Online Appendix

"Two-Sided Market Power in Firm-to-Firm Trade"

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This Appendix is organized as follows. Section A contains derivations of all mathematical expressions in the text, including proofs of Propositions. Section B contains the discussion of theory extensions. Section C contains details about the data and sample selection criteria. Section D provides additional empirical results referenced in the text. Section E provides additional details regarding the estimation.

A Mathematical Derivations

This appendix derives the key equations from the main text: the bilateral markup μ_{ij} (equation (2.6)) and the bilateral pass-through elasticity Φ_{ij} (equation (2.11)).

A.1 Proof of Proposition 1

To derive μ_{ij}, we first obtain the demand elasticity ε_{ij} from the importer's cost minimization problem, then solve the bilateral bargaining problem.

Demand Elasticity ε_{ij}

Our baseline model assumes that the importer first chooses the input quantity to minimize costs given a price, then negotiates the price bilaterally with the exporter. The importer's nested CES production structure (equations (2.2)–(2.3)) yields the demand for input q_{ij} in (2.4):

$$q_{ij} = q_j^f \varsigma_{ij}^\rho \left(\frac{p_{ij}}{p_j^f} \right)^{-\rho},$$

where $p_j^f = \left(\sum_i \varsigma_{ij}^\rho p_{ij}^{1-\rho} \right)^{\frac{1}{1-\rho}}$ is the price index (i.e., shadow cost) of imported inputs. Solving the outer CES aggregator for total input demand yields:

$$q_j^f = \gamma c_j q_j \left(p_j^f \right)^{-1}, \tag{A.1}$$

$$q_j^d = (\varrho - \gamma) c_j q_j \left(p_j^d \right)^{-1}, \tag{A.2}$$

where c_j is the unit cost of output q_j, given by:

$$c_j = \left[\varphi_j^{-1} \left(\frac{p_j^f}{\gamma} \right)^\gamma \left(\frac{p_j^d}{\varrho - \gamma} \right)^{\varrho - \gamma} \right]^{\frac{1}{\varrho}} q_j^{\frac{1-\varrho}{\varrho}} \equiv k_j q_j^{\frac{1-\varrho}{\varrho}}. \tag{A.3}$$

This form illustrates symmetry with exporter-side technology. Finally, note that the cost share of foreign inputs is constant and equal to

$$\frac{p_j^f q_j^f}{p_j^f q_j^f + p_j^d q_j^d} = \frac{\gamma}{\varrho}.$$

A relevant object for our derivations will be $\frac{d \ln c_j}{d \ln p_j^f}$, namely, the elasticity of the marginal cost c_j with respect to p_j^f. To find this elasticity, we first use the demand function downstream to write q_j as

$$q_j = \left(\frac{\nu}{\nu - 1}\right)^{-\nu} c_j^{-\nu} D_j, \tag{A.4}$$

where D_j is the firm-level demand shifter. Substituting equation (A.4) into equation (A.3) and rearranging, we can write:

$$c_j = \left[z_j^{-1} \left(\frac{p_j^f}{\gamma}\right)^{\gamma} \left(\frac{p_j^d}{\varrho - \gamma}\right)^{(\varrho - \gamma)} \right]^{\frac{1}{\varrho + \nu - \nu\varrho}} \left(\frac{\nu}{\nu - 1}\right)^{-\nu\frac{1-\varrho}{\varrho + \nu - \nu\varrho}} (D_j)^{\frac{1-\varrho}{\varrho + \nu - \nu\varrho}},$$

which implies

$$\frac{d \ln c_j}{d \ln p_j^f} = \frac{\gamma}{\varrho + \nu - \nu\varrho}.$$

Armed with these equations, we proceed to find the elasticity of interest. Given the log demand:

$$\ln q_{ij} = \ln q_j^f + \rho \ln \varsigma_{ij} - \rho \left(\ln p_{ij} - \ln p_j^f\right),$$

and equation (A.1), we find equation (2.9):

$$\begin{aligned} \varepsilon_{ij} = -\frac{d \ln q_{ij}}{d \ln p_{ij}} &= -\left(\frac{d \ln q_j^f}{d \ln p_j^f} + \rho\right) \frac{d \ln p_j^f}{d \ln p_{ij}} + \rho \\ &= \left((\nu - 1)\frac{d \ln c_j}{d \ln p_j^f} + 1 - \rho\right) s_{ij} + \rho \\ &= \eta s_{ij}^f + (1 - s_{ij}^f)\rho, \end{aligned} \tag{A.5}$$

where we defined

$$\begin{aligned} \eta \equiv -\frac{d \ln q_j^f}{d \ln p_j^f} &= \frac{(\nu - 1)\gamma}{\varrho + \nu(1 - \varrho)} + 1. \\ &= \frac{(\varrho - \gamma) + \nu(1 - (\varrho - \gamma))}{\varrho + \nu(1 - \varrho)}. \end{aligned}$$

Equilibrium Price

The problem of the $i - j$ pair is to choose a bilateral price p_{ij} that solves the following problem:

$$\max_p \Big(\underbrace{\pi_i(p) - \tilde{\pi}_{i(-j)}}_{GFT_{ij}^i(p)}\Big)^{1-\phi} \Big(\underbrace{\pi_j(p) - \tilde{\pi}_{j(-i)}}_{GFT_{ij}^j(p)}\Big)^{\phi}, \tag{A.6}$$

where $\phi \in (0,1)$ is j's bargaining power, and the terms inside parentheses are the gains from trade for exporter i ($GFT^{i}_{ij}(p)$) and importer j ($GFT^{j}_{ij}(p)$), written as a function of p_{ij}.

The FOC associated with the problem (A.6) can be written as:

$$0 = \frac{d\ln \pi_i}{d\ln p_{ij}} + \frac{\phi}{1-\phi} \cdot \frac{GFT^{i}_{ij}}{\pi_i} \frac{\pi_j}{GFT^{j}_{ij}} \cdot \frac{d\ln \pi_j}{d\ln p_{ij}}, \tag{A.7}$$

where we used the fact that $\frac{dGFT^{k}_{ij}}{dp} = \frac{d\pi_k}{dp}$ for $k = \{i, j\}$. In what follows, we derive expressions for $\frac{d\ln \pi_i}{d\ln p_{ij}}, \frac{d\ln \pi_j}{d\ln p_{ij}}, GFT^{i}_{ij}$ and GFT^{j}_{ij}.

Exporter i's Profits and Gains from Trade–Firm i's profit under a successful negotiation can be expressed as

$$\pi_i = p_{ij}q_{ij} + \sum_{k\neq j} p_{ik}q_{ik} - \theta c_i q_i,$$

where $c_i = k_i q_i^{\frac{1-\theta}{\theta}}$. The elasticity of the profit π_i with respect to p_{ij} can be found as:

$$\frac{d\ln \pi_i}{d\ln p_{ij}} = \frac{q_{ij}}{\pi_i}(\varepsilon_{ij} - 1)\left(\mu^{\text{oligopoly}}_{ij} c_i - p_{ij}\right), \tag{A.8}$$

where $\varepsilon_{ij} \equiv -\frac{d\ln q_{ij}}{d\ln p_{ij}}$ is defined in equation (A.5) and

$$\mu^{\text{oligopoly}} := \frac{\varepsilon_{ij}}{\varepsilon_{ij} - 1}.$$

The "outside" profit of firm i are

$$\tilde{\pi}_{i(-j)} = \sum_{k\neq j} p_{ik}q_{ik} - \theta \widetilde{c_i q_i}.$$

For a constant k_i and given $q_i = \sum_{j\in\mathcal{Z}_i} q_{ij}$, the total cost in case of failed agreement can be found as:

$$\begin{aligned}\theta \widetilde{c_i q_i} &= \theta c_i q_i \left(\frac{\widetilde{q_i}}{q_i}\right)^{\frac{1}{\theta}}. \\ &= \theta c_i q_i \left(1 - x_{ij}\right)^{\frac{1}{\theta}}.\end{aligned}$$

The exporter's gains from trade GFT^i_{ij} are thus given by:

$$\begin{aligned} GFT^i_{ij}(p_{ij}) &\equiv \pi_i(p) - \tilde{\pi}_{i(-j)} \\ &= q_{ij}\left(p_{ij} - c_i \mu^{\text{oligopsony}}_{ij}\right), \end{aligned} \tag{A.9}$$

where $\mu^{\text{oligopsony}}_{ij} := \theta \left[\frac{\Delta^x_{ij}}{x_{ij}}\right]$ and $\Delta^x_{ij} := \left[1 - (1 - x_{ij})^{\frac{1}{\theta}}\right]$.

Importer j's Profits and Gains from Trade–Firm j's profit under a successful negotiation can be expressed as

$$\pi_j = p_j q_j - \varrho c_j q_j = \frac{\gamma}{\eta - 1} c_j q_j,$$

where c_j is defined in equation (A.3), and q_j in equation (A.4). The elasticity of the profit π_j with respect to p_{ij} can be found as:

$$-\frac{d \ln \pi_j}{d \ln p_{ij}} = (\eta - 1) s_{ij}. \tag{A.10}$$

The outside profit of firm j under a failed negotiation is

$$\tilde{\pi}_{j(-i)} = \frac{\gamma}{\eta - 1} \widetilde{c_j q_j},$$

where $\varrho \widetilde{c_j q_j}$ denotes the total "outside" cost of importer j. The assumptions on technology and demand downstream imply that we can write:

$$\widetilde{c_j q_j} = (1 - s_{ij})^{\frac{\eta - 1}{\rho - 1}} c_j q_j.$$

Putting things together, the importer's gains from trade can be written as:

$$GFT_j(p_{ij}) = \pi_j \Delta^s_{ij} \tag{A.11}$$

where we defined $\Delta^s_{ij} := \left(1 - (1 - s_{ij})^{\frac{\eta - 1}{\rho - 1}}\right)$.

