\frac{\rho_A^\tau}{\rho}\right)^{\theta - \alpha(\varepsilon-1)} \tau^{-(1+\alpha(\varepsilon-1))}.$$

We therefore obtain the following closed-form expression that we use to calibrate θ:

$$\theta = \frac{\log\left(\frac{M_A^\tau}{M_A}\right) + [1 + \alpha(\varepsilon - 1)] \log \tau}{\log\left(\frac{\rho_A^\tau}{\rho}\right)} + \alpha(\varepsilon - 1), \tag{A.98}$$

where we have event-study estimates for $\log\left(\frac{M_A^\tau}{M_A}\right)$ and $\log\left(\frac{\rho_A^\tau}{\rho}\right)$; we observe $\tau = 1.14$; we calibrate $\varepsilon = 1.19$; and we calibrate α to match the initial share of imports from China in U.S. manufacturing value-added.

Cost Disadvantage of Country B (w_B/w_A): From equations (A.94) and (A.95). we obtain the

following closed-form expression that we use to calibrate w_B/w_A:

$$\frac{w_B}{w_A} = \left(\frac{\rho_A^\tau}{\rho}\tau\right)^{\frac{\theta-\alpha(\varepsilon-1)}{\theta}}, \tag{A.99}$$

where we have an event-study estimate for $\log\left(\frac{\rho_A^\tau}{\rho}\right)$; we observe $\tau = 1.14$; we calibrate $\varepsilon = 1.19$; we calibrate α to match the initial share of imports from China in U.S. manufacturing value-added; and we calibrate θ from equation (A.98) above.

Online Appendix B: Calibration Appendix

When Tariffs Disturb Global Supply Chains
(Not for Publication)

by

Gene M. Grossman, Elhanan Helpman and Stephen J. Redding

August 2023

Table of Contents

B.1 Introduction

In this Calibration Appendix, we provide further details on the calibration of the model's parameters using the estimated price and quantity responses to the Trump administration's tariffs. All sections of this Calibration Appendix contain additional information for Section 5 of the paper.

In Subsection B.2, we provide some descriptive evidence on the Trump tariffs. In Subsection B.3, we provide further evidence of a relocation of import sourcing away from China and towards Other Asian countries in response to these tariffs.

In Subsection B.4, we replicate the event-study estimates of the price and quantity responses to the Trump tariffs in Amiti et al. (2020). We use these event-study estimates to generate predicted changes in U.S.-China import values and Chinese export prices, which we use in our calibration of the model's parameters.

In Subsection B.5, we discuss in further detail the calibration of the model's parameters using initial import shares and the estimated price and quantity responses to the Trump tariffs. In Subsection B.6, we provide further details on the terms of trade and welfare predictions of our calibrated model.

In Subsection B.7, we show the wedge between the perceived marginal cost of inputs and expected input prices as a function of the size of the tariff for our calibrated parameter values.

In Subsections B.8-B.10, we report a number of robustness tests on our baseline calibration of the model. Subsection B.8 examines the robustness of our quantitative conclusions to the assumption of alternative parameter values.

Subsection B.9 reports further robustness checks, including recalibrating our model excluding consumer goods and for a shorter sample period ending in December 2018. Subsection B.10 reports a counterfactual in which the country where new searches occur is the home country (reshoring), such that the profits of new suppliers are included in home welfare.

In Subsection B.11, we provide further information on the data sources used for the calibration of the model parameters.

B.2 Trump administration tariffs

From February 2018 to the end of our sample period in October 2019, the Trump administration imposed eight waves of new U.S. tariffs. Starting in July 2018, the last five of these tariff waves targeted U.S. imports from China. In Figure B.1 below, we show the unweighted average of new U.S. tariffs on China for these last five waves. In July and September 2018, average tariffs of 25 percent were imposed on $34 billion and $16 billion of U.S. imports, respectively. In October 2018 and June 2019, average tariffs of around 10 percent were applied to $200 and $200 billion of U.S. imports, respectively. In September 2019, average tariffs of 15 percent were introduced on $112 billion of U.S. imports.[32]

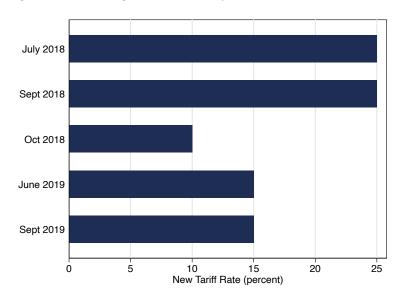[32]Import values are headline values when each tariff wave was imposed.

Figure B.1: Average Tariff Rate by Wave of Tariffs on China

Note: Unweighted average of the additional U.S. tariffs imposed on imports from China by tariff wave; total U.S. import values affected by each wave of tariffs on China were: $34 billion (July 2018); $16 billion (September 2018); $200 billion (October 2018); $200 billion (June 2019); $112 billion (September 2019); these import values are headline values when each tariff wave was imposed from Amiti et al. (2020).

While countries have traditionally targeted final consumption goods with tariffs, the Trump administration's tariffs on China were distinctive in that they initially were concentrated on intermediate goods. In Figure B.2, we show the share of import value on which additional U.S. tariffs on China were imposed by category of good and tariff wave. Early tariff waves were concentrated on intermediate and capital goods. Later tariff waves expanded to include consumer goods, as the administration began to "run out" of intermediate and capital goods to target.

In our baseline specification in the paper, we calibrate our model for all goods, recognizing that supply chains can extend to consumer goods. In Section B.9.1 of this calibration appendix, we report a robustness test, in which we exclude consumer goods from the calibration, and demonstrate a similar pattern of results.

B.3 Relocation of Import Sourcing

In the introduction in the paper, we provide evidence that the Trump tariffs on China lead to a relocation of import sourcing away from China and towards other Asian countries. In this subsection of the calibration appendix, we provide further evidence in support of this relocation of import sourcing.

In Figure B.3, we show the shares of China and other Asian countries in the total value of U.S. imports. We define other Asian countries as Bangladesh, Cambodia, Hong Kong, India, Indonesia, Malaysia, Pakistan, Philippines, Singapore, Sri Lanka, Taiwan, Thailand, and Vietnam, as identified by Kearney (2020), in addition to China, as "traditional offshoring trade partners."

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Figure B.2: Share of Import Value on Which Additional Tariffs were Imposed by Category of Good and Tariff Wave

Note: Share of import value on which additional tariffs were imposed by product end-use according to the U.S. Census Bureau classification.

After the first wave of tariffs on China in July 2018 (marked by the dashed vertical line), we find a sharp decline in China's share of U.S. imports of around 3 percent (left scale), and a corresponding rise in Other Asia's share of U.S. imports of a similar magnitude (right scale). This similarity between the decline for China and the rise for Other Asia's import share provides a first piece of evidence of a relocation of import sourcing from China to Other Asia.

In Figure B.4, we provide additional evidence of this relocation using the extensive margin of the number of products by import source. The vertical bars show the number of products that were (i) sourced from China in the twelve months preceding the first Trump tariff wave on China in July 2018, (ii) not sourced from other Asian countries during this preceding twelve-month period, and (iii) sourced from other Asian countries following the first Trump tariff wave on China in July 2018. In the immediate aftermath of this first wave of tariffs on China (announced June 15, 2018 and enacted July 6, 2018), we observe a substantial number of products for which there is a relocation of import sourcing from China to other Asian countries.

In Table 1 in the paper, we provide regression evidence that an increase in U.S. tariffs on China relative to U.S. tariffs on Other Asian countries reduces U.S. imports from China and increases U.S. imports from these Other Asian countries. We now provide further evidence that these empirical findings are not driven by differences in pre-trends between U.S. imports from these two groups of countries.

In our baseline specification in the paper, we estimate the following regression of the log value of U.S. imports for either China or Other Asia ($\log(m_{jit})$ for $j = CH$ or $j = OA$) on the log of one plus the U.S. *ad valorem* tariff on China minus the log of one plus the U.S. *ad valorem* tariff

Figure B.3: Share of China and Other Asia in U.S. Imports

Note: Black solid line shows share of U.S. imports from China; gray solid line shows share of U.S. imports from other Asian countries; we define other Asian countries as Bangladesh, Cambodia, Hong Kong, India, Indonesia, Malaysia, Pakistan, Philippines, Singapore, Sri Lanka, Taiwan, Thailand, and Vietnam following Kearney (2020); dashed vertical line shows the date of the first Trump tariff wave on China; both series seasonally adjusted by removing month fixed effects.

on Other Asia ($\log\left(\tau_{CHit}/\tau_{OAit}\right)$):

$$\log m_{jit} = \beta \log\left(\frac{\tau_{CHit}}{\tau_{OAit}}\right) + \eta_i + d_t + u_{jit}, \tag{B.1}$$

where j denotes exporter (either China or Other Asia); i indicates 10-digit Harmonized Tariff Schedule (HTS) products; t indexes date (month × year); τ_{jit} is one plus the *ad valorem* import tariff; β is the key coefficient of interest on log relative tariffs; η_i are fixed effects for 10-digit HTS products; d_t are date fixed effects; u_{jit} is a stochastic error; and we cluster standard errors by Harmonized System (HS) 8-digit product to control for serial correlation over time and because some tariffs were imposed at this level.

We estimate this regression (B.1) for China and Other Asia separately using observations across products and over time.[33] The inclusion of the product and date fixed effects implies that this specification has a "difference-in-differences" interpretation, where the first difference is over time, and the second difference is across products experiencing different levels of tariff increases. The inclusion of the date fixed effects controls for different time trends in imports across all products for China and Other Asia (e.g., imports across all products could be growing faster or slower for Other Asia compared to China even before the imposition of the Trump tariffs). The key identifying assumption is parallel trends within a given exporter for products experiencing high versus low changes in relative tariffs.

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[33] In contrast, our event-study specifications in Subsection B.4 of this Calibration Appendix use observations across exporting countries, products and time.
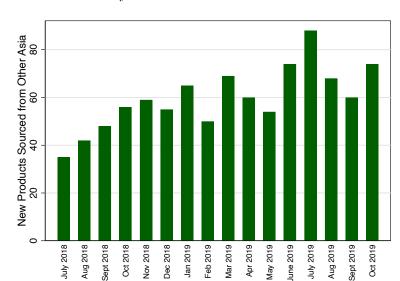
Figure B.4: Products Previously Sourced from China and Now Sourced from Other Asia

Note: Vertical bars show number of products that were (i) sourced from China during the 12 months before the first wave of tariffs on China in July 2018, (ii) not sourced from other Asian countries during this preceding 12-month period; (iii) sourced from other Asian countries after the first wave of tariffs on China in July 2018; other Asian countries are defined as in Figure B.3.