We're now ready to solve for the bilateral price p_{ij}. Substituting equations (A.8), (A.9), (A.10), and (A.11) into the FOC in equation (A.7), we obtain:

$$\mu_{ij} := \frac{p_{ij}}{c_i} = (1 - \omega_{ij}) \mu^{\text{oligopoly}}_{ij} + \omega_{ij} \mu^{\text{oligopsony}}_{ij} \tag{A.12}$$

where the weighting factor is

$$\omega_{ij} := \frac{\frac{\phi}{1-\phi}\lambda_{ij}}{1 + \frac{\phi}{1-\phi}\lambda_{ij}} \in (0,1) \tag{A.13}$$

and where

$$\begin{aligned}\lambda_{ij} &:= \frac{\pi_j}{GFT_{ij}^j} \cdot \left(-\frac{d\ln \pi_j}{d\ln p_{ij}} \cdot (\varepsilon_{ij} - 1)^{-1} \right) \\ &= \underbrace{\frac{\pi_j}{GFT_{ij}^j}}_{\lambda_{ij}^N} \cdot \underbrace{-\frac{d\ln \pi_j}{d\ln p_{ij} q_{ij}}}_{\lambda_{ij}^I} \\ &= \left(\Delta_{ij}^s\right)^{-1} \cdot \frac{\eta - 1}{\varepsilon_{ij} - 1} s_{ij} > 0.\end{aligned} \tag{A.14}$$

Equations (A.12)-(A.14) forms the basis for Proposition 1 in Section 2. □

A.2 Proof of Proposition 2

Proposition 2 characterizes how the bilateral markup μ_{ij} co-moves with the exporter's and importer's bilateral market shares, s_{ij} and x_{ij}.

Part (i): μ_{ij} and Exporter's supplier share s_{ij} To study how μ_{ij} responds to the exporter's supplier share s_{ij}, note that the oligopoly markup $\mu_{ij}^{\text{oligopoly}}$ is strictly increasing in s_{ij} under standard assumptions ($\eta < \rho < \infty$). Differentiating the overall markup μ_{ij} in equation (A.12) with respect to s_{ij} yields:

$$\frac{\partial \mu_{ij}}{\partial s_{ij}} = (1 - \omega_{ij}) \cdot \underbrace{\frac{\partial \mu_{ij}^{\text{oligopoly}}}{\partial s_{ij}}}_{>0} + \frac{\partial \omega_{ij}}{\partial s_{ij}} \cdot \underbrace{\left(\mu_{ij}^{\text{oligopsony}} - \mu_{ij}^{\text{oligopoly}} \right)}_{<0}.$$

The first term is strictly positive when $\omega_{ij} < 1$ (i.e., $\phi < 1$), reflecting the direct effect of s_{ij} on the oligopoly markup. The second term captures how changes in s_{ij} affect the bargaining weight ω_{ij} and thus the relative influence of the oligopsony markdown. Although ω_{ij} is hump-shaped in s_{ij}, increasing at low values and decreasing at high values, its sensitivity to s_{ij} is limited in most of the parameter space. As a result, $\frac{\partial \omega_{ij}}{\partial s_{ij}}$ is typically small, and the first (positive) term generally dominates.

In contrast, when $\phi = 1$ (full importer bargaining power), the bilateral markup reduces to the oligopsony markdown: $\mu_{ij} = \mu_{ij}^{\text{oligopsony}}$, and $\omega_{ij} = 1$. In this case,

$$\frac{\partial \mu_{ij}}{\partial s_{ij}} = 0.$$

Thus, we have:

$$\frac{\partial \mu_{ij}}{\partial s_{ij}} = \begin{cases} \gtreqless 0 & \text{if } \phi < 1 \text{ (typically positive)}, \\ = 0 & \text{if } \phi = 1. \end{cases}$$

Thus, μ_{ij} can increase with s_{ij} in our theory only when $\phi < 1$, which proves the first part of Proposition 1.

Part (ii): μ_{ij} and Importer's buyer share x_{ij} The effect of x_{ij} on μ_{ij} is limited to the oligopsony markdown term and is therefore easier to characterize. Differentiating the bilateral markup with respect to x_{ij} yields:

$$\frac{\partial \mu_{ij}}{\partial x_{ij}} = \omega_{ij} \cdot \underbrace{\frac{\partial \mu_{ij}^{\text{oligopsony}}}{\partial x_{ij}}}_{<0 \text{ if } \theta<1}.$$

The markdown $\mu_{ij}^{\text{oligopsony}}$ decreases with x_{ij} when marginal cost is increasing (i.e., $\theta < 1$), as larger buyers elicit stronger cost reductions and thus negotiate lower prices. This implies:

$$\frac{\partial \mu_{ij}}{\partial x_{ij}} < 0 \iff \omega_{ij} > 0 \text{ and } \theta < 1.$$

Therefore, observing a negative slope of μ_{ij} with respect to the importer's share x_{ij} provides evidence of both importer bargaining power ($\phi > 0$ so that $\omega_{ij} > 0$) and decreasing returns to scale ($\theta < 1$). This completes the proof of Proposition 2. □

A.3 Proof of Proposition 3

The log (tariff-inclusive) price is given by:

$$\ln p_{ij} = \ln \mu_{ij} + \ln c_i + \ln T_c,$$

where c_i and μ_{ij} are as in equations (2.1) and (2.6), respectively.

Taking a full log-differential and rearranging terms yields:

$$
\begin{aligned}
d\ln p_{ij} &= -\Gamma_{ij} \cdot d\ln p_{ij} - \Lambda_{ij} d\ln p_{ij} + d\ln T_c \\
\frac{d\ln p_{ij}}{d\ln T_c} &= \frac{1}{1+\Gamma_{ij}+\Lambda_{ij}},
\end{aligned}
$$

where $\Gamma_{ij} \equiv -\frac{d\ln \mu_{ij}}{d\ln p_{ij}}$ and $\Lambda_{ij} \equiv -\frac{d\ln c_i}{d\ln p_{ij}}$ are the partial *markup* and *cost* elasticities, respectively.

The Cost Elasticity

Taking the logarithm of equation (2.1), we obtain:

$$
\ln c_i = \ln k_i + \frac{1-\theta}{\theta}\ln q_i.
$$

It immediately follows that:

$$
\begin{aligned}
\Lambda_{ij} \equiv -\frac{d\ln c_i}{d\ln p_{ij}} &= \frac{1-\theta}{\theta}\frac{d\ln q_i}{d\ln q_{ij}}\left(-\frac{d\ln q_{ij}}{d\ln p_{ij}}\right) \\
&= \frac{1-\theta}{\theta} \cdot x_{ij} \cdot \varepsilon_{ij} \geq 0.
\end{aligned}
$$

Moreover, the comparative statics with respect to the bilateral shares are easy to compute as:

$$
\frac{d\Lambda_{ij}}{dx_{ij}} = \frac{1-\theta}{\theta} \cdot \varepsilon_{ij} \geq 0,
$$

with strict inequality whenever $\theta < 1$, whereas:

$$
\frac{d\Lambda_{ij}}{ds_{ij}} = \frac{1-\theta}{\theta} \cdot x_{ij} \cdot (\eta - \rho) < 0.
$$

Thus, the cost elasticity weakly increases with the importer's buyer share x_{ij}, and it decreases with the exporter's supplier share s_{ij}.

Markup Elasticity

Taking logs of equation (2.6) and differentiating, we obtain:

$$d\ln\mu_{ij} = \frac{(1-\omega_{ij})\mu_{ij}^{\text{oligopoly}}}{\mu_{ij}}\, d\ln\mu_{ij}^{\text{oligopoly}} + \frac{\omega_{ij}\mu_{ij}^{\text{oligopsony}}}{\mu_{ij}}\, d\ln\mu_{ij}^{\text{oligopsony}} + \frac{\omega_{ij}\left(\mu_{ij}^{\text{oligopsony}} - \mu_{ij}^{\text{oligopoly}}\right)}{\mu_{ij}}\, d\ln\omega_{ij}.$$

Rearranging terms, the price elasticity of the bilateral markup can be expressed as:

$$\Gamma_{ij} \equiv -\frac{d\ln\mu_{ij}}{d\ln p_{ij}} = \frac{(1-\omega_{ij})\mu_{ij}^{\text{oligopoly}}}{\mu_{ij}}\,\Gamma_{ij}^{\text{oligopoly}} + \frac{\omega_{ij}\mu_{ij}^{\text{oligopsony}}}{\mu_{ij}}\,\Gamma_{ij}^{\text{oligopsony}} + \left(1 - \frac{\mu_{ij}^{\text{oligopoly}}}{\mu_{ij}}\right)\Gamma_{ij}^{\omega},$$

where: $\Gamma_{ij}^{\text{oligopoly}} \equiv -\frac{d\ln\mu_{ij}^{\text{oligopoly}}}{d\ln p_{ij}}$, $\Gamma_{ij}^{\text{oligopsony}} \equiv -\frac{d\ln\mu_{ij}^{\text{oligopsony}}}{d\ln p_{ij}}$, and $\Gamma_{ij}^{\omega} \equiv -\frac{d\ln\omega_{ij}}{d\ln p_{ij}}$.

Oligopoly Markup Elasticity–The oligopoly markup elasticity is given by:

$$\Gamma_{ij}^{\text{oligopoly}} \equiv -\frac{d\ln\mu_{ij}^{\text{oligopoly}}}{d\ln p_{ij}} = -\frac{d\ln\mu_{ij}^{\text{oligopoly}}}{d\ln s_{ij}} \cdot \frac{d\ln s_{ij}}{d\ln p_{ij}}.$$

From the definition of s_{ij}, the last term is:

$$\frac{d\ln s_{ij}}{d\ln p_{ij}} = -\left(\rho - 1\right)\left(1 - s_{ij}\right).$$

Given $\mu_{ij}^{oligopoly} = \frac{\varepsilon_{ij}}{\varepsilon_{ij}-1}$, we find:

$$-\frac{d\ln\mu_{ij}^{\text{oligopoly}}}{d\ln s_{ij}} = -\frac{1}{(\varepsilon_{ij}-1)} \cdot \frac{\rho - \varepsilon_{ij}}{\varepsilon_{ij}},$$

which implies:

$$\Gamma_{ij}^{\text{oligopoly}} = -\frac{d\ln\mu_{ij}^{\text{oligopoly}}}{d\ln s_{ij}} \cdot \frac{d\ln s_{ij}}{d\ln p_{ij}} = \frac{1}{\varepsilon_{ij}-1}\frac{\rho - \varepsilon_{ij}}{\varepsilon_{ij}}\left(\rho - 1\right)\left(1 - s_{ij}\right) \geq 0.$$

Oligopsony Markup Elasticity– The oligopsony markup elasticity is given by:

$$\Gamma_{ij}^{\text{oligopsony}} \equiv -\frac{d\ln\mu_{ij}^{\text{oligopsony}}}{d\ln p_{ij}} = -\left(\frac{d\ln\mu_{ij}^{\text{oligopsony}}}{d\ln x_{ij}}\right)\left(\frac{d\ln x_{ij}}{d\ln p_{ij}}\right).$$