A potential concern is that there could be differences in pre-trends within a given exporter for products experiencing different levels of tariff increases. As first step to addressing this concern, we augment the regression specification in equation (B.1) with linear time trends for each 2-digit HS sector, which allows 2-digit sectors to have different linear pre-trends. In this augmented specification, the estimated coefficient on log relative tariffs (β) is identified from deviations from these linear time trends. As shown in Table B.1, we find the same pattern of results as in our baseline specification in Table 1 in the paper. We find that imports from China were significantly lower for goods that experienced large tariff hikes, while imports from Other Asia were correspondingly higher. We find this pattern whether we consider all goods (Columns (1) and (2)) or exclude consumer goods (Columns (3) and (4)).

As a further check for differences in pre-trends, we estimate a placebo specification, using 12-month periods before and after each Trump tariff wave. We begin by computing the log change in relative U.S. tariffs, measured as the log of one plus the U.S. *ad valorem* tariff on China minus the log of one plus the U.S. *ad valorem* tariff on Other Asia. We refer to pairs of countries and 10-digit Harmonized Tariff Schedule (HTS) products on which new tariffs were imposed by the Trump administration as treated country-products. We assign each of these treated country-products to the first tariff wave in which it was treated. For each of these treated country-product pairs, we compute the log change in relative tariffs between the last month before that tariff wave and the twelfth month thereafter. For untreated country-products, we use the same twelve-month period for differencing as for the first tariff wave. We next compute the log difference in U.S. imports from China and Other Asia for these twelve-month periods before and after each tariff wave.

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Table B.1: U.S. Imports from China and Other Asian Countries

	(1)	(2)	(3)	(4)
	Log U.S. Imports from China	Log U.S. Imports from Other Asia	Log U.S. Imports from China	Log U.S. Imports from Other Asia
	All Goods	All Goods	Excluding Consumer Goods	Excluding Consumer Goods
Log Relative Tariffs	-1.893***	0.329***	-1.631***	0.290***
	(0.090)	(0.090)	(0.118)	(0.109)
Product Fixed Effects	Yes	Yes	Yes	Yes
Month Fixed Effects	Yes	Yes	Yes	Yes
Date × HS2 Linear Time Trends	Yes	Yes	Yes	Yes
R-squared	0.88	0.86	0.87	0.86
Observations	279,980	279,980	183,236	183,236

Note: Observations are at the source-HTS10-date level from January 2016 to October 2019, where source is either China or Other Asia, and date is month × year; Columns (1) and (2) include all goods; Columns (3) and (4) exclude consumption goods; regressions include only products with positive imports from both sources; log Relative Tariffs is the log difference between one plus the *ad valorem* tariff rate on imports from China and one plus the weighted-average *ad valorem* tariff rate on imports from Other Asia; Other Asia is defined as in Figure B.3 above; the weighted-average tariffs use the annual import values in 2017 as weights. Standard errors are clustered at the HS8 level; *, ** and *** indicate significance at the 10, 5 and 10 percent, respectively.

Finally, we estimate separate long-difference regressions of these log changes in U.S. imports *before* and *after* each tariff wave ($\Delta_{12} \log m_{jit}$) on the log change in tariffs *after* each tariff wave ($\Delta_{12}^{Post} \log \left(\frac{\tau_{CHit}}{\tau_{OAit}} \right)$):

$$\Delta_{12} \log m_{jit} = \beta \Delta_{12}^{Post} \log \left(\frac{\tau_{CHit}}{\tau_{OAit}} \right) + u_{jit}, \tag{B.2}$$

where j denotes exporter (either China or Other Asia); i indicates 10-digit Harmonized Tariff Schedule (HTS) products; t indexes a twelve-month period; τ_{jit} is defined as one plus the *ad valorem* tariff; u_{jit} is a stochastic error; and we again cluster standard errors by HS 8-digit product, because some tariffs were imposed at this level.

We estimate this regression (B.2) separately over the twelve-month periods *before* and *after* each Trump Tariff wave, such that observations correspond to a cross-section of ten-digit Harmonized System (HS) products. In Columns (1) and (2) of Table B.2, we report the results for the twelve-month period *after* each Trump tariff wave. Consistent with the results in Table B.1 above, we find statistically significant reductions in imports from China and statistically significant increases in imports from Other Asia after the Trump tariffs. In contrast, in Columns (3) and (4), we report the results using import growth for the twelve-month period *before* each Trump tariff wave and log changes in tariffs for the twelve-month period *after* each Trump tariff wave. We find a quite different relationship between *past* import growth and *future* tariff changes. In Column (3), we find a positive (rather than negative) and statistically significant relationship between past import growth from China and future tariff changes. In Column (4), we find a positive but statistically insignificant relationship between past import growth from Other Asia and future tariff changes.

This pattern of results provides evidence that our findings in Columns (1) and (2) of Table B.2, and in Table B.1 above, are not capturing differences in pre-trends.

Table B.2: Long Differences of U.S. Imports from China and Other Asian Countries

	(1)	(2)	(3)	(4)
	Δ log U.S. Imports from China	Δ log U.S. Imports from Other Asia	Δ log U.S. Imports from China	Δ log U.S. Imports from Other Asia
	All Goods	All Goods	All Goods	All Goods
Δ log Trump Tariff	-1.992***	0.568**	0.742***	0.024
	(0.231)	(0.245)	(0.200)	(0.234)
Time Period	12 Months Post Trump Tariff	12 Months Post Trump Tariff	12 Months Pre Trump Tariff	12 Months Pre Trump Tariff
Observations	5,988	5,988	5,676	5,393
R-squared	0.01	0.00	0.00	0.00

Note: Observations are a cross-section of HTS10 products sourced from either China (Columns (1) and (3)) or Other Asia (Columns (2) and (4)); Δ log Relative Tariff Post is the log change in U.S. relative tariffs on China and Other Asia for the twelve-month period *after* each Trump tariff wave; relative tariffs are defined using one plus the *ad valorem tariff*; in Columns (1) and (2), the log changes in U.S. imports are for the twelve-month period *after* each Trump tariff wave; in Columns (3) and (4), the log changes in U.S. imports are for the twelve-month periods *before* each Trump Tariff wave; Columns (1) and (3) report results for U.S. imports from China; Columns (2) and (4) report results for U.S. imports from Other Asia; Other Asia is defined as in Figure B.3 above; standard errors are clustered at the HTS8 level. *, ** and *** indicate significance at the 10, 5 and 10 percent, respectively.

Taken together, the empirical findings of this subsection provide evidence of a relocation of import sourcing from China to other Asian countries following the Trump administration's tariffs on China. Such a relocation of import sourcing occurs in the model for parameter values for which $\tau > \tau_c$, which is satisfied for our calibrated parameter values below.

B.4   Price and Quantity Responses to the Trump Tariffs

We follow Amiti et al. (2019, 2020) and Fajgelbaum et al. (2019) in estimating the price and quantity response to the Trump tariffs using an event-study specification. In particular, we replicate the event-study estimates in Amiti et al. (2020), since the sample period includes the two later waves of U.S. tariffs on China in June and September 2019.[34] We estimate the impact of these tariffs on export prices and import values using all waves of tariffs from January 2018 to October 2019. Using the estimated coefficients and the new tariffs imposed on China by the Trump administration, we generate predicted changes in U.S.-China import values and Chinese export prices, which we use below in our calibration of the model's parameters.

We consider the following event-study regression specification for exporting country j, product

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[34]In contrast, the sample periods in Amiti et al. (2019) and Fajgelbaum et al. (2020) end in December 2018 and April 2019, respectively.

i and month t:

$$\log x_{jit} = \eta_{ji} + \sum_{s=-T}^{T} \beta_s \left(1_{jis} \times \log \left(\frac{\tau_{jis}}{\tau_{ji0}} \right) \right) + \mu_{jt} + \delta_{it} + u_{jit}, \qquad \text{(B.3)}$$

where x_{jit} is either U.S. import prices (unit values) inclusive of the tariff or U.S. import values. The coefficients β_s are elasticities estimated over different time horizons s. The excluded category is the last untreated month (i.e., $\beta_0 = 0$). We measure the log change in tariffs between month s and the last untreated month ($\log(\tau_{jis}/\tau_{ji0})$), where τ_{jis} is defined as one plus the *ad valorem* tariff. Products correspond to Harmonized Tariff Schedule (HTS) 10-digit categories. We include country-product fixed effects (η_{ji}) to control for the level of import prices or values in the last untreated month and capture differences in quality or comparative advantage across countries and products. The country-time fixed effects (μ_{jt}) capture time-varying factors that affect import prices or values (e.g., exchange rates). The product-time fixed effects (δ_{it}) allow for time-varying forces that affect import prices or values for a product across all countries (e.g., common technological change).

We begin by replicating the event-study estimates in Figures 2 and 3 of Amiti et al. (2020). In Columns (1) and (3) of Table B.3, we report the estimated elasticities for U.S. import prices (inclusive of the tariffs). In line with a range of other empirical studies, we find no evidence of pre-trends, and high rates of pass-through for the Trump tariffs. In the twelve months leading up to a tariff wave, we find coefficients that are close to zero and, if anything, negative. In contrast, in the months immediately after a tariff wave, we find large, positive and statistically significant coefficients that are close to one. After 12 months, we find an elasticity of U.S. import prices with respect to the tariff of 0.96, which implies a corresponding elasticity of export prices with respect to the tariff of $0.96 - 1 = -0.04$.

In Columns (2) and (4), we report the estimated elasticities for U.S. import values. In line with other evidence, we again find little evidence of pre-trends, and substantial changes in U.S. import sourcing in response to the Trump tariffs. In the twelve months leading up to a tariff wave, we find coefficients that are typically small in magnitude and often statistically insignificant. In contrast, in the months immediately after a tariff wave, we find large, negative and statistically significant coefficients. After 12 months, we find an elasticity of import values with respect to the tariffs of -2.15.

This estimated elasticity of U.S. imports after 12 months of -2.15 is close to the estimated partial trade elasticity of -2.53 in Fajgelbaum et al. (2020), and lies within the 95 percent confidence interval around that parameter estimate (from -3.02 to -1.75). Similarly, the implied elasticity of foreign export prices after 12 months of -0.04 from Table B.3 is comparable with the estimated elasticity of zero in Fajgelbaum et al. (2020), and lies within the 95 percent confidence interval around that parameter estimate (from -0.14 to 0.10).

Using the estimated coefficients from this event-study specification $(\widehat{\beta}_s)$, we compute predicted changes in U.S. imports from China and Chinese export prices as a result of the new tariffs imposed

Table B.3: Estimated Event-Study Elasticities

Treatment Time	(1) Import Prices (inclusive of tariff)	(2) Import Values	Treatment Time	(3) Import Prices (inclusive of tariff)	(4) Import Values
$s=-12$	-0.0724**	-0.3651***	$s=1$	0.8363***	-0.9984***
$s=-11$	-0.1457***	-0.3038***	$s=2$	0.8421***	-1.3307***
$s=-10$	-0.1269***	-0.2551**	$s=3$	0.8228***	-1.1347***
$s=-9$	-0.0737*	-0.2077*	$s=4$	0.8903***	-1.7749***
$s=-8$	-0.0889**	-0.4807***	$s=5$	0.8300***	-1.8006***
$s=-7$	-0.0616	-0.0038	$s=6$	0.9304***	-1.8699***
$s=-6$	-0.0791**	0.1628	$s=7$	0.9325***	-1.5783***
$s=-5$	-0.0647*	0.2894***	$s=8$	0.9529***	-1.8811***
$s=-4$	-0.0307	-0.1297	$s=9$	0.9438***	-1.6504***
$s=-3$	-0.0075	0.1007	$s=10$	0.8592***	-1.9125***
$s=-2$	-0.0452	0.1154	$s=11$	0.8836***	-2.1148***
$s=-1$	0.0131	-0.0255	$s=12$	0.9559***	-2.1485***

Note: Replication of the event-study estimates in Figures 1 and 2 of Amiti et al. (2020); estimated coefficients (β_s) on the interactions between treatment years (s) and tariff changes; negative values of s correspond to months before a tariff wave; positive values of s correspond to months after a tariff wave; *** significant at the 1 percent level; ** significant at the 5 percent level; * significant at the 10 percent level.

on China ($j=A$) by the Trump administration:

$$\log\left(\frac{\widehat{x_{Ais}}}{x_{Ai0}}\right) = \widehat{\beta}_s\left(1_{Ais} \times \log\left(\frac{\tau_{Ais}}{\tau_{Ai0}}\right)\right).$$

Aggregating across products, we obtain the predicted change in the value of U.S. imports from China and average Chinese exporter prices. In Columns (1) and (3) of Table B.4, we report the predicted decline in the average price received by Chinese exporters. By October 2019, we find a small reduction in Chinese export prices of 2.14 percent. In Columns (2) and (4), we report the corresponding predicted decline in the value of U.S.-China imports. By October 2019, we find a substantial reduction in U.S.-China imports of 34.23 percent.

We use these two empirical moments for the percentage decline in Chinese export prices and U.S.-China imports of 2.14 and 34.23 percent, respectively, in our calibration of the model's parameters in the next subsection.

B.5 Parameter Calibration

We discipline the quantitative predictions of our model for the terms of trade and welfare by calibrating its parameters such that it matches the above empirical estimates of the price and quantity responses to the Trump tariffs.

We interpret the home country as corresponding to the United States and Country A as representing China. Motivated by our empirical findings of a relocation of U.S. imports towards other Asian countries in response to the Trump tariffs, we use Other Asia as the destination for new searches in our baseline specification (Country B). In Section B.10 of this Calibration Appendix,

Table B.4: Predicted Percentage Changes in Chinese Export Prices and U.S.-China Import Values in Response to the Trump Tariffs

	(1)	(2)		(3)	(4)
Year and Month	Chinese Export Prices	U.S.-China Import Values	Year and Month	Chinese Export Prices	U.S.-China Import Values
2018m2	-0.01	-0.05	2019m1	-0.84	-13.64
2018m3	-0.01	-0.08	2019m2	-0.98	-14.48
2018m4	-0.12	-0.75	2019m3	-0.51	-14.42
2018m5	-0.11	-0.95	2019m4	-0.65	-13.80
2018m6	-0.12	-0.81	2019m5	-0.51	-15.38
2018m7	-0.37	-3.04	2019m6	-1.55	-21.21
2018m8	-0.39	-3.61	2019m7	-1.87	-24.55
2018m9	-0.46	-3.92	2019m8	-1.81	-24.15
2018m10	-1.10	-9.72	2019m9	-1.77	-32.64
2018m11	-1.19	-11.44	2019m10	-2.14	-34.23
2018m12	-1.07	-10.95			

Note: Predicted percentage changes in Chinese export prices and U.S.-China import values over time; we use the estimated event-study coefficients from Table B.3, subtracting one from the coefficients for import prices (inclusive of the tariff) to obtain the implied change in export prices (exclusive of the tariff); we multiply these estimated coefficients by the change in U.S.-China import tariffs, and aggregate across 10-digit Harmonized Tariff Schedule (HTS) products.

we report a counterfactual, in which we instead evaluate the welfare effects of the Trump tariffs under the counterfactual assumption that all relocated parts of supply chains return to the United States.

We interpret the differentiated sector in the model as the manufacturing sector in the data. We map the outside sector in the model to the non-manufacturing sector in the data, and take the stance that wages in the home country (the United States) are pinned down in the non-manufacturing sector, which is much bigger than the manufacturing sector as a share of U.S. GDP. We choose the home wage as the numeraire. Thus, the home country's gross domestic product (GDP) in the initial zero-profit equilibrium before the tariff is given by L; its manufacturing value added equals $n\ell$; and its manufacturing expenditure equals PX. Although consumer expenditure equals consumer income, manufacturing expenditure can differ from manufacturing value added, because of the outside sector.

We assume a Pareto distribution of supplier productivity $(G(a) = a^\theta)$, as commonly assumed in the theoretical and empirical literature on heterogeneous firms following Melitz (2003). The key parameter determining the return to supplier search is the Pareto shape parameter (θ). A larger value for θ corresponds to less dispersion in supplier productivity $(1/a)$, and hence less dispersion in supplier costs (a).

In the remainder of this section, we discuss the calibration of each of the model's parameters in turn: the tariff (τ); the elasticity of demand for the differentiated sector (ε); the elasticity of substitution across varieties within the differentiated sector (σ); home population (L); the wage in Country A (w_A); the dispersion of supplier productivity (θ); the cost disadvantage of Country B (w_B/w_A); the input cost share (α); the Nash bargaining parameter (β); and the fixed operating,

entry and search costs (f_o, f_e, f).

In Table B.5, we list these parameters, their calibrated values, and the source for each calibrated value, as discussed further in the remainder of this subsection. In Subsection B.11, we provide further details of the data sources used for the calibration of the model's parameters.

B.5.1 Tariff

In our baseline specification, we set the tariff equal to the import-weighted average of the tariffs imposed by the Trump administration on China across all goods, using 2017 import shares as weights, which yields $\tau = 1.1401$. Given our other calibrated model parameters, we show below that $\tau > \tau_c$, such that firms search for new suppliers in Country B, consistent with the relocation of import sourcing observed in the data.

B.5.2 Elasticity of Demand for the Differentiated Sector (ϵ)

We calibrate the elasticity of demand for the differentiated sector (ε) based on the estimated demand elasticity across 4-digit NAICS sectors using the Trump administration tariffs in Fajgelbaum et al. (2020): $\varepsilon = 1.19$. This calibrated value is close to the estimate of 1.36 at the same level of sector aggregation in Redding and Weinstein (2021). Hence, these empirical estimates provide support for our assumption of elastic demand across sectors ($\varepsilon > 1$).

B.5.3 Elasticity of Substitution Across Varieties (σ)

The elasticity of substitution across varieties within the differentiated sector (σ) determines the mark-up of prices over marginal cost. Therefore, we calibrate this parameter based on the estimated markup using U.S. data of $\frac{\sigma}{\sigma-1} = 1.61$ from De Loecker et al. (2020). The implied value for the elasticity of substitution is $\sigma = \frac{1.61}{0.61} = 2.64$, which satisfies our assumption of a higher demand elasticity across goods within the differentiated sector than across sectors ($\sigma > \varepsilon$).

B.5.4 Home Labor Supply (L)

We choose the home labor supply such that home GDP in the initial zero-profit equilibrium before the tariff is equal to U.S. GDP in 2017 before the Trump tariffs ($L = 19.4773$ trillion).

B.5.5 Country A Wage (w_A)

We calibrate the wage in China (w_A) such its income per capita equals one fifth of that in home ($w_A/w = 0.2$), which is line with relative gross domestic product (GDP) per capita in purchasing power parity (PPP) terms in China and the United States in 2017.