From the definition of x_{ij}, the last term is:

$$\frac{d\ln x_{ij}}{d\ln p_{ij}} = -(1-x_{ij})\varepsilon_{ij}.$$

Given $\mu_{ij}^{oligopsony} := \theta\left(\frac{1-(1-x_{ij})^{\frac{1}{\theta}}}{x_{ij}}\right)$, we find:

$$\frac{d\ln\mu_{ij}^{\text{oligopsony}}}{d\ln x_{ij}} = \left(\frac{x_{ij}\left(1-x_{ij}\right)^{\frac{1}{\theta}-1}}{\theta\left(1-\left(1-x_{ij}\right)^{\frac{1}{\theta}}\right)} - 1\right)$$

which implies:

$$\Gamma_{ij}^{\text{oligopsony}} = -\left(\frac{d\ln\mu_{ij}^{\text{oligopsony}}}{d\ln x_{ij}}\right)\left(\frac{d\ln x_{ij}}{d\ln p_{ij}}\right) = \left(\frac{x_{ij}\left(1-x_{ij}\right)^{\frac{1}{\theta}-1}}{\theta\left(1-\left(1-x_{ij}\right)^{\frac{1}{\theta}}\right)} - 1\right)(1-x_{ij})\varepsilon_{ij}.$$

with

$$\begin{aligned}
\frac{\partial\Gamma_{ij}^{\text{oligopsony}}}{\partial x_{ij}} &= \left[\frac{\partial}{\partial x_{ij}}\left(\frac{x_{ij}(1-x_{ij})^{\frac{1}{\theta}-1}}{\theta\left[1-(1-x_{ij})^{\frac{1}{\theta}}\right]}\right)(1-x_{ij})\right.\\
&\qquad\left. - \left(\frac{x_{ij}(1-x_{ij})^{\frac{1}{\theta}-1}}{\theta\left[1-(1-x_{ij})^{\frac{1}{\theta}}\right]} - 1\right)\right]\varepsilon_{ij}\\
&= \left[\frac{\left((1-x_{ij})^{\frac{1-\theta}{\theta}} - \frac{1-\theta}{\theta}x_{ij}(1-x_{ij})^{\frac{1}{\theta}-2}\right)\theta\left[1-(1-x_{ij})^{\frac{1}{\theta}}\right] - x_{ij}(1-x_{ij})^{\frac{2}{\theta}-2}}{\theta^2\left[1-(1-x_{ij})^{\frac{1}{\theta}}\right]^2}\right](1-x_{ij})\\
&\qquad - \left(\frac{x_{ij}(1-x_{ij})^{\frac{1}{\theta}-1}}{\theta\left[1-(1-x_{ij})^{\frac{1}{\theta}}\right]} - 1\right)\\
&= \left[\left(\frac{1-\frac{1-\theta}{\theta}\cdot\frac{x_{ij}}{1-x_{ij}}}{\theta\left[1-(1-x_{ij})^{\frac{1}{\theta}}\right]} - \frac{(1-x_{ij})^{\frac{1}{\theta}-1}}{\mu_{ij}^{\text{oligopsony}}\theta\left[1-(1-x_{ij})^{\frac{1}{\theta}}\right]}\right)(1-x_{ij})^{\frac{1}{\theta}}\right.
\end{aligned}$$

$$- \left(\frac{x_{ij}(1-x_{ij})^{\frac{1}{\theta}-1}}{\theta\left[1-(1-x_{ij})^{\frac{1}{\theta}}\right]} - 1 \right) \Bigg]$$

Omega Elasticity

The elasticity of the weight ω_{ij} with respect to price is:

$$\Gamma_{ij}^{\omega} \equiv -\frac{d\ln\omega_{ij}}{d\ln p_{ij}} = \frac{d\ln\omega_{ij}}{d\ln s_{ij}}\left(-\frac{d\ln s_{ij}}{d\ln p_{ij}}\right).$$

Given

$$\frac{d\ln\omega_{ij}}{d\ln s_{ij}} = (1-\omega_{ij})\,\frac{d\ln\lambda_{ij}}{d\ln s_{ij}},$$

the above elasticity becomes:

$$\Gamma_{ij}^{\omega} = \frac{d\ln\lambda_{ij}}{d\ln s_{ij}}\,(1-\omega_{ij})\,(\rho-1)\,(1-s_{ij}),$$

Since $\lambda_{ij} = \frac{(\eta-1)s_{ij}}{\varepsilon_{ij}-1}\cdot\left(1-(1-s_{ij})^{\frac{\eta-1}{\rho-1}}\right)^{-1}$, we find:

$$\frac{d\ln\lambda_{ij}}{d\ln s_{ij}} = 1 - \frac{\varepsilon_{ij}-\rho}{\varepsilon_{ij}-1} - \frac{\eta-1}{\rho-1}\cdot\frac{(1-s_{ij})^{\frac{\eta-1}{\rho-1}}}{1-(1-s_{ij})^{\frac{\eta-1}{\rho-1}}}\cdot\frac{s_{ij}}{(1-s_{ij})}.$$

Thus:

$$\Gamma_{ij}^{\omega} = \left(1 - \frac{\varepsilon_{ij}-\rho}{\varepsilon_{ij}-1} - \frac{\eta-1}{\rho-1}\cdot\frac{(1-s_{ij})^{\frac{\eta-1}{\rho-1}}}{1-(1-s_{ij})^{\frac{\eta-1}{\rho-1}}}\cdot\frac{s_{ij}}{(1-s_{ij})}\right)(1-\omega_{ij})\,(\rho-1)\,(1-s_{ij}).$$

□

A.4 Proof of Proposition 4

We now prove Proposition 4, which characterizes the equilibrium comovement between pass-through Φ_{ij} and the bilateral market shares x_{ij} and s_{ij}.

Comparative Statics with Respect to x_{ij}— We begin by analyzing how pass-through Φ_{ij} responds to the importer's buyer share x_{ij}. As discussed in the main text, Φ_{ij} depends on x_{ij} through two channels: (i) the oligopsony markdown elasticity $\Gamma_{ij}^{\text{oligopsony}}$, which is non-monotonic (U-shaped) in x_{ij}, and (ii) the cost elasticity Λ_{ij}, which increases linearly in x_{ij} when $\theta < 1$.

When $\theta = 1$, both elasticities are zero: $\Gamma_{ij}^{\text{oligopsony}} = \Lambda_{ij} = 0$. Therefore, pass-through is constant in x_{ij}:

$$\left.\frac{\partial \Phi_{ij}}{\partial x_{ij}}\right|_{\theta=1} = 0.$$

When $\theta < 1$, however, both elasticities are active. The pass-through elasticity can be written as:

$$\Phi_{ij} = \frac{1}{1 + \Gamma_{ij} + \Lambda_{ij}} = \frac{1}{1 + \cdots + \omega_{ij} \cdot \frac{\mu_{ij}^{\text{oligopsony}}}{\mu_{ij}} \cdot \Gamma_{ij}^{\text{oligopsony}} + \Lambda_{ij}},$$

where "$\cdots$" denotes terms that do not depend on x_{ij}. Differentiating with respect to x_{ij}:

$$\frac{\partial \Phi_{ij}}{\partial x_{ij}} = -\frac{1}{(1 + \Gamma_{ij} + \Lambda_{ij})^2} \cdot \frac{\partial}{\partial x_{ij}} \left(\omega_{ij} \cdot \frac{\mu_{ij}^{\text{oligopsony}}}{\mu_{ij}} \cdot \Gamma_{ij}^{\text{oligopsony}} + \Lambda_{ij} \right).$$

Let:

$$T_1 \equiv \omega_{ij} \cdot \frac{\mu_{ij}^{\text{oligopsony}}}{\mu_{ij}} \cdot \Gamma_{ij}^{\text{oligopsony}}, \quad T_2 \equiv \Lambda_{ij}.$$

We can expand these as:

$$T_1 = \omega_{ij} \cdot \left(\frac{(1 - x_{ij})^{\frac{1}{\theta} - 1} - \mu_{ij}^{\text{oligopsony}}}{\mu_{ij}} \right) (1 - x_{ij}) \varepsilon_{ij},$$
$$T_2 = \frac{1 - \theta}{\theta} \cdot x_{ij} \cdot \varepsilon_{ij}.$$

While T_1 is non-monotonic in x_{ij}, T_2 increases linearly in x_{ij} and dominates T_1 for all x_{ij}. This can be verified numerically; for instance, when $\theta = \frac{1}{2}$:

$$T_1 + T_2 = x_{ij} \cdot \varepsilon_{ij} \left(1 - \frac{\omega_{ij}}{\mu_{ij}} \cdot \left(\frac{5}{2} - \frac{3}{2} x_{ij} \right) \right),$$

which increases in x_{ij} as the term in parentheses remains positive.

Hence, the term in the numerator of $\frac{\partial \Phi_{ij}}{\partial x_{ij}}$ increases in x_{ij}, implying:

$$\text{sign}\left(\frac{\partial \Phi_{ij}}{\partial x_{ij}} \right) = -\,\text{sign}\left(\frac{\partial \Lambda_{ij}}{\partial x_{ij}} \right),$$

so that:

$$\frac{\partial \Phi_{ij}}{\partial x_{ij}} \leq 0.$$

This proves that, under $\theta < 1$, pass-through decreases in x_{ij}, a robust and testable implication of the model.