Table B.5: Calibration of Model Parameters

Parameter	Notation	Value	Source
Tariff	τ	1.14	Imported-weighted average tariff imposed on China by the Trump Administration
Sector elasticity	ε	1.19	Estimated sector elasticity from Fajgelbaum et al. (2020)
Variety elasticity	σ	2.64	Estimated markup from De Loecker et al. (2020)
Home wage		1	Numeraire
Labor supply	L	19.48	U.S. Gross Domestic Product (GDP) in 2017
Country A wage	w_A	0.20	Relative China-U.S. GDP per capita 2017 before the Trump tariffs (purchasing power parity)
Bargaining power	β	0.50	Central Value
Productivity dispersion	θ	9.6993	Estimated log change in U.S. imports from China in response to the Trump tariffs by October 2019 from the event-study estimates in Amiti et al. (2020) of -34.23 percent ($\log(M_A{}^\tau/M_A)$).
Country B cost disadvantage	w_B/w_A	1.1155	Estimated log change in Chinese export prices in response to the Trump tariffs by October 2019 from the event-study estimates in Amiti et al. (2020) of -2.14 percent ($\log(\rho_A{}^\tau/r_A)$).
Imported input share	α	0.1791	Initial share of imports from China in U.S. manufacturing value added in 2017 before the Trump tariffs 22.95 percent (M_A/nwl).
Fixed operating cost	f_o	0.0007	Initial share of manufacturing value added in U.S. GDP in 2017 before the Trump tariffs of 11.3 percent (nl/L).
Fixed search cost	f	$f_o/100$	Institute of Management (2018)
Fixed entry cost	f_e	$\tau_c < \tau < \tau_{ex}$	Condition for relocation of import sourcing

Note: The first column lists each parameter; the second column contains the corresponding notation; the third column gives its calibrated value; the fourth column summarizes the source for this calibrated value; relative changes in productivity ($\bar{b}^\tau/\bar{a}$ and $\bar{a}^\tau/\bar{a}$) and welfare ($(V^\tau - V)/npx$) are invariant to the fixed costs as long as the theoretical restrictions in equations (B.7) and (B.8) are satisfied; we calibrate the fixed entry (f_e) and search costs (f) to ensure that these theoretical restrictions are satisfied; we choose a central value for the bargaining parameter ($\beta = 0.5$) for our baseline specification and report robustness tests for alternative values of this parameter.

B.5.6 Productivity Dispersion (θ), Country B Cost Disadvantage (w_B/w_A), Input Cost Share (α), and Fixed Operating Cost (f_o)

We choose the four parameters (θ, w_B/w_A, α, f_o) such that the model exactly matches the following four empirical moments:

1. The initial share of imports from China in U.S. manufacturing value added in 2017 before the Trump tariffs ($M_A/n\ell$).

2. The initial share of manufacturing value added in U.S. GDP in 2017 before the Trump tariffs ($n\ell/L$).

3. The estimated log change in U.S. imports from China in response to the Trump tariffs by October 2019 from the event-study estimates in Amiti et al. (2020) ($\log(M_A^\tau/M_A)$).

4. The estimated log change in Chinese export prices in response to the Trump tariffs by October 2019 from the event-study estimates in Amiti et al. (2020) ($\log(\rho_A^\tau/\rho_A)$).

In the model, all inputs are imported from China in the initial equilibrium before the tariff, which implies that the initial share of imports from China in manufacturing value added ($M_A/n\ell$)

is largely determined by the share of inputs in production costs (α). Therefore, by controlling this parameter, we can ensure that the model exactly matches this empirical moment.

In contrast, the initial share of manufacturing value added in GDP before the tariff ($n\ell/L$) is heavily influenced by the fixed operating cost (f_o), which affects the size of the differentiated sector. Hence, by controlling this parameter, we can ensure that the model also exactly matches this empirical moment.

The log changes in U.S. imports from China ($\log\left(M_A^\tau/M_A\right)$) and Chinese export prices ($\log\left(\rho_A^\tau/\rho_A\right)$) are closely related to the productivity dispersion parameter (θ) and the cost disadvantage of Country B (w_B/w_A). In particular, for the empirically-relevant range of parameters in which there is a partial relocation of supply chains to Other Asia ($\tau_c < \tau < \tau_{ex}$), we show in Section 5.1 of Online Appendix A that we have the following closed-form solutions for these moments:

$$\log\left(\frac{M_A^\tau}{M_A}\right) = \log\left(\frac{1}{\tau^{\theta+1}}\left(\frac{w_B}{w_A}\right)^\theta\right), \tag{B.4}$$

$$\log\left(\frac{\rho_A^\tau}{\rho_A}\right) = \log\left(\frac{1}{\tau}\frac{w_B}{w_A}\frac{\overline{b}^\tau}{\overline{a}}\right) = \log\left(\frac{\tau_c}{\tau}\right), \tag{B.5}$$

where recall that:

$$\tau_c = \left(\frac{w_B}{w_A}\right)^{\frac{\theta}{\theta-\alpha(\varepsilon-1)}}. \tag{B.6}$$

From equations (B.4)-(B.6), we obtain the following closed-form expressions for θ and w_B/w_A:

$$\theta = \frac{\log\left(\frac{M_A^\tau}{M_A}\right) + [1 + \alpha\left(\varepsilon - 1\right)]\log\tau}{\log\left(\frac{\rho_A^\tau}{\rho}\right)} + \alpha\left(\varepsilon - 1\right),$$

$$\frac{w_B}{w_A} = \left(\frac{\rho_A^\tau}{\rho}\tau\right)^{\frac{\theta-\alpha(\varepsilon-1)}{\theta}},$$

where we have event-study estimates for $\log\left(\frac{M_A^\tau}{M_A}\right) = -0.3423$ and $\log\left(\frac{\rho_A^\tau}{\rho}\right) = -0.0214$; we observe $\tau = 1.1401$; we calibrate $\varepsilon = 1.19$; and we calibrate α to match the initial share of imports from China in U.S. manufacturing value-added.

We thus obtain the following calibrated values for the four parameters (θ, w_B/w_A, α, f_o):

$$\theta = 9.6993,$$
$$w_B/w_A = 1.1155,$$
$$\alpha = 0.1791,$$
$$f_o = 0.0007.$$

To match the combination of a sharp drop in U.S.-China imports and a small drop in Chinese export prices, we require a relatively large value for the productivity dispersion parameter ($\theta = 9.70$)

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and a relatively small value for the cost disadvantage of Country B ($w_B/w_A = 1.12$). In Online Appendix B.8, we show how the model's predictions for these two moments vary for alternative values of the productivity dispersion (θ) and cost disadvantage (w_B/w_A) parameters.

Our calibrated relative cost disadvantage of Country B of $w_B/w_A = 1.12$ is larger than observed relative income per capita in purchasing power parity terms between Other Asian countries and China. However, w_B/w_A in the model corresponds to the relative wage per efficiency unit of labor in Country B, which can differ from relative observed wages. By construction, relative production costs in Other Asia must have been higher than in China before the tariff, otherwise these imports would not have been sourced from China. More broadly, if labor is less productive in Other Asian countries than in China, relative production costs in Other Asia will be larger than relative observed wages.

B.5.7 Bargaining Parameter (β)

The responses of U.S.-China import values and Chinese export prices to the tariff in equations (B.4)-(B.9) are invariant with respect to the parameter β that controls the relative bargaining power of buyers and suppliers. Nevertheless, this bargaining parameter influences the estimated welfare effects of the tariff, because it affects the wedge between the perceived marginal cost of inputs and expected input prices, the level of employment and input use in the differentiated sector, and equilibrium search costs. Since this parameter for buyer-supplier bargaining power is hard to determine using the available data, we report results for a range of different values of this parameter. We choose a central value of $\beta = 0.5$ for our baseline specification and report robustness tests for alternative values of this parameter.

B.5.8 Fixed Entry and Search Costs (f_e, f)

Under our assumption of a Pareto productivity distribution, *relative changes* in productivity ($\overline{b}^\tau/\overline{a}$ and $\overline{a}^\tau/\overline{a}$) and welfare ($(V^\tau - V)/npx$) in response to the tariff are *invariant* to the fixed costs (f_o, f_e, f), as shown in Section 5 of Online Appendix A. Therefore the value of these fixed costs does not matter for the quantitative predictions of relative changes that interest us. Of course, these fixed costs (f_o, f_e, f) do affect the *levels* of productivity and welfare before and after the tariff, but they do so in a way that keeps the ratios constant.

Nevertheless, the model does impose some theoretical restrictions on the empirically-relevant values of these fixed costs (f_o, f_e, f). First, for an interior equilibrium in which firms only accept suppliers with sufficiently low cost draws ($\overline{a} < 1$), we require the fixed search cost to be sufficiently large relative to the fixed operating and fixed entry costs that the following inequality holds:

$$\overline{a}^\theta = \frac{f}{f_o + f_e} \frac{\theta - \alpha(\sigma - 1)}{\beta\alpha(\sigma - 1)} < 1. \tag{B.7}$$

Second, for the tariff to lead to a reorganization of supply chains to Other Asian countries with no exit by domestic firms ($\tau_c < \tau < \tau_{ex}$), we require that the relative value of the fixed operating

and entry costs satisfies the following inequality:

$$\left(\frac{w_A}{w_B}\right)^{\frac{\theta\alpha(\varepsilon-1)}{\theta-\alpha(\varepsilon-1)}} < \frac{1}{1+f_e/f_o} < \frac{\theta-(1-\beta)\,\alpha\,(\sigma-1)}{\theta-\alpha\,(\sigma-1)}\left(\frac{w_A}{w_B}\right)^{\frac{\theta\alpha(\varepsilon-1)}{\theta-\alpha(\varepsilon-1)}}, \tag{B.8}$$

where $0 < \frac{w_A}{w_B} < 1$; $0 < \frac{1}{1+f_e/f_o} < 1$; and $1 < \frac{\theta-(1-\beta)\alpha(\sigma-1)}{\theta-\alpha(\sigma-1)} < \infty$.

Since the values of the fixed costs (f_o, f_e, f) do not matter for our key objects of interest, which are the *relative changes*, we just need to ensure that (B.7) and (B.8) are satisfied. To this end, we choose the fixed costs according to the following procedure.

First, we choose the value of the fixed operating cost (f_o) such that the share of the differentiated sector in GDP in the model before the tariff matches the initial share of the manufacturing sector in US GDP in 2017 before the Trump tariffs, as discussed above.

Second, given this value for the fixed operating cost (f_o), we choose the fixed entry cost (f_e) such that the parameter inequality for the relocation of supply chains to Other Asia in equation (B.8) is satisfied. In particular, we choose the fixed entry cost (f_e) such that $1/(1+f_e/f_o)$ lies mid-way between its lower bound of $(w_A/w_B)^{\frac{\theta\alpha(\varepsilon-1)}{\theta-\alpha(\varepsilon-1)}}$ and its upper bound of one.

Third, we calibrate the fixed search cost (f) as 1 percent of the fixed operating cost (f_o), based on the evidence reported in Institute of Supply Management (2018), which ensures that the parameter inequality for an interior equilibrium in equation (B.7) is satisfied.

B.5.9 Model Fit

We now discuss the model's fit. The initial share of imports from China in manufacturing value added ($M_A/n\ell$) is largely determined by the share of inputs in production costs (α). Therefore, for our calibrated parameter values, the model exactly matches the initial share of imports from China in U.S. manufacturing value added (22.95 percent in the model and data).

Similarly, the initial share of manufacturing value added in GDP before the tariff ($n\ell/L$) is heavily influenced by the fixed operating cost (f_o). Therefore, for our calibrated parameter values, the model exactly matches the initial share of manufacturing value added in U.S. GDP (11.30 percent in the model and data).

Our calibrated model also replicates the estimated decline in U.S.-China imports of 34.23 percent from the event-study estimates of Amiti et al. (2020). The corresponding estimated elasticity of U.S. imports with respect to the Trump tariffs from this event-study specification is -2.15 (see Column (4) of Table B.3 of Online Appendix B.4). This estimated elasticity is close to the estimated partial trade elasticity of -2.53 in Fajgelbaum et al. (2020), and lies within the 95 percent confidence interval around that parameter estimate (from -3.02 to -1.75).

Our calibrated model also exactly reproduces the estimated decline in Chinese export prices of 2.14 percent from the event-study estimates of Amiti et al. (2020). The corresponding estimated elasticity of foreign export prices with respect to the Trump tariffs from this event-study specification is $0.96-1 = -0.04$ (see Column (3) of Table B.3 of Online Appendix B.4). This estimated

elasticity is comparable with the estimated elasticity of zero in Fajgelbaum et al. (2020), and lies within the 95 percent confidence interval around that parameter estimate (from -0.14 to 0.10).

Although not directly targeted in our calibration, our model also predicts a reallocation of imports from China to Other Asia that is of a similar magnitude to that observed in the data. In the empirically-relevant range of the parameter space where there is a (partial) reorganization of supply chains to Other Asia ($\tau_c < \tau < \tau_{ex}$), we have the following closed-form solution for this import reallocation in the model:

$$
\frac{M_B^\tau}{M_A^\tau - M_A} = \frac{\left[1 - \left(\frac{\tau_c}{\tau}\right)^\theta\right]}{\left(\frac{\tau_c}{\tau}\right)^\theta - \tau\left(\tau_c\frac{w_A}{w_B}\right)^\theta},
\tag{B.9}
$$

where recall that:

$$
\tau_c = \left(\frac{w_B}{w_A}\right)^{\frac{\theta}{\theta - \alpha(\varepsilon - 1)}}.
$$

From October 2017 to October 2019, the observed change in Other Asia's share of U.S. imports relative to the change in China's share of U.S. imports is $(M_B^\tau/(M_A^\tau - M_A)) = -0.96$, as shown in Figure 1 in the paper. In comparison, the predicted import reallocation in the model is $(M_B^\tau/(M_A^\tau - M_A)) = -0.64$. Whereas the observed change of -0.96 reflects the influence of all the economic shocks that occurred over the period from October 2017 to October 2019, the predicted change in the model of -0.64 reflects the impact of the Trump tariffs on China alone. Nevertheless, the predicted import reallocation in the model from these tariffs alone goes a long way towards explaining the observed import reallocation in the data. In the new equilibrium after the imposition of the tariff, we find that the shares of products sourced from China and Other Asia are 0.81 and 0.19, respectively.

B.6 Terms of Trade and Welfare Effects

In this subsection, we provide further details on the predicted terms of trade and welfare effects of tariffs in our calibrated model.

B.6.1 Terms of Trade

In Figure B.5, we show changes in the terms of trade as a function of the level of the tariff. The solid black line depicts the relative change in home's average input price (ρ^τ/ρ), which corresponds to an inverse measure of its overall terms of trade. The gray dashed line indicates the relative change in home's average input price from Country A (ρ_A^τ/ρ), which is inversely related to its terms of trade with that nation. Both terms of trade are invariant with respect to the bargaining parameter (β), as shown in Online Appendix B.8.3.

For small tariffs in the range $\tau \in (1, w_B/w_A)$, the solid black line is upward-sloping, as larger tariffs progressively strengthen the bargaining position of the suppliers, which implies that renego-

tiation under the shadow of the tariff increases the average input price. However, for our calibrated parameter values with a relatively small cost disadvantage of Country B (w_B/w_A), we find that this effect is small in magnitude, such that at $\tau = w_B/w_A$, we have $\rho^\tau/\rho = 1.0002$ close to one. Throughout this range of tariffs, all imports are sourced from Country A, such that the gray dashed line for home's average input price from Country A coincides with the black solid line for its overall average input price.
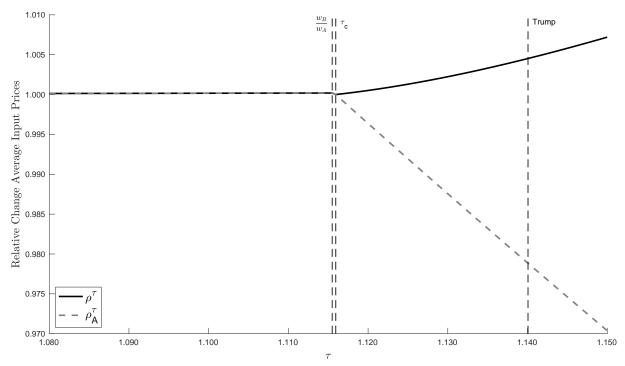
Figure B.5: Relative Change in Average Input Prices (Inverse Terms of Trade)

Note: Black solid line shows the relative change in overall average input prices under the tariff (ρ^τ/ρ); gray dashed line shows the relative change in average input prices from Country A (ρ_A^τ/ρ); vertical black dashed lines show w_B/w_A, τ_c and our calibrated Trump tariff on China of $\tau = 1.14$.

Next comes a range of larger tariffs with $\tau \in (w_B/w_A, \tau_c)$ wherein an increase in the tariff strengthens the bargaining power of the *buyers* without inducing any relocation away from Country A. In this narrow interval, the solid black line is downward-sloping (improving terms of trade), until at τ_c, the average input price returns to its free trade level ($\rho^\tau/\rho = 1$). As all imports continue to be sourced from Country A throughout this range of tariffs, the gray dashed and black solid lines again coincide with one another.

For still larger tariffs with $\tau > \tau_c$, there are two offsetting effects of further tariff hikes. On the one hand, higher tariffs continue to strengthen the buyers' bargaining positions vis-à-vis their suppliers in Country A. This strengthening bargaining position leads to a further improvement in the terms of trade with Country A (ρ_A^τ/ρ), as shown by the downward-sloping gray dashed line. On the other hand, increases in the tariff rate beyond τ_c cause parts of the supply chain to relocate from a relatively low-cost to a relatively high-cost country. When this relatively high-cost country is a foreign nation, as in our baseline specification here, this amounts to Vinerian trade diversion,

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and it contributes towards an overall deterioration in the terms of trade.

In Lemma A.5 of this Online Appendix, we show that this Vinerian trade diversion effect dominates if and only if $\tau > (\theta+1)/\theta$. For our calibrated parameter values, we have $(\theta+1)/\theta = 1.10$, whereas $\tau_c = 1.12$. Therefore, throughout the entire range of tariffs $\tau > \tau_c$ further increases in tariffs raise average input prices and lead to a deterioration in the terms of trade, as shown by the upward-sloping solid black line. Across this range of tariffs $\tau > \tau_c$, we find that our novel mechanism for terms of trade effects through bargaining in the shadow of the tariff (downward-sloping gray dashed line) is quantitatively sizable relative to Vinerian trade diversion (the difference between the upward-sloping solid black line and the downward-sloping gray dashed line).

For our calibrated parameter values that match the estimated price and quantity responses to the Trump tariffs on China ($\tau = 1.14$), we find a small improvement in home's terms of trade with Country A ($\rho_A^{\tau=1.14}/\rho = 0.9788$), and a small deterioration in its overall terms of trade ($\rho^{\tau=1.14}/\rho = 1.0045$).

B.6.2 Welfare Decomposition

In Figure B.6, the solid black line shows the percentage change in home welfare relative to differentiated sector expenditure $((V^\tau - V)/npx)$.[35] We also decompose this welfare impact into the contributions of the terms of trade (black dashed line), differentiated sector employment (gray dashed line), differentiated sector inputs (gray solid line), and additional search costs in Country B (black dashed-dotted line). The relative contributions of these terms are endogenous and affected by the strength of buyer-supplier bargaining power and search frictions. Figure B.6 shows results for our baseline value of the bargaining parameter ($\beta = 0.5$). We report results for lower ($\beta = 0.35$) and higher ($\beta = 0.65$) values of this bargaining parameter below. We report a further robustness test varying this bargaining parameter from 0.1 to 0.9 in Online Appendix B.8.3.

To implement this decomposition, we use the expressions for the derivatives of welfare for the intervals $\tau \in (1, \tau_c)$ and $\tau \in (\tau_c, \tau_{ex})$ in equations (28) and (31). We implement this decomposition using numerical derivatives, by considering a grid of small increments (0.0001) in tariffs, and cumulating the resulting changes in each component of welfare from $\tau = 1$ to $\tau = 1.2$.[36] Again we denote w_B/w_A, τ_c and the Trump tariff of $\tau = 1.14$ by the dashed black vertical lines.
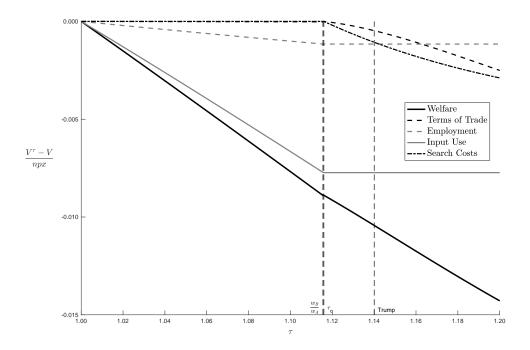
In Proposition 3 in Section 4.1 in the paper, we provide a necessary and sufficient condition for welfare to be decreasing in the tariff at $\tau = 1$, a condition that is satisfied for our calibrated parameter values. For values of $\tau < w_B/w_A$, an increase in the tariff leads to a deterioration in the terms of trade as suppliers in Country A are able to negotiate a higher price, which contributes negatively to welfare (the black dashed line falls below zero). However, for our calibrated parameter values with a relatively small cost disadvantage of Country B (w_B/w_A), this effect is small in

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[35] We normalize the change in home welfare by differentiated sector expenditure to ensure that these welfare changes are invariant to the choice of units to measure home income, given the presence of an additive constant in our quasi-linear utility function (equation (1)).