□

Comparative Statics with Respect to s_{ij}— We now turn to how pass-through Φ_{ij} varies with the exporter's supplier share s_{ij}. Unlike the case of x_{ij}, this relationship is more complex, as all components, namely, $\Gamma_{ij}^{\text{oligopoly}}$, $\Gamma_{ij}^{\text{oligopsony}}$, Γ_{ij}^{ω}, and Λ_{ij}, may vary with s_{ij}. Specifically,

$$\Phi_{ij} = \frac{1}{1+\Gamma_{ij}+\Lambda_{ij}} = \frac{1}{1+\frac{(1-\omega_{ij})\mu_{ij}^{\text{oligopoly}}}{\mu_{ij}}\Gamma_{ij}^{\text{oligopoly}} + \frac{\omega_{ij}\mu_{ij}^{\text{oligopsony}}}{\mu_{ij}}\Gamma_{ij}^{\text{oligopsony}} + \left(1-\frac{\mu_{ij}^{\text{oligopoly}}}{\mu_{ij}}\right)\Gamma_{ij}^{\omega} + \Lambda_{ij}}.$$

Differentiating with respect to s_{ij} gives:

$$\begin{aligned}\frac{\partial \Phi_{ij}}{\partial s_{ij}} = -\frac{\partial}{\partial s_{ij}}\Bigg(&\frac{(1-\omega_{ij})\mu_{ij}^{\text{oligopoly}}}{\mu_{ij}}\Gamma_{ij}^{\text{oligopoly}} + \frac{\omega_{ij}\mu_{ij}^{\text{oligopsony}}}{\mu_{ij}}\Gamma_{ij}^{\text{oligopsony}} \\ &+ \left(1-\frac{\mu_{ij}^{\text{oligopoly}}}{\mu_{ij}}\right)\Gamma_{ij}^{\omega} + \Lambda_{ij}\Bigg) \cdot \left(1+\Gamma_{ij}+\Lambda_{ij}\right)^{-2}.\end{aligned}$$

When $\theta = 1$, both $\Gamma_{ij}^{\text{oligopsony}} = 0$ and $\Lambda_{ij} = 0$, and the expression simplifies to:

$$\frac{\partial \Phi_{ij}}{\partial s_{ij}} = -\frac{\partial}{\partial s_{ij}}\left(\frac{(1-\omega_{ij})\mu_{ij}^{\text{oligopoly}}}{\mu_{ij}}\Gamma_{ij}^{\text{oligopoly}} + \left(1-\frac{\mu_{ij}^{\text{oligopoly}}}{\mu_{ij}}\right)\Gamma_{ij}^{\omega}\right) \cdot (1+\Gamma_{ij})^{-2}.$$

To build intuition, consider the limit $s_{ij} \to 1$, where $\omega_{ij} \to \phi$ and $\Gamma_{ij}^{\omega} \to 0$. Then:

$$\frac{\partial \Phi_{ij}}{\partial s_{ij}} \propto \begin{cases} -\frac{\partial}{\partial s_{ij}}\left(\frac{(1-\phi)\mu_{ij}^{\text{oligopoly}}}{\mu_{ij}}\Gamma_{ij}^{\text{oligopoly}} + \frac{\phi\mu_{ij}^{\text{oligopsony}}}{\mu_{ij}}\Gamma_{ij}^{\text{oligopsony}} + \Lambda_{ij}\right) & \text{if } \theta < 1, \\ -\frac{\partial}{\partial s_{ij}}\left(\frac{(1-\phi)\mu_{ij}^{\text{oligopoly}}}{\mu_{ij}}\Gamma_{ij}^{\text{oligopoly}}\right) & \text{if } \theta = 1. \end{cases}$$

The term involving $\Gamma_{ij}^{\text{oligopoly}}$ is hump-shaped in s_{ij}, while the remaining components, particularly Λ_{ij}, decline monotonically with s_{ij} due to $\frac{\partial \varepsilon_{ij}}{\partial s_{ij}} = -(\rho - \eta) < 0$. Quantitatively, these latter terms dominate in most parameter ranges.

Thus, we have:

$$\text{sign}\left(\frac{\partial \Phi_{ij}}{\partial s_{ij}}\right) \propto \begin{cases} (+) & \text{if } \theta < 1 \text{ or } s_{ij} \text{ sufficiently large,} \\ (-) & \text{if } \theta = 1 \text{ and } s_{ij} \text{ sufficiently small.} \end{cases}$$

Due to the non-monotonicity and interaction of multiple channels, the relationship between Φ_{ij} and s_{ij} does not yield a clean, general prediction. While pass-through may increase with s_{ij} under decreasing returns to scale and sufficient buyer power, the sign of this relationship depends on the relative strength of strategic complementarities, oligopsony markdowns, and cost elasticity. As a result, we omit this relationship from Proposition 3 and focus instead on the more robust prediction involving x_{ij}.

□

B Theory: Discussion and Extensions

B.1 Efficient Bargaining

In the efficient bargaining setup, the importer and exporter negotiate over a two-part tariff (p, q) by maximizing a Nash product of generalized firm-specific gains from trade (GFT):

$$\max_{p,q} \left[GFT^i_{ij}(p,q)\right]^{1-\phi} \left[GFT^j_{ij}(p,q)\right]^{\phi} \quad \text{s.t.} \quad GFT^i_{ij} \geq 0, \quad GFT^j_{ij} \geq 0$$

where:

$$\begin{aligned} GFT^i_{ij}(p_{ij}, q_{ij}) &\equiv \pi_i(p) - \tilde{\pi}_{i(-j)} = p_{ij}q_{ij} - \left(\theta c_i q_i - \theta \widetilde{c_i q_i}\right), \\ GFT^j_{ij}(p_{ij}, q_{ij}) &\equiv \pi_j(p) - \tilde{\pi}_{j(-i)} = (p_j q_j - \tilde{p}_j \tilde{q}_j) - p_{ij}q_{ij}. \end{aligned}$$

This formulation corresponds to a setting in which the firm pair first selects the input quantity q_{ij} to maximize joint surplus, and then negotiates over the price p_{ij} to determine how surplus is split.

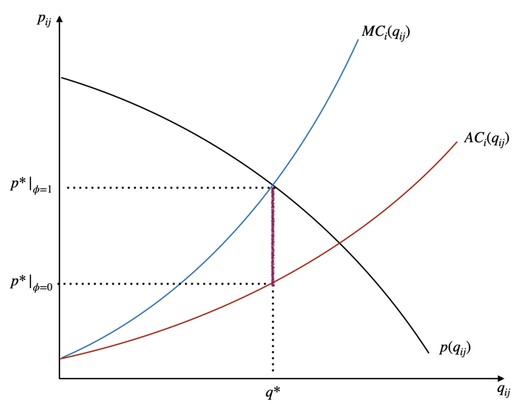


FIGURE B.1: Efficient Bargaining

The efficient quantity solves:

$$\begin{aligned} q^*_{ij} : \quad & \arg\max_q \left[GFT^i_{ij}(q) + GFT^j_{ij}(q)\right] \\ : \quad & \frac{d(p_j q_j)}{dq_{ij}} = \frac{d(\theta c_i q_i)}{dq_{ij}} \end{aligned}$$

That is, the efficient quantity q^*_{ij} equates the exporter's marginal cost to the importer's marginal revenue, similar to the outcome under vertical integration. Solving yields:

$$q_{ij}^* : \quad p_{ij} = c_i(q_{ij}^*),$$

so that the negotiated price equals the exporter's marginal cost.

Given q_{ij}^*, the price p_{ij} solves the Nash bargaining problem:

$$\max_{p_{ij}} \left(p_{ij}q_{ij}^* - \Delta C_i(q_{ij}^*)\right)^{1-\phi} \left(\Delta R_j(q_{ij}^*) - p_{ij}q_{ij}^*\right)^{\phi},$$

where $\phi \in (0,1)$ denotes the importer's bargaining power. The terms $\Delta R_j(q_{ij})$ and $\Delta C_i(q_{ij})$ represent the additional revenue for the importer and the additional cost for the exporter attributable to the match:

$$\begin{aligned} \Delta R_j(q_{ij}) &= p_j q_j - \widetilde{p_j q_j}, \\ \Delta C_i(q_{ij}) &= \theta c_i q_i - \theta \widetilde{c_i q_i}. \end{aligned}$$

Standard derivations lead to the equilibrium price:

$$\begin{aligned} p_{ij} &= (1-\phi) \cdot \frac{\Delta R_j(q_{ij})}{q_{ij}} + \phi \cdot \frac{\Delta C_i(q_{ij})}{q_{ij}} \\ &= (1-\phi) \cdot MC_i(q_{ij}^*) + \phi \cdot AC(q_{ij}^*) \end{aligned}$$

a weighted average of the per-unit downstream revenue gain and per-unit upstream cost increase from the match, with bargaining weights given by ϕ.

Figure B.1 illustrates the set of feasible equilibria. The efficient quantity is q^*, while the negotiated price ranges between $MC(q^*)$ and $AC(q^*)$ depending on ϕ.

B.2 Supply-Driven Quantity Bargaining

In the case of supply-driven quantity bargaining, the exporter first chooses the quantity q_{ij} for a given price p_{ij} to maximize profits, and bargaining occurs over the price, holding the induced supply curve fixed. For tractability, we solve the dual problem where the exporter selects a price p_{ij} for a given quantity q_{ij}, and bargaining takes place over the quantity. Formally, this is expressed as:

$$\begin{cases} \max_{p_{ij}} \pi_i(p_{ij}; q_{ij}) \\ \max_{q_{ij}} \left[GFT_{ij}^i(q_{ij}, p_{ij})\right]^{1-\phi} \left[GFT_{ij}^j(q_{ij}, p_{ij})\right]^{\phi}, \end{cases}$$

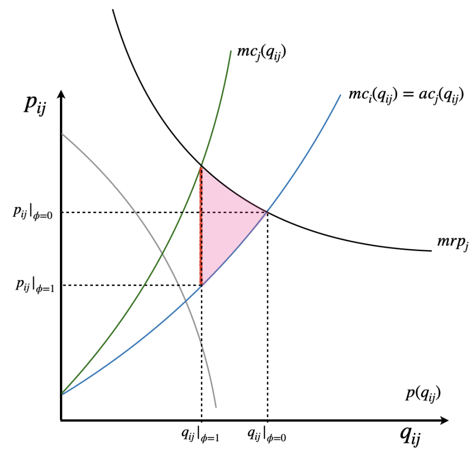


FIGURE B.2: Supply-Driven Quantity Bargaining

where the dependence on price and quantity in other parts of the network is left implicit. The solution to the exporter's problem yields the supply function, which we write as:

$$p_{ij}(q_{ij}) = k_i q_i^{\frac{1-\theta}{\theta}}, \quad \text{where} \quad q_i = q_{i(-j)} + q_{ij},$$

as in equation (2.1). Solving the bargaining problem using derivations similar to those in Section A.1 of this Appendix yields the following expression for the bilateral price:

$$p_{ij} = (1 - \omega_{ij}^S) \cdot c_i + \omega_{ij}^S \cdot \psi_{ij}^{-1} MRP_j,$$

where

$$\psi_{ij} = 1 + c'_{i,q_{ij}} = 1 + \frac{1-\theta}{\theta} x_{ij}.$$

Here, ω_{ij}^S is given by:

$$\omega_{ij}^S \equiv \frac{\frac{\phi}{1-\phi} \cdot \lambda_{ij}^S}{1 + \frac{\phi}{1-\phi} \cdot \lambda_{ij}^S} \quad \text{and} \quad \lambda_{ij}^S \equiv \frac{GFT_{ij}^i}{GFT_{ij}^j} \psi_{ij} = \frac{p_{ij} q_{ij} - \theta c_i q_i \Delta_{ij}^x}{p_j q_j \Delta_{ij}^s - p_{ij} q_{ij}} \psi_{ij}.$$

Hence, the bilateral price is a convex combination of the exporter's marginal cost (c_i) and a term reflecting the markdown (ψ_{ij}) below the importer's marginal revenue product ($MRP_j \equiv \frac{dp_j q_j}{dq_{ij}}$). As in the demand-driven quantity bargaining case, the weight ω_{ij}^S has an intuitive interpretation as the importer's effective bargaining power.

For $\phi = 0$, $\omega_{ij}^S = 0$, and the allocation is efficient with $p_{ij} = c_i$. For $\phi = 1$, $\omega_{ij}^S = 1$, and we obtain the standard oligopsony benchmark where the input price is a markdown below the importer's marginal revenue product, with the markdown equal to one plus the importer's residual supply elasticity. This reflects the importer's view, where the cost of increasing quantity is driven by raising the unit price for all inframarginal units when supply curves are upward-sloping.

Figure B.2 plots the set of feasible allocations. The red line indicates the pure oligopsony markdown, and the pink area represents the set of markdowns for $\phi \in (0, 1)$.

While this case is intuitive, it is more complex to characterize due to the term λ_{ij}^S, which is itself a function of prices and quantities and thus no longer a simple function of market shares as in the baseline case. As a result, bringing this model to the data is less straightforward than our baseline model.

B.3 Generalized Outside Option

In the baseline model, we assume that the importer's (exporter's) gains from trade are given by the firm's total payoff from trading with all partners, minus the payoff from trading with all partners except exporter i (importer j). In simpler terms, each importer (exporter) treats itself as the marginal buyer (supplier). This implies that, in case of disagreement, neither party considers the possibility of forming new relationships, which substantially influences the definition of outside profits for both importers and exporters.

We now consider a more general specification that imposes less structure on outside options. Let

$$\Delta_{ij}^{c_i} = \frac{\tilde{c}_i}{c_i} \qquad \text{and} \qquad \Delta_{ij}^{c_j} = \frac{\tilde{c}_j}{c_j}$$

denote the percentage change in exporter i's and importer j's marginal cost in the event of a failed negotiation. Under this generalization, the gains from trade for firms i and j are given by:

$$\begin{aligned} GFT_{ij}^i(p_{ij}) &= q_{ij}\left(p_{ij} - c_i \mu_{ij}^{\text{oligopsony},G}\right), \\ GFT_{ij}^j(p_{ij}) &= \pi_j \Delta_{ij}^{s,G}, \end{aligned}$$

where we define:

$$\begin{aligned} \mu_{ij}^{\text{oligopsony},G} &:= \theta\left[\frac{\Delta_{ij}^x}{x_{ij}}\right], \qquad \Delta_{ij}^x := \left[\frac{1 - \Delta_{ij}^{c_i}(1 - x_{ij})}{x_{ij}}\right], \\ \Delta_{ij}^{s,G} &:= 1 - \left(\Delta_{ij}^{c_j}\right)^{1-\nu}. \end{aligned}$$

The first-order condition under this generalized outside option implies:

$$\mu_{ij} := \frac{p_{ij}}{c_i} = (1 - \omega_{ij}^G)\mu_{ij}^{\text{oligopoly}} + \omega_{ij}^G \mu_{ij}^{\text{oligopsony},G}, \tag{B.1}$$

where the weighting factor is given by:

$$\omega_{ij}^G := \frac{\frac{\phi}{1-\phi}\lambda_{ij}^G}{1 + \frac{\phi}{1-\phi}\lambda_{ij}^G} \in (0,1),$$
$$\lambda_{ij}^G := \frac{\gamma s_{ij}}{\Delta_{ij}^{s,G}} \cdot \frac{\nu - 1}{\varepsilon_{ij} - 1} > 0.$$

Equation (B.1) shares the structure of the markup equation in equation (2.6), but with two key differences. First, the term λ_{ij} now depends on $\Delta_{ij}^{s,G}$, which cannot be expressed solely as a function of the supplier share. Second, the oligopsony markdown depends on Δ_{ij}^{x}, which likewise cannot be written as a function of the buyer share alone.

To summarize, generalizing the structure of outside options preserves the overall structure of the markup equation and yields similar comparative statics. However, it introduces an identification problem: the effective bargaining power and oligopsony markdown now depend on unobserved terms, such as $\Delta_{ij}^{s,G}$ and Δ_{ij}^{x}, that cannot be expressed solely as functions of market shares. In the absence of external data to estimate these terms, empirical implementation becomes infeasible without further assumptions. Imposing the more restrictive baseline assumption enables us to express both components as functions of observable bilateral market shares and a small set of structural parameters, allowing us to implement the model using available data and avoid excessive computational complexity.

B.4 Full Pass-Through Elasticity

In deriving Proposition 3, we assumed that the shock is applied at the firm-to-firm level and that prices and quantities in other relationships remain fixed. These assumptions allow us to isolate the direct, short-run effects of a shock. However, actual trade policy shocks, such as the Trump tariffs, often apply at the exporter- or product-level and may induce broader adjustments that our static, partial equilibrium model does not capture.

This section extends the analysis to incorporate certain *indirect effects* by capturing how a shock to exporter i influences prices and quantities in other relationships, and how those changes feed back into the bilateral price p_{ij}. While we continue to abstract from full general equilibrium forces, this exercise clarifies how network spillovers may cause reduced-form pass-through estimates to deviate from structural ones, as emphasized by Berger et al. (2022).

We generalize the cost shock to an exporter-level shock, denoted ϑ_i, and re-derive the relevant elasticities to allow for cross-relationship spillovers. First, the impact on the importer's buyer share becomes:

$$\frac{d\ln x_{ij}}{d\ln\vartheta_i} = -\varepsilon_{ij}(1-x_{ij})\frac{d\ln p_{ij}}{d\ln\vartheta_i} + \sum_{z\in\mathcal{Z}_i,\, z\neq j} x_{iz}\varepsilon_{iz}\frac{d\ln p_{iz}}{d\ln\vartheta_i}.$$

The effect on the exporter's marginal cost is:

$$\frac{d\ln c_i}{d\ln\vartheta_i} = \frac{1-\theta}{\theta}\left(-\varepsilon_{ij}x_{ij}\frac{d\ln p_{ij}}{d\ln\vartheta_i} - \sum_{z\in\mathcal{Z}_i,\, z\neq j} x_{iz}\varepsilon_{iz}\frac{d\ln p_{iz}}{d\ln\vartheta_i}\right).$$

We also account for the fact that p_{ij} affects rival suppliers' shares and prices. The elasticity of supplier share with respect to the shock is:

$$\frac{d\ln s_{ij}}{d\ln\vartheta_i} = (1-\rho)\frac{d\ln p_{ij}}{d\ln\vartheta_i}\left((1-s_{ij}) + s_{ij}(1-\rho)\sum_{k\in\mathcal{Z}_j,\, k\neq i} s_{kj}\Gamma^s_{kj}\right).$$

Incorporating these indirect effects, the full pass-through elasticity $\Psi_{ij} = \frac{d\ln p_{ij}}{d\ln\vartheta_i}$ is implicitly defined by:

$$\Psi_{ij} = \tilde{\Phi}_{ij} + \tilde{\Phi}_{ij}\left(\Gamma^x_{ij} - \frac{1-\theta}{\theta}\right)\sum_{z\in\mathcal{Z}_i,\, z\neq j} x_{iz}\varepsilon_{iz}\Psi_{iz},$$

where:

$$\tilde{\Phi}_{ij} = \left[1 + \Gamma^s_{ij}(\rho-1)\left((1-s_{ij}) - s_{ij}(\rho-1)\sum_{k\in\mathcal{Z}_j,\, k\neq i} s_{kj}\Gamma^s_{kj}\right) + \Gamma^x_{ij}\varepsilon_{ij}(1-x_{ij}) + \frac{1-\theta}{\theta}\varepsilon_{ij}x_{ij}\right]^{-1}.$$

This elasticity Ψ_{ij} embeds two key indirect effects beyond the direct elasticity Φ_{ij} derived earlier.

First, an increase in p_{ij} may cause rivals' supplier shares (e.g., s_{kj}) to rise, increasing their prices p_{kj} via strategic interactions. These adjustments dampen the original substitution away from exporter i, raising $\tilde{\Phi}_{ij}$ relative to Φ_{ij}.

Second, a cost shock to firm i may propagate to other buyers $z \in \mathcal{Z}_i$, affecting p_{iz}, which then feeds back into x_{ij} via firm i's overall scale and market presence. These changes affect

p_{ij} through both the markup and cost channels, amplifying pass-through further.

Together, these network spillovers push the full pass-through elasticity Ψ_{ij} away from the direct elasticity Φ_{ij}. Whether the net effect is amplification or attenuation depends on the strength of substitution patterns and strategic responses,an empirical question. In the main text, we focus on the direct pass-through elasticity Φ_{ij}, which is tightly grounded in our model's Nash-in-Nash structure and match-level pricing assumptions.

C Data Appendix

C.1 Related-Party Trade Measured via Ownership Linkages

A key advantage of the ORBIS dataset is the breadth and detail of its ownership information. It provides comprehensive listings of both direct and indirect shareholders and subsidiaries, along with indicators of each firm's independence, global ultimate ownership, and group affiliations. This enables us to identify corporate structures at the firm level, including ownership links between firms located in different countries. We define a parent–subsidiary relationship as one in which the parent firm holds at least a 50% ownership stake in the affiliate.

Linking U.S. Importers to Multinational Ownership To identify U.S.-based multinational firms, we match firms in the Census Business Register to their ORBIS counterparts using names, addresses, and GPS coordinates. This linkage combines probabilistic record matching with manual validation, producing a high match rate. As a result, we can flag U.S. establishments that are either majority-owned affiliates of foreign multinationals or parent firms with majority-owned affiliates abroad. This information allows us to identify multinationals with operations in the U.S. without relying solely on the Related Party Trade (RPT) indicator reported in the LFTTD.