[36] Given our use of these small tariff increments, we find that the cumulative sum of these small changes in welfare is close to our closed-form solution for the overall change in welfare $((V^\tau - V)/npx)$.
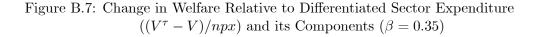
magnitude and not discernible visibly. We find that the welfare loss from the reduction in input use (gray solid line) is substantially larger than the welfare loss from the reallocation of employment away from the differentiated sector (gray dashed line), highlighting that our results are not simply capturing a change in the size of the differentiated sector. As the tariff rises to τ_c, we find a reduction in welfare of 0.89 percent of pre-tariff spending on differentiated products or 0.10 percent of pre-tariff GDP.
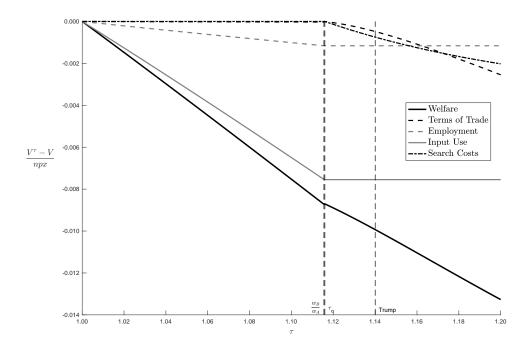
Figure B.6: Change in Welfare Relative to Differentiated Sector Expenditure $((V^\tau - V)/npx)$ and its Components $(\beta = 0.50)$

Note: Baseline value of bargaining parameter $(\beta = 0.50)$; changes in welfare and its components are scaled by differentiated sector expenditure (npx) to ensure that they are invariant to the choice of units in which to measure home income; black solid line shows the overall change in welfare $((V^\tau - V)/npx)$; black dashed line shows the change in the terms of trade $((\rho^\tau - \rho)/npx)$; gray dashed line shows the change in employment $((\ell^\tau - \ell)/npx)$; gray solid line shows the change in input use $((m^\tau - m)/npx)$; black dashed-dotted line shows the additional fixed costs for new searches in Country B (Σ/npx); vertical black dashed lines show w_B/w_A, τ_c and our calibrated Trump tariff on China of $\tau = 1.14$.

Further increases in the tariff beyond τ_c reduce welfare if equation (32) is violated, which again is the case for our calibrated parameter values. For all $\tau \in (\tau_c, \tau_{ex})$, both employment and input use in the differentiated sector are invariant with respect to the tariff, such that both of these welfare components are flat (gray dashed and gray solid line). In contrast, as the tariff rises above τ_c, the additional search costs incurred in Country B reduce home welfare (black dashed-dotted line). Furthermore, we find that these additional search costs are quantitatively substantial relative to the impact of tariff on welfare through employment in the differentiated sector. For our calibrated parameters, we find that increases in the tariff beyond τ_c also lead to a deterioration in the terms of trade (the black dashed line falls further below one), as Vinerian trade diversion (the replacement

Figure B.7: Change in Welfare Relative to Differentiated Sector Expenditure
$((V^\tau - V)/npx)$ and its Components $(\beta = 0.35)$

Note: Robustness to a lower value of the bargaining parameter $(\beta = 0.35)$; each line is defined in the same way as in Figure B.6 above.

of a lower cost source of supply in Country A with a higher cost source of supply in Country B) dominates the improvement in the terms of trade (through renegotiation in the shadow of the tariff).

Taking these results as a whole, we find welfare losses from the tariff that increase with the size of the tariff. For the Trump tariffs on China ($\tau = 1.14$), this welfare loss is around 1.04 percent of pre-tariff spending on differentiated products or 0.12 percent of pre-tariff GDP. This predicted welfare loss is somewhat larger than existing empirical findings for the Trump tariffs. Amiti et al. (2019) and Fajgelbaum et al. (2020) estimate welfare losses from the Trump tariffs of \$8.2 billion and \$7.2 billion, respectively, which correspond to around 0.04 percent of GDP.

While our predicted welfare losses are larger than those in Fajgelbaum et al. (2020), there are several differences between the two papers. First, we consider a longer sample period, which includes additional waves of tariffs on China in June and September 2019.[37] Second, they examine the welfare effects of both U.S. tariffs and foreign retaliatory tariffs, whereas our analysis does not include foreign retaliatory tariffs. Third, their quantitative model allows for general equilibrium changes in relative wages (and hence the terms of trade), whereas our assumption of an outside sector implies that relative wages are exogenously fixed. Fourth, we develop a new model of buyer-supplier search and bargaining, which highlights a novel source of changes in the terms of trade

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[37]We report a robustness test for a shorter sample period ending in December 2018 in Online Appendix B.9.2.

Figure B.8: Change in Welfare Relative to Differentiated Sector Expenditure $((V^\tau - V)/npx)$ and its Components $(\beta = 0.65)$

Note: Robustness to a higher value of the bargaining parameter $(\beta = 0.65)$; each line is defined in the same way as in Figure B.6 above.

through buyer-supplier bargaining in the shadow of the tariff. Therefore, there is no reason for the estimated welfare losses to be exactly the same in the two papers.

Our findings of a welfare reduction from the Trump tariffs on China are robust to the consideration of a wide range of values for the bargaining parameter (β). In Figures B.7 and B.8, we implement our welfare decomposition for lower $(\beta = 0.35)$ and higher $(\beta = 0.65)$ values of the bargaining parameter, respectively. The welfare reduction from the Trump tariffs on China increases with the bargaining parameter. However, even for $\beta = 0.35$, we find a welfare reduction of 0.99 percent of pre-tariff spending on differentiated products or 0.11 percent of pre-tariff GDP. For $\beta = 0.65$, this welfare reduction rises to 1.09 percent of pre-tariff spending on differentiated products or 0.12 percent of pre-tariff GDP. For both alternative values of the bargaining parameter, we find substantial contributions from changes in input use (gray solid line) and search costs (black dashed-dotted line) relative to changes in employment (gray dashed line). In Online Appendix B.8.3, we report a further robustness test varying this bargaining parameter from 0.1-0.9.

B.7 Input Wedge

In our welfare decomposition in equation (28) in the paper and the previous subsection, the impact of changes in input use $(dm^\tau/d\tau)$ on welfare depends on the wedge between the perceived marginal

cost of inputs ($\frac{\sigma}{\sigma-1}\phi^\tau$) and expected input prices (ρ^τ).

In Figure B.9, the solid black line shows the value of this wedge ($\frac{\sigma}{\sigma-1}\phi^\tau/\rho^\tau$) for our baseline parameter values and values of the tariff ranging from $\tau \in [1, 1.2]$. Although, in principle, this wedge can be either less than or greater than one, we find that it is greater than one across this entire range of values of the tariff. For the Trump tariff ($\tau = 1.14$), it takes the value 1.70.
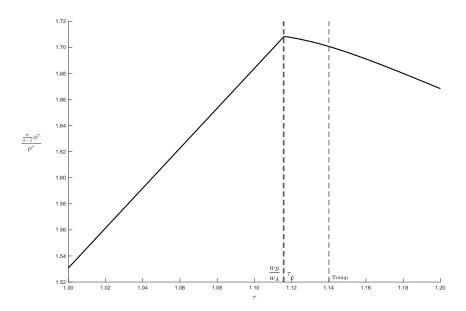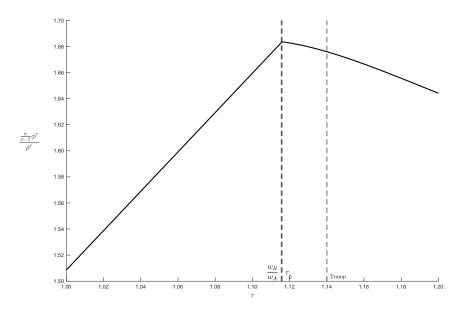
Figure B.9: Input Wedge for Alternative Values of the Tariff ($\beta = 0.50$)

Note: Baseline value of bargaining parameter ($\beta = 0.50$); ratio of the perceived marginal cost of inputs ($\frac{\sigma}{\sigma-1}\phi^\tau$) to expected input prices (ρ^τ) for our calibrated parameter values and alternative values of the tariff ranging from $\tau \in [1, 1.2]$; vertical black dashed lines show w_B/w_A, τ_c and our calibrated Trump tariff on China of $\tau = 1.14$.
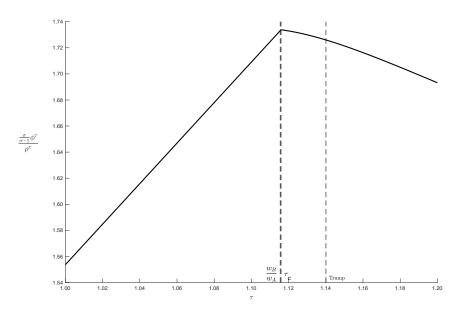
In Figures B.7 and B.8, we compute the value of this wedge for a lower ($\beta = 0.35$) and higher ($\beta = 0.65$) value of the bargaining parameter, respectively. As for our welfare decomposition above, we observe a similar pattern of results across this range of values of the bargaining parameter. The magnitude of the wedge increases with the bargaining parameter. For the Trump tariff ($\tau = 1.14$), we find a wedge of 1.68 for $\beta = 0.35$, which rises to 1.73 for $\beta = 0.65$.

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Figure B.10: Input Wedge for Alternative Values of the Tariff ($\beta = 0.35$)

Note: Robustness to a lower value of the bargaining parameter ($\beta = 0.35$); each line is defined in the same way as in Figure B.9 above.

Figure B.11: Input Wedge for Alternative Values of the Tariff ($\beta = 0.65$)

Note: Robustness to a higher value of the bargaining parameter ($\beta = 0.65$); each line is defined in the same way as in Figure B.9 above.

B.8 Robustness to Alternative Parameter Values

In this section of the calibration appendix, we examine the robustness of our model's quantitative predictions to the assumption of alternative values for model parameters. In Subsection B.8.1, we vary the productivity dispersion parameter (θ). In Subsection B.8.2, we adjust the cost disadvantage of Country B (w_B/w_A). In Subsection B.8.3, we modify the parameter for the strength of buyer-supplier bargaining power (β).

B.8.1 Productivity Dispersion Parameter (θ)

In Figure B.12, we vary the productivity dispersion parameter (θ), holding constant all other model parameters at their baseline values in Table B.5 above. We show the model's predictions for changes in U.S.-China import values (top left); Chinese export prices (top right); expected input prices, which are inversely related to the terms of trade (bottom left); and U.S. welfare as a percentage of differentiated sector expenditure (bottom right).
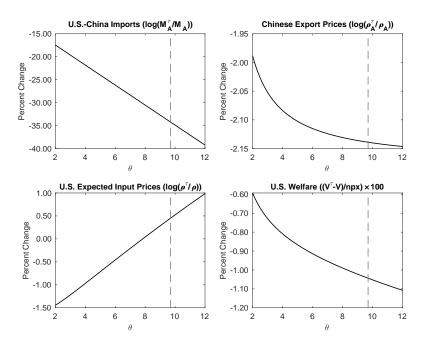
Figure B.12: Model Predictions for Alternative Values of θ

Note: Model predictions for alternative values of the productivity dispersion parameter (θ) and our baseline value of other parameters from Table B.5 above; top-left panel shows the log change in U.S.-China import values ($\log\left(M_A^\tau/M_A\right)$) in percent; top-right panel shows the log change in Chinese export prices ($\log\left(\rho_A^\tau/\rho_A\right)$) in percent; bottom left panel shows the log change in the overall terms of trade ($\log\left(\rho^\tau/\rho\right)$); bottom right panel shows the change in welfare as a percentage of differentiated sector expenditure, ($\left(\left(V^\tau - V\right)/npx\right) \times 100$); gray dashed line vertical line shows the baseline parameter value of $\theta = 9.6993$.

A larger value of θ implies less dispersion in supplier productivity, which means that it easier to find new suppliers in Country B (Other Asia), and hence implies a larger drop in U.S.-China import values and Chinese export prices. As we vary θ from $2 - 12$, we find that the log change in U.S.-China imports ($\log\left(M_A^\tau/M_A\right)$) ranges from around -39 to -17 percent (top-left panel);

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the log change in Chinese export prices $(\log{(\rho_A^\tau/\rho_A)})$ varies from around -2.15 to -1.99 percent (top-right panel); and the log change in overall expected input prices $(\log{(\rho^\tau/\rho)})$ spans -1.44 to 0.98 percent (bottom-left panel). Nevertheless, we find a similar welfare reduction from the Trump tariff $((V^\tau - V)/npx)$ across this entire range of values for θ, which equals around $0.59 - 1.11$ percent of differentiated sector expenditure (bottom-right panel), or around $0.07 - 0.13$ percent of GDP. Therefore, the model is able to accommodate both larger and smaller declines in U.S.-China import values and Chinese export prices than those estimated in the data. Nevertheless, the model's welfare predictions are robust across this range of values for the productivity dispersion parameter (θ).

B.8.2 Country B Cost Disadvantage (w_B/w_A)

In Figure B.13, we vary Country B's cost disadvantage (w_B/w_A), holding constant all other model parameters at their baseline values in Table B.5 above. We again show the model's predictions for changes in U.S.-China import values (top left); Chinese export prices (top right); expected input prices, which are inversely related to the terms of trade (bottom left); and U.S. welfare as a percentage of differentiated sector expenditure (bottom right).
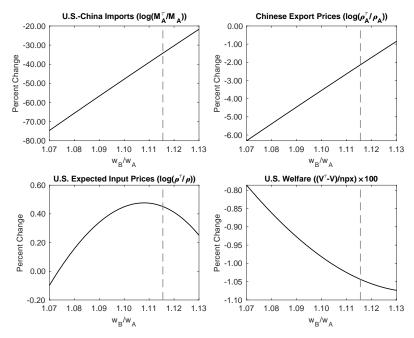
Figure B.13: Model Predictions for Alternative Values of w_B/w_A

Note: Model predictions for alternative values of the cost disadvantage of Other Asia (w_B/w_A) and the baseline value of all other parameters from Table B.5; top-left panel shows the log change in U.S.-China import values $(\log{(M_A^\tau/M_A)})$ in percent; top-right panel shows the log change in Chinese export prices $(\log{(\rho_A^\tau/\rho_A)})$ in percent; bottom left panel shows the log change in the overall terms of trade $(\log{(\rho^\tau/\rho)})$; bottom right panel shows the change in welfare as a percentage of differentiated sector expenditure, $(((V^\tau - V)/npx) \times 100)$; gray dashed line vertical line shows the baseline parameter value of $w_B/w_A = 1.1155$.

A smaller value of $w_B/w_A > 1$ implies a higher return to searching for new suppliers in Country

B (Other Asia), and hence a larger drop in import values and exporter prices from Country A (China), other things equal. As we vary w_B/w_A from $1.07 - 1.13$, we find that the log change in U.S.-China imports $(\log{(M_A^\tau/M_A)})$ ranges from around -75 to -22 percent (top-left panel); the log change in Chinese export prices $(\log{(\rho_A^\tau/\rho_A)})$ varies from around -6.32 to -0.84 percent (top-right panel); and the log change in overall expected input prices $(\log{(\rho^\tau/\rho)})$ spans -0.10 to 0.48 percent. Nevertheless, we find a similar welfare reduction from the Trump tariff $((V^\tau - V)/npx)$ across this entire range of values for w_B/w_A, which equals around 0.79 to 1.07 percent of differentiated sector expenditure (bottom-right panel), or around 0.09 to 0.12 percent of GDP. Therefore, we once more find that the model is able to accommodate both larger and smaller declines in U.S.-China import values and Chinese export prices than those estimated in the data. However, the model's welfare predictions are again robust across this range of values for the cost disadvantage of Country B (w_B/w_A).

B.8.3   Bargaining Parameter (β)

In Figure B.14, we vary the bargaining parameter (β), holding constant all other model parameters at their baseline values in Table B.5 above. We again show the model's predictions for changes in U.S.-China import values (top left); Chinese export prices (top right); expected input prices, which are inversely related to the terms of trade (bottom left); and U.S. welfare as a percentage of differentiated sector expenditure (bottom right).

As shown in Section 5.1 of Online Appendix A, for the empirically relevant range of parameter values with a partial reorganization of supply chains to Other Asia ($\tau_c < \tau < \tau_{ex}$), the decline in U.S.-China imports (top-left panel), Chinese export prices (top-right panel) and overall average input prices (bottom-left panel) are all invariant with respect to the bargaining parameter (β). Therefore, we observe a horizontal line for each of these variables with respect to β. In contrast, the absolute magnitude of the welfare reduction from the Trump tariff $((V^\tau - V)/npx)$ increases with β. Nevertheless, even as we vary β across the entire interval from $0.1 - 0.9$, we find that this welfare reduction remains within the relatively narrow interval of around $0.91 - 1.18$ percent of differentiated sector expenditure (bottom-right panel), or around $0.10 - 0.13$ percent of GDP. Therefore, we again find that the welfare predictions of our model are robust to the consideration of alternative parameter values.

Figure B.14: Model Predictions for Alternative Values of β

Note: Model predictions for alternative values of the bargaining parameter (β) and the baseline value of all other parameters from Table B.5; top-left panel shows the log change in U.S.-China import values ($\log\left(M_A^\tau/M_A\right)$) in percent; top-right panel shows the log change in Chinese export prices ($\log\left(\rho_A^\tau/\rho_A\right)$) in percent; bottom left panel shows the log change in the overall terms of trade ($\log\left(\rho^\tau/\rho\right)$); bottom right panel shows the change in welfare as a percentage of differentiated sector expenditure, ($\left(\left(V^\tau - V\right)/npx\right) \times 100$); gray dashed line vertical line shows the baseline parameter value of $\beta = 0.50$.

B.9 Further Robustness Checks

In our baseline specification, we use the event-study estimates of Amiti et al. (2020) for the sample period ending in October 2019, and calibrate our model for all goods, recognizing that supply chains can extend to consumer goods. In this section of the Calibration Appendix, we report two further robustness tests. In Subsection B.9.1, we recalibrate our model excluding consumer goods. In Subsection B.9.2, we recalibrate our model for a shorter sample period that focuses only on the waves of Trump tariffs introduced up to December 2018.

B.9.1 Robustness to Excluding Consumer Goods

In our baseline specification, we calibrate our model for all goods, recognizing that supply chains can extend to consumer goods. In this section of the Calibration Appendix, we report a robustness test, in which we recalibrate the model excluding consumer goods.

We begin by re-estimating the price and quantity response to the Trump tariffs using the event-study specification in equation (B.3), dropping consumer goods as defined by the U.S. Census Bureau from the estimation sample. As reported in Amiti et al. (2020), estimated rates of pass-through of the Trump tariffs into U.S. import prices are smaller for intermediate inputs than

for consumer goods, implying larger declines in Chinese export prices for intermediate inputs. Nevertheless, even after excluding consumer goods, we continue to find high rates of pass-through into U.S. import prices. By October 2019, we estimate a reduction in Chinese export prices of 4.26 percent (compared to 2.14 percent in our baseline specification). We also continue to find large quantity responses. By October 2019, we estimate a decline in U.S.-China import values of 31.85 percent (compared to 34.23 percent in our baseline specification).

Following an analogous approach as for our baseline specification, we set the tariff equal to the import-weighted average of the tariffs imposed by the Trump administration, excluding consumer goods. We calibrate the four parameters (θ, w_B/w_A, α, f_o) to match (i) the initial share of imports from China in U.S. manufacturing value added in 2017 before the Trump tariffs; (ii) the initial share of manufacturing value added in U.S. GDP in 2017 before the Trump tariffs; (iii) the estimated reduction in U.S.-China imports excluding consumer goods of 4.26 percent; (iv) the estimated reduction in Chinese export prices excluding consumer goods of 31.85 percent. All other calibrated parameters are held constant at the same values as in our baseline specification.