Identifying Cross-Border Ownership Links To assess whether the foreign exporter also belongs to the same corporate group, we match the Manufacturer ID (MID) reported in LFTTD to firm records in ORBIS. The MID is constructed by U.S. Customs based on the exporter's name, address, and country of origin using a set of formatting rules. The MID begins with a two-character country code (or a province code for Canada), followed by a name-based segment derived from the first three letters of the first and second words in the company's name. If the company name consists of only one word, the first six letters are used. The next segment contains the first four digits from the address number, and the final three characters are the first three alphabetic characters of the city name. Standard formatting conventions apply, including the exclusion of punctuation, one-letter initials, and common stop words such as "the," "and," or "of." Country-specific prefixes (e.g., "OAO" or "ZAO" in Russia or "PT" in Indonesia) are also omitted when constructing the MID.

Using these same rules, we replicate the MID structure for foreign firms in the ORBIS database. We then match each MID in the customs data to candidate firms in ORBIS based on the reconstructed name segment. We assess the quality of each potential match using two dimensions: location and product alignment. A location score is computed based on the match between city names in the MID and in ORBIS. A product match score is computed by comparing the NAICS6 industry code listed in ORBIS to the HS6 product code recorded in the customs data, using the concordance developed by Pierce and Schott (2009). We retain only those matches where both location and product scores exceed 90%. In addition, we drop from the matched dataset any ORBIS firm with fewer than five transactions to filter out spurious exporters and potential noise.

Another concern is that the MID may sometimes refer to intermediaries rather than manufacturers. Although U.S. customs rules require that the MID correspond to the producer or manufacturer, not to wholesalers or freight forwarders, compliance with this rule is imperfect. To mitigate this concern, we use ORBIS industry codes to exclude retailers, wholesalers, and logistics providers from the matched dataset.

Finally, another challenge with the MID is that it is not a unique firm identifier: a given MID can correspond to multiple legal entities. In our matched data, we address this issue directly by checking whether a MID maps to more than one firm in ORBIS. If multiple firms share the same MID but belong to the same corporate group based on majority ownership links reported in ORBIS, we retain the match. Otherwise, we exclude the ambiguous MID from the analysis.

Taken together, these steps yield a linked dataset that offers a more transparent and conservative definition of related-party trade, based on majority ownership (at least 50%). In contrast to the standard related-party trade (RPT) flag in customs data, which applies a lower threshold of 6% ownership for imports, this approach reduces false positives and more precisely captures transactions where ownership ties are likely to influence pricing. By combining MID-based matching with firm-level ownership structures, the final dataset is well-suited for analyzing pricing behavior in cross-border transactions.

C.2 Data Cleaning, Sample Construction and Summary Statistics

We construct the analysis sample in several steps to align the data with the model's structure and requirements.

We begin by removing observations that are incomplete or inconsistent with the modeling framework. Specifically, we drop transactions with missing or zero values for import value or quantity, invalid exporter identifiers (e.g., strings with fewer than three characters or beginning with a number), or U.S. importers that cannot be linked to the Longitudinal Business Database (LBD). We also exclude transactions associated with special provisions or temporary classifications (HS codes 98–99).

Next, we restrict our attention to trade in intermediate and capital goods by removing HS10 products, which are classified as consumption goods under the BEC system.

Although the customs data are reported at the transaction level, we aggregate them to the annual level for each buyer–supplier–product triplet. We choose annual aggregation because few relationships appear in adjacent months or in the same month across years. We then retain only those triplets that are active in at least two consecutive years and where the supplier transacts the same HS10 product with more than one U.S. buyer. This ensures a panel structure with repeated observations, supporting the identification of the model's parameters.

We also exclude related-party trade, which is less likely to reflect decentralized bargaining and more likely to involve internal pricing practices such as transfer pricing.[35] In our baseline, a buyer–supplier pair is flagged as related if ORBIS identifies a shared corporate parent. To preserve coverage, we retain all observations not flagged as related by either ORBIS or the LFTTD. For robustness, we also consider two alternative definitions: one based solely on the LFTTD flag, and another combining it with ORBIS data to identify the U.S. importer as a multinational. See Appendix C.1 for further details.

To address outliers, we follow Heise (2024) and apply two filters. First, we drop observations with extreme price levels, defined as log unit values below the 1st or above the 99th percentile of the HS10 product–country distribution. Second, we trim extreme price changes by excluding year-on-year log price differences smaller than -4 or greater than $+4$. These outliers are removed from estimation but retained when computing tenure and relationship length. We also exclude all HS10 products under HS chapter 27 (energy-related goods), which lie outside the scope of the model.

[35] Bernard et al. (2006) shows that related-party prices differ systematically from arm's-length transactions, including lower average prices and different pass-through behavior.

After applying these restrictions, which exclude outliers, energy products, and related-party trade, and focusing on repeated, arm's-length relationships, the sample retains over 20% of U.S. imports by value and nearly 15% of buyer–supplier–product triplets.

Finally, we restrict attention to suppliers that sell the same HS10 product to more than one U.S. buyer. This condition is essential for the identification of the model's firm-level parameters and ensures that the empirical setting aligns with the model's structure oulined in Setion 4.

Table C.1 summarizes the cumulative impact of these steps. Panel A focuses on the 2001–2016 sample used for structural estimation. Panel B reports the corresponding summary for the 2017–2018 sample used in the pass-through analysis. The first row of each panel ("All Imports") includes all U.S. import records for the relevant years. Subsequent rows show the effect of each restriction in turn, including the requirement that buyer–supplier pairs trade the same product in two consecutive calendar years, the exclusion of consumption and energy goods, and the restriction to arm's-length relationships with sufficient variation for identification.

The final rows show the estimation samples used in the analysis. For 2001–2016 (Panel A), the data include approximately $880 billion in import value, 480,000 buyer–supplier pairs, and 630,000 buyer–supplier–HS10 triplets. For 2017–2018 (Panel B), the final sample includes $160 billion in imports, 190,000 pairs, and 250,000 triplets.[36] These samples correspond exactly to the data used in estimation and post-estimation analysis.

Table C.2 reports a similar analysis using a broader sample that includes capital, intermediate, and consumption goods ("BEC – All (Consec.)"), rather than limiting to consumption goods only. Analogous to Table 1, Table C.3 reports the summary statistics of this broader sample.

[36]Panel A omits intermediate sample steps and shows only the full and final samples for 2001–2016, as these are not reported in the analysis nor disclosed under Census data policies. The same applies to Table C.2.

Table C.1: Sample Composition by Period – Excluding BEC-Classified Consumption Goods

Sample	Import value (bn USD)	Importers (th)	Exporters (th)	Pairs (th)	Triplets (th)
Panel A: 2001–2016					
All Imports	22,000	1,000	6,900	17,000	40,000
BEC – Non-Cons. (Consec.)	-	-	-	-	-
+ No Energy/Outliers/RPT	-	-	-	-	-
+ Supplier Multi-Buyer	880	70	100	480	630
Panel B: 2017–2018					
All Imports	2,000	330	1,300	2,500	5,300
BEC – All (Consec.)	1,600	160	530	890	1,800
BEC – Non-Cons. (Consec.)	1,000	120	320	540	950
+ No Energy/Outliers/RPT	420	110	270	470	730
+ Supplier Multi-Buyer	160	71	43	190	250

Notes: This table reports sample characteristics for a series of progressively restricted datasets used in the empirical analysis. The first row ("All Imports") includes all U.S. import records in the sample period. All subsequent rows restrict the sample to buyer–supplier pairs that trade the same HS-10 product in two consecutive calendar years. The "BEC – excl. Cons. (Consec.)" sample includes only capital and intermediate goods, excluding consumption goods as defined by the Broad Economic Categories (BEC) classification. The next sample ("+ No Energy/Outliers") adds four filters: (i) transactions involving energy-sector goods are excluded; (ii) observations with price levels below the 1st percentile or above the 99th percentile of the within-product price distribution are removed; (iii) extreme log price changes (above 4 or below –4) are excluded; and (iv) related-party transactions, which are defined as trade between entities with ownership ties or corporate control, are dropped following U.S. Census Bureau classification. "+ Supplier Multi-Buyer" restricts to suppliers that trade with at least two different buyers in consecutive years for the same product. "Import value" denotes the total annual value of imports in billions of U.S. dollars. "Importers" and "Exporters" correspond to distinct U.S. buyers and foreign suppliers, respectively. "Pairs" refer to unique buyer–supplier–product matches. "Triplets" refer to unique buyer–supplier–product–year combinations. All figures are reported separately for the 2001–2016 and 2017–2018 periods and are rounded to four significant digits in accordance with U.S. Census Bureau disclosure guidelines. These samples are the exact ones used in the empirical analysis. Source: FSRDC Project Number 2109 (CBDRB-FY25-P2109-R12520).

Table C.2: Sample Composition by Period – All BEC Categories

Sample	Import value (bn USD)	Importers (th)	Exporters (th)	Pairs (th)	Triplets (th)
Panel A: 2001–2016					
All Imports	22,000	1,000	6,900	17,000	40,000
BEC – All (Consec.)	-	-	-	-	-
+ No Energy/Outliers/RPT	-		-	-	-
+ Supplier Multi-Buyer	1,600	110	210	990	1,500
Panel B: 2017–2018					
All Imports	2,000	330	1,300	2,500	5,300
BEC – All (Consec.)	1,600	160	530	890	1,800
+ No Energy/Outliers/RPT	710	150	470	800	1,500
+ Supplier Multi-Buyer	260	99	79	330	470

Notes: This table reports sample characteristics for a series of progressively restricted datasets used in the empirical analysis. The first row ("All Imports") includes all U.S. import records in the sample period. All subsequent rows restrict the sample to buyer–supplier pairs that trade the same HS-10 product in two consecutive calendar years. The "BEC – All Categories (Consec.)" sample retains all transactions in capital, intermediate, and consumption goods as defined by the Broad Economic Categories (BEC) system, subject to the consecutive-year condition. The next sample ("+ No Energy/Outliers") adds four filters: (i) transactions involving energy-sector goods are excluded; (ii) observations with price levels below the 1st percentile or above the 99th percentile of the within-product price distribution are removed; (iii) extreme log price changes (above 4 or below –4) are excluded; and (iv) related-party transactions are dropped following U.S. Census Bureau classification. "+ Supplier Multi-Buyer" restricts to suppliers that trade with at least two different buyers in consecutive years for the same product. "Import value" denotes the total annual value of imports in billions of U.S. dollars. "Importers" and "Exporters" correspond to distinct U.S. buyers and foreign suppliers, respectively. "Pairs" refer to unique buyer–supplier–product matches. "Triplets" refer to unique buyer–supplier–product–year combinations. All figures are reported separately for the 2001–2016 and 2017–2018 periods and are rounded to four significant digits in accordance with U.S. Census Bureau disclosure guidelines. Source: FSRDC Project Number 2109 (CBDRB-FY25-P2109-R12520).

Table C.3: Summary Statistics – All BEC Categories (2001–2018)

Variable	Mean	Std. Dev.	P25	Median	P75
Panel A: Characteristics of Trade Relationships					
s_{ijh}: Supplier share	0.27	0.32	0.02	0.10	0.43
x_{ijh}: Buyer share	0.27	0.30	0.03	0.13	0.45
Relationship length (product h)	3.90	2.60	2.50	3.50	5.50
Relationship length (all products)	4.60	3.10	2.50	4.50	6.50
# Transactions (product h)	100	890	6.50	16	50
# Transactions (all products)	410	3200	13	45	180
# Products per pair	5.60	12.00	1.50	2.50	5.50
Multi-HS10 dummy	0.68	0.47	0.00	1.00	1.00
# Suppliers per buyer (HS10)	2.00	3.60	1.50	2.50	6.50
Buyer tenure (all products)	9.50	4.90	5.50	9.50	14.00
Buyer tenure (product h)	6.80	4.30	3.50	6.50	10.00
# Buyers per supplier (HS10)	3.00	3.40	2.50	3.50	5.50
Supplier tenure (all products)	7.70	4.40	4.50	7.50	11.00
Supplier tenure (product h)	6.00	3.80	3.50	5.50	9.50
Corr. between s_{ijh} and x_{ijh}	0.053	—	—	—	—
Panel B: Prices					
$\log p$ (pre-duty)	3.40	2.50	1.50	3.10	5.10
$\log p$ (pre-duty, excl. charges)	3.30	2.50	1.40	3.00	5.00
$\log p^{\text{duty}}$ (post-duty)	3.40	2.50	1.50	3.10	5.20

Notes: This table reports summary statistics for a sample that covers all BEC product categories except energy goods, and excludes statistical outliers and related-party trade. It further restricts to suppliers that trade with at least two different U.S. buyers in consecutive years. This corresponds to the cumulative sample underlying the "+ Supplier Multi-Buyer" row in Panel B of Table C.2. Columns report the mean, standard deviation, and selected quantiles (25th percentile, median, and 75th percentile) for each variable. Prices in Panel B are log unit values (FOB value over quantity), with variants including charges or duties. s_{ijh} denotes exporter i's share in buyer j's imports of product h; x_{ijh} denotes buyer j's share in exporter i's U.S. exports of the same product. Relationship length and tenure are in years; concentration is measured at the HS10–year level. Counts of buyers, suppliers, and origin countries are per product per firm. Statistics are based on confidential LFTTD data and rounded to four significant digits per U.S. Census Bureau Disclosure Guidelines. Source: FSRDC Project Number 2109 (CBDRB-FY25-P2109-R12520).

D Additional Empirical Results

D.1 Decomposition of Price Dispersion

To explore the sources of price heterogeneity, we report in Table D.1 the results from OLS regressions decomposing price variation using the specification:

$$\ln p_{ijht} = FE_i + FE_j + FE_{ht} + \beta \boldsymbol{X}_{ijht} + \varepsilon_{ijht},$$

estimated over the period 2001-2016. We consider three alternative prices: prices that exclude both duties and charges ($\ln p_{ijht}$), prices that include charges but exclude duties ($\ln p^{c}_{ijht}$), and prices that include duties but exclude charges ($\ln p^{\text{duty}}_{ijht}$).

Table D.1 finds that controlling for product and year fixed effects explains approximately 50% of the overall price dispersion, while 4% is attributed to match-specific residuals. Notably, this figure changes substantially when isolating variation within supplier–product–year combinations (Panel B), with the buyer–supplier match accounting for 77% of the price variance. This emphasizes that a significant share of price heterogeneity stems from bilateral characteristics that are not solely attributable to either buyer or supplier individually.

Table D.1: Fixed-Effect Decomposition of Price Dispersion

Source of Variation	$\ln p_{ijht}$	$\ln p^{c}_{ijht}$	$\ln p^{\text{duty}}_{ijht}$
Panel A: Overall price dispersion			
FE_{ht}	0.483	0.485	0.486
FE_i	0.427	0.424	0.423
FE_j	0.0452	0.0464	0.0463
Match residual	0.0444	0.0441	0.0442
Panel B: Within exporter–product dispersion			
FE_j	0.231	0.233	0.233
Match residual	0.768	0.765	0.765

Notes: The columns correspond to alternative price definitions: $\ln p_{ijht}$ excludes both duties and charges; $\ln p^{c}_{ijht}$ includes charges but excludes duties; $\ln p^{\text{duty}}_{ijht}$ includes duties but excludes charges. The estimation sample includes importer–exporter–product matches observed in two consecutive calendar years, and applies the following restrictions: (i) excludes transactions involving consumption goods (based on the BEC classification), energy-sector products, statistical outliers, and related-party trade; and (ii) retains only suppliers that trade with at least two distinct U.S. buyers in consecutive years. This corresponds to the cumulative sample underlying the "+ Supplier Multi-Buyer" row in Panel B of Table C.1. The control vector $\boldsymbol{X}_{ijht}$ includes the log of transaction value, the log of relationship longevity (years since the exporter first supplied the buyer with the given HS10 product), and the log of the relative number of partners (the supplier's number of HS10-level buyers divided by the buyer's number of HS10-level suppliers). The sample includes 1,2000,000 importer–exporter–product–year observations, which have been rounded to four significant digits per U.S. Census Bureau disclosure guidelines. $R^2 = 0.956$. All coefficients in a regression model are significantly different from zero at the 1% significance level. Source: FSRDC Project Number 2109 (CBDRB-FY25-P2109-R12520).

D.2 Pass-Through Heterogeneity

Table D.2 examines the heterogeneity in tariff pass-through through specification (3.2) by including buyer-by-year fixed effects (FE_{jt}). This more demanding specification accounts for time-varying shocks at the buyer level, while also controlling for product–year and exporter country–year fixed effects ($FE_{ht}+FE_{ct}+FE_{jt}$). Findings replicate the results of incomplete tariff pass-through reported in Table 3, suggesting that exporters adjust marginal costs in response to demand shifts from dominant importers, thereby absorbing a substantial fraction of tariff shocks. These results demonstrate the critical role of the cost channel as, by Proposition 3, the pass-through decreases with the buyer share x_{ij}.

TABLE D.2: Pass-Through and Relationship Heterogeneity, Stringent Fixed Effects

Dependent variable:	$\Delta \ln p_{ijht}$					
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta \ln(1+\tau_{cht})$	-0.223	-0.342	-0.230	-0.154	-0.163	-0.292
	(0.109)	(0.155)	(0.096)	(0.130)	(0.107)	(0.145)
$\Delta \ln(1+\tau_{cht}) \cdot \ln \text{longevity}_{ijht}$		0.086				0.097
		(0.044)				(0.044)
$\Delta \ln(1+\tau_{cht}) \cdot s_{ijht-1}$			0.023		0.029	0.018
			(0.141)		(0.157)	(0.157)
$\Delta \ln(1+\tau_{cht}) \cdot x_{ijht-1}$				-0.271	-0.271	-0.280
				(0.127)	(0.135)	(0.130)
$FE_{ht}+FE_{ct}+FE_{jt}$	Yes	Yes	Yes	Yes	Yes	Yes
Observations	249,000	249,000	249,000	249,000	249,000	249,000
R-squared	0.31	0.31	0.31	0.31	0.31	0.31

Notes: This table reports estimates of the pass-through of statutory tariffs, $\Delta \ln(1+\tau_{cht})$, to duty-exclusive prices at the exporter–importer–product–year level, $\Delta \ln p_{ijht}$. Columns (2) and (6) interact tariffs with the log of relationship longevity, measured as the number of years that buyer j and supplier i have transacted in product h. Columns (3) and (5) interact tariffs with the lagged supplier share, s_{ijht-1}, defined as supplier i's share in buyer j's imports of product h. Columns (4) and (5) interact tariffs with the lagged buyer share, x_{ijht-1}, defined as buyer j's share in supplier i's exports of product h. All regressions include product–year, exporter country–year, and importer–year fixed effects ($FE_{ht}+FE_{ct}+FE_{jt}$). Controls include: (i) $\ln \text{longevity}_{ijht}$; (ii) $\Delta \ln q_{i(-j)ht}$, the change in exporter i's total sales of h to U.S. buyers other than j; and (iii) $\Delta \ln p_{(-i)jht}$, the weighted average price change charged by other suppliers of h to buyer j, using lagged shares as weights. Standard errors are clustered at the HS8 product and exporter-country level. The sample corresponds to the "+ Supplier Multi-Buyer" definition in Table C.1. Observation counts are rounded to four significant digits per U.S. Census Bureau disclosure guidelines. Source: FSRDC Project Number 2109 (CBDRB-FY25-P2109-R12520).