In Panel A of Table B.6, we summarize the difference in calibrated parameters (θ, w_B/w_A, α, f_o) for our baseline specification (Column (1)) and this robustness test excluding consumer goods (Column (2)). To match the larger estimated fall in Chinese export prices excluding consumer goods (4.26 percent compared to our baseline 2.14 percent), the model requires a lower value for the Pareto shape parameter for supplier productivity ($\theta = 3.7206$ compared to $\theta = 9.6993$ in our baseline specification). We find a similar cost disadvantage for Country B (w_B/w_A), which equals 1.1192 compared to 1.1155 in our baseline specification. Our calibrated values for the imported input share (α) and fixed operating cost (f_o) are almost unchanged.

In Panel B of Table B.6, we compare the terms of trade and welfare predictions for our baseline specification (Column (1)) and this robustness test excluding consumer goods (Column (2)). Expected input prices (ρ^τ) are a weighted average of expected input prices with Countries A (ρ_A^τ) and B (ρ_B^τ), weighted by the probability of sourcing from each country. The model without consumer goods is calibrated to a larger fall in expected input prices with Country A. As a result, we find a small reduction in overall expected input prices (-1.81 percent), compared to a small rise in expected input prices in our baseline specification (0.45 percent). Nevertheless, since the terms of trade is only one channel through which the tariff affects welfare, we find a similar overall welfare loss from the tariff ($(V^\tau - V)/npx$) for this specification excluding consumer goods: 0.79 percent of differentiated sector expenditure (0.09 percent of GDP) compared to 1.04 percent of differentiated sector expenditure (0.12 percent of GDP) for our baseline specification.

B.9.2 Robustness to Shorter Sample Period

In our baseline specification, we calibrate our model's parameters to the event-study estimates of the price and quantity responses to the Trump tariffs from Amiti et al. (2020), which are based on a sample period that ends in October 2019. In contrast, the sample periods in Amiti et al. (2019) and Fajgelbaum et al. (2020) end in December 2018 and April 2019, respectively. In this

Table B.6: Robustness to Excluding Consumption Goods and a
Shorter Sample Period

		(1)	(2)	(3)
		Baseline Specification	**Excluding Consumer Goods**	**Sample End December 2018**
Panel A: Calibrated Parameters				
Productivity dispersion	θ	9.6993	3.7206	5.1103
Country B cost disadvantage	w_B / w_A	1.1155	1.1192	1.0432
Imported input share	α	0.1791	0.1683	0.1791
Fixed operating cost	f_o	0.0007	0.0007	0.0007
Panel B: Model Predictions				
Country A Expected Input Prices	$\rho_A{}^\tau/\rho_A$	-2.14%	-4.26%	-1.07%
Overall Expected Input Prices	ρ^τ/ρ	0.45%	-1.81%	-0.78%
Change in Welfare	$(V^\tau\text{-}V)/npx$	-1.04%	-0.79%	-0.27%

Note: Column (1) reports parameter estimates from our baseline specification using estimated log changes in U.S.-China import values and Chinese exporter prices from Amiti et al. (2020) for all goods; Column (2) reports parameter estimates using estimated log changes in U.S.-China import values and Chinese exporter prices from Amiti et al. (2020) excluding consumption goods; Column (3) reports parameter estimates using estimated log changes in U.S.-China import values and Chinese exporter prices from Amiti et al. (2020) for all goods for the shorter sample period ending in December 2018.

section of the Calibration Appendix, we recalibrate our model for a shorter sample period ending in December 2018.

Following an analogous approach as for our baseline specification, we set the tariff equal to the import-weighted average of the tariffs imposed by the Trump administration up to December 2018. We calibrate the four parameters (θ, w_B/w_A, α, f_o) to match (i) the initial share of imports from China in U.S. manufacturing value added in 2017 before the Trump tariffs; (ii) the initial share of manufacturing value added in U.S. GDP in 2017 before the Trump tariffs; (iii) the estimated reduction in U.S.-China imports by December 2018 of 1.07 percent (Column (1) of Table B.4 in Online Appendix B.4); (iv) the estimated reduction in Chinese export prices by December 2018 goods of 10.95 percent (Column (2) of Table B.4 in Online Appendix B.4). All other calibrated parameters are held constant at the same values as in our baseline specification.

In Panel A of Table B.6, we summarize the difference in calibrated parameters (θ, w_B/w_A, α, f_o) for our baseline specification (Column (1)) and this robustness test with a shorter sample period (Column (3)). To match the smaller estimated reductions in U.S.-China imports and Chinese export prices over this shorter sample period, we require smaller values for the Pareto shape parameter for supplier productivity ($\theta = 5.1103$ compared to $\theta = 9.6993$ in our baseline specification) and the cost disadvantage for Country B ($w_B/w_A = 1.0432$ compared to $w_B/w_A = 1.1155$ in our baseline specification). Our calibrated values for the imported input share (α) and fixed operating cost (f_o) are virtually unchanged.

In Panel B of Table B.6, we compare the terms of trade and welfare predictions for our baseline specification (Column (1)) and this robustness test with a shorter sample period (Column (3)). Given the small reduction in expected input prices with Country A of 1.07 percent, we find a

small reduction in overall expected input prices of 0.78 percent, which compares to the small rise in our baseline specification of 0.45 percent. Nevertheless, because the terms of trade is only one component of welfare, we continue to find a welfare reduction from the Trump tariffs of 0.27 percent percent of differentiated sector expenditure (0.03 percent of GDP).

Therefore, over this shorter sample period, we find a welfare loss from the Trump tariffs closer to the estimate of 0.04 percent of GDP in Amiti et al. (2019) and Fajgelbaum et al. (2020). However, there are a number of differences between the theoretical models considered in these papers, including the treatment of retaliation, the existence of an outside sector, and the presence of buyer-supplier bargaining and search costs. Therefore, there is no necessary reason for the welfare predictions of these models to be exactly the same as one another.

B.10   Onshoring Robustness

In our baseline calibration, we evaluate the welfare effects of the tariff under the assumption that the country for new searches (Country B) is Other Asian countries, based on our empirical findings above of a relocation of import sourcing from China to Other Asian countries. Under this assumption, the profits of new suppliers do not count towards home welfare, because they are accrued in Other Asian countries.

In this subsection, we undertake a counterfactual, in which the country for new searches is the home country (onshoring), but we hold all other parameters including marginal costs constant at the same values as in our baseline specification. In this counterfactual, the only difference from our baseline specification is that the profits of these new suppliers are included in home welfare, because they are accrued domestically.

In Figure B.15, we show the change in welfare relative to differentiated sector expenditure ($(V^\tau - V)/npx$) for alternative values of τ ranging from 1 to 1.2. The black solid line shows the change in welfare in our baseline specification, in which new searches occur offshore, and the profits of these new suppliers are not included in home welfare. The gray dashed line shows the change in welfare in this robustness test, in which new searches occur onshore, and the profits of these new suppliers are included in home welfare. While the inclusion of the profits of new suppliers reduces the welfare costs of the tariff, we continue to find that the Trump tariffs on China are welfare reducing.
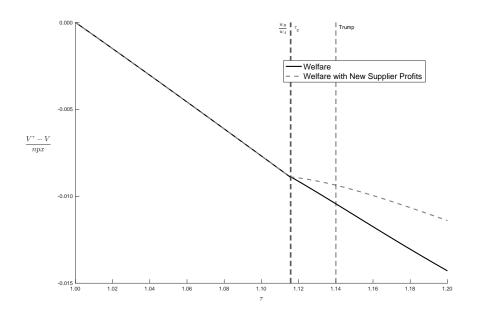
Figure B.15: Robustness of the Welfare Effects of the Tariff to Onshoring

Note: Black solid line shows the welfare loss from the tariff as a percentage of differentiated sector expenditure $((V^\tau - V)/npx)$ for our baseline specification, in which searches for new suppliers occur offshore, and new supplier profits are not included in home welfare; gray dashed line shows this welfare loss for our robustness test in which searches for new suppliers occur onshore, and new supplier profits are included in home welfare. Black dashed lines show w_B/w_A, τ_c and our calibrated value of the Trump tariffs on China of $\tau = 1.14$.

B.11 Data Sources

In this subsection, we discuss the data sources used for our calibration of the model in Subsection B.5 of this Calibration Appendix above.

U.S. Import Values and Import Prices: We use the data on U.S. import values and prices from Amiti et al. (2020) for the event-study estimates of the price and value response to the Trump administration's tariffs in Subsection B.4 above. Data on U.S. import values and quantities at the 10-digit level of the Harmonized Tariff Schedule (HTS10) are from the U.S. Census Bureau and U.S. Trade Representative (USTR). The import values are divided by the import quantities to obtain unit values (foreign export prices) for each source country and 10-digit product. These unit values are multiplied by duty rates from the U.S. International Trade Commission (USITC) to obtain U.S. import prices inclusive of tariffs. We also use these data to compute the import-weighted average of the new tariffs imposed on China by the Trump administration (2017 import value weights) in our calibration of the model; to compute the average tariffs by wave in Figure B.1 and the import share by category of good and tariff wave in Figure B.2 in Subsection B.2 above; to construct the import shares of China and Other Asia in Figure 1 in the paper and Figure B.3 in Subsection B.3 above; to measure the relocation of import sourcing from China to Other Asia in Figure B.4 in Subsection B.3 above; and in the difference-in-differences regressions in Table 1 in the paper and

Tables B.1 and B.2 in Subsection B.3 above.

US GDP: We assume a home wage of $w = 1$ and calibrate home population (L) using data on U.S. gross domestic product (GDP) in 2017 in current price dollars ($19.477337 trillion) from the World Bank: `https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?locations=US`.

Relative GDP in China and United States: We assume a relative wage in China and the United States of $w_A = 0.2$ based on data on relative GDP per capita in 2017 in China and the United States in purchasing power parity (PPP) terms from the Penn World Tables.

Manufacturing Share of US GDP: We choose a value for the fixed operating cost in the differentiated sector (f_o) to match a share of manufacturing value added in U.S. GDP in 2017 of 11.30 percent based on Federal Reserve Economic Data (FRED): `https://fred.stlouisfed.org/series/VAPGDPMA`.

Procurement Costs: We choose a value for the fixed search cost relative to the fixed operating cost (f/f_o) to match a share of procurement in firm costs of around 1 percent based on the estimates in Institute of Management (2018).

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