Nonlinear Effects To explore nonlinearities in tariff pass-through along the distribution of bilateral concentration, we interact the tariff change with quartile dummies of the lagged supplier share ($s_{ijh,t-1}$) and buyer share ($x_{ijh,t-1}$). Specifically, we estimate equation D.1, where

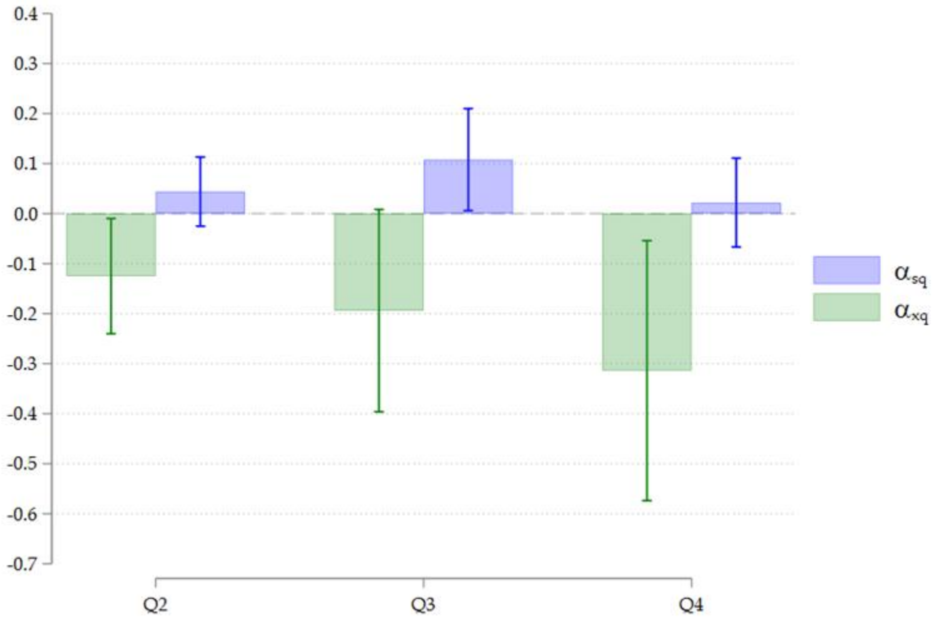
$\mathbf{1}\{s_{ijh,t-1} \in Q_q\}$ and $\mathbf{1}\{x_{ijh,t-1} \in Q_q\}$ are indicator variables for quartiles $q = 2, 3, 4$, with the first quartile serving as the omitted category. To separate level and interaction effects, the regression also includes the shares $s_{ijh,t-1}$ and $x_{ijh,t-1}$ themselves as covariates. This specification allows us to test whether pass-through varies nonlinearly across the concentration distribution, while flexibly controlling for underlying differences in market structure. Panel (A) of Figure D.1 includes product–time and exporting country–sector fixed effects, while Panel (B) features product–time, importer–time, and exporting country–time fixed effects.

$$\Delta \ln p_{ijht} = \alpha_0 + \alpha_1 \Delta \ln(1 + \tau_{cht}) + \sum_{q=2}^{Q} \alpha_{s,q} \cdot \Delta \ln(1 + \tau_{cht}) \cdot \mathbf{1}\{s_{ijh,t-1} \in Q_q\}$$
$$+ \sum_{q=2}^{Q} \alpha_{x,q} \cdot \Delta \ln(1 + \tau_{cht}) \cdot \mathbf{1}\{x_{ijh,t-1} \in Q_q\} + \gamma' \mathbf{X}_{ijht} + \mathbf{FE} + \epsilon_{ijht}. \qquad \text{(D.1)}$$

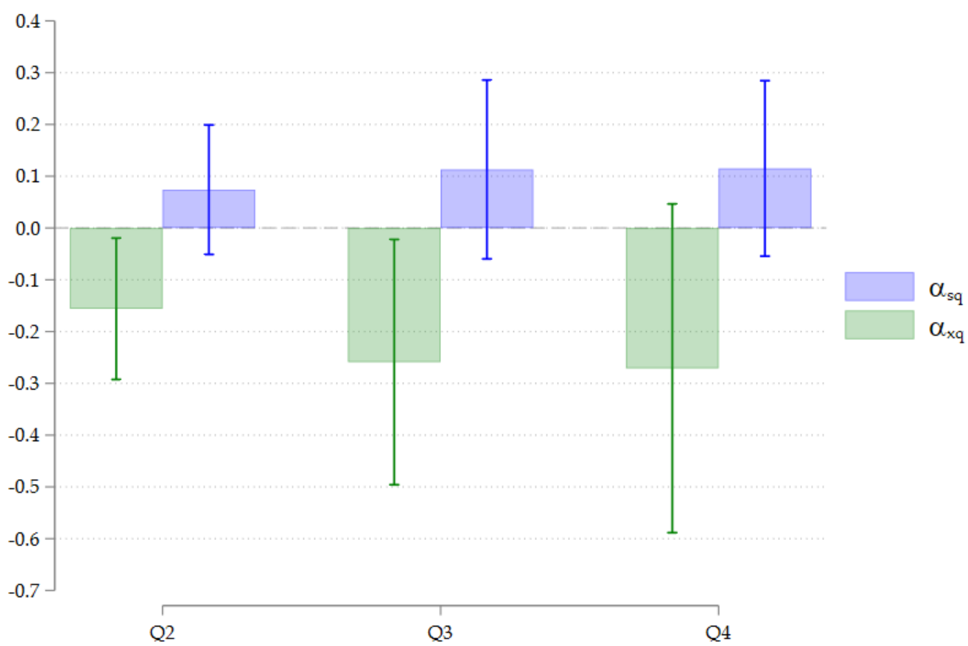
The results reveal no evidence of nonlinearities in pass-through with respect to supplier shares (in purple). Interaction coefficients across the upper quartiles of s_{ijht} are uniformly positive, but small in magnitude and statistically insignificant, indicating that supplier concentration does not materially affect the degree of pass-through. In contrast, buyer shares exhibit a strong, monotonic relationship (in green): pass-through declines significantly at higher quartiles of x_{ijht}, consistent with the model's prediction that dominant buyers constrain suppliers' ability to shift cost shocks.

FIGURE D.1: Pass-Through by Bilateral Market Share Quartiles

(A) Fixed Effects: $FE_{ht} + FE_{cs}$



(B) Fixed Effects: $FE_{ht} + FE_{ct} + FE_{jt}$



Notes: The figure plots estimated coefficients from regressions of bilateral price changes on tariff changes interacted with quartiles of supplier share (s_{ijht}) and buyer share (x_{ijht}). The first quartile serves as the omitted category. The estimated coefficients correspond to equation (D.1), where $\alpha_{s,q}$ and $\alpha_{x,q}$ capture the interaction of the tariff term with the qth quartile of supplier and buyer shares, respectively. The top panel includes product-year and exporting country-sector fixed effects. The bottom panel includes product-year, importer-year, and exporting country-year fixed effects. Bars indicate 95% confidence intervals. Source: FSRDC Project Number 2109 (CBDRB-FY25-P2109-R12520).

Additional Robustness: GE Controls and Price Definitions Table D.3 presents robustness checks using alternative price definitions and specifications. Columns (1)-(2) exclude the general equilibrium controls from our baseline model. Columns (3)-(4) use duty-exclusive prices that *include* charges, while Columns (5)-(6) use tariff-inclusive prices. In all cases, we interact tariff changes with lagged supplier and buyer shares, and hold fixed effects constant across specifications for comparability. Across all variations, pass-through estimates and their interaction effects with bilateral market shares remain stable in sign and magnitude, supporting the robustness of the main findings.

Table D.3: Additional Robustness: GE Controls and Price Definitions

Dependent variable:	$\ln p_{ijht}$ (excl. GE controls)		$\ln p^{c}_{ijht}$ (before duty, incl. charges)		$\ln p^{\text{duty}}_{ijht}$ (tariff inclusive)	
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta \ln(1+\tau_{cht})$	-0.060	-0.153	-0.032	-0.114	0.506	0.401
	(0.093)	(0.106)	(0.091)	(0.104)	(0.099)	(0.126)
$\Delta \ln(1+\tau_{cht}) \cdot s_{ijht-1}$	0.048	0.036	0.033	0.004	0.017	0.007
	(0.069)	(0.162)	(0.080)	(0.165)	(0.068)	(0.143)
$\Delta \ln(1+\tau_{cht}) \cdot x_{ijht-1}$	-0.399	-0.278	-0.407	-0.280	-0.421	-0.287
	(0.113)	(0.136)	(0.112)	(0.134)	(0.121)	(0.145)
$FE_{ht} + FE_{cs}$	Yes	No	Yes	No	Yes	No
$FE_{ht} + FE_{ct} + FE_{jt}$	No	Yes	No	Yes	No	Yes
Observations	249,000	249,000	249,000	249,000	249,000	249,000
R-squared	0.04	0.31	0.04	0.31	0.05	0.31

Notes: This table reports robustness checks on tariff pass-through specifications using alternative price definitions and control sets. Columns (1)–(2) exclude general equilibrium controls; Columns (3)–(4) use pre-duty prices including charges; and Columns (5)–(6) use tariff-inclusive prices. In each case, we report specifications using either baseline fixed effects ($FE_{ht} + FE_{cs}$) or a more stringent set of fixed effects ($FE_{ht} + FE_{ct} + FE_{jt}$). Standard errors are clustered at the HS8 product and exporter-country level. The number of observations is rounded to four significant digits in accordance with U.S. Census Bureau disclosure guidelines. Source: FSRDC Project Number 2109 (CBDRB-FY25-P2109-R12520).

D.3 Additional Results on Model Estimation

We assess the robustness of our structural estimates in Section 4.2. We first replicate the main GMM estimation using an expanded sample that includes all Broad Economic Categories (BECs), rather than excluding consumption goods as in the baseline. This extended product scope allows us to test whether our key parameter estimates, namely, returns to scale (θ) and relative bargaining power (ϕ), are sensitive to the exclusion of consumer-oriented products. As shown in Table D.4, the results remain fairly stable, suggesting that the baseline findings are not driven by product composition.

We then examine how sensitive the estimates are to alternative values of calibrated model parameters. First, we vary the elasticity of substitution across foreign varieties (ρ) by setting $\rho = 5$ instead of 10, which is consistent with the lower end of the estimates in the literature. Second, we relax the assumption of constant returns to scale for the importers and set $\varrho = 0.5$ instead of 1. We report the results in Table D.5. Column (1) shows the estimated values when setting $\rho = 5$, and Column (2) shows the estimated values when setting $\varrho = 0.5$. Furthermore, in Table D.5, we also estimate the parameters using an alternative sample constructed by utilizing the RPT indicator from LFTTD.[37] Columns (3) and (4) report the estimated values for this set of sample. Throughout these alternative setups,the resulting estimates remain robust, suggesting that the estimated values are not sensitive to particular values of other parameters or set of sample.

[37]See Section 3.3 for the discussion on selection through RPT indicators.

Table D.4: Estimated Model Primitives - All BEC Categories

Panel A: Calibrated Parameters		
$\hat{\nu}$	$\hat{\gamma}$	$\hat{\rho}$
4	0.5	10

Panel B: Estimated Parameters (GMM)	(1)	(2)	(3)	(4)
Rel. bargaining power: $\ln \widehat{\frac{\phi}{1-\phi}}$	1.162		0.558	
	(0.026)		(0.022)	
Returns to scale ($\hat{\theta}$)	0.505	0.573	0.432	0.586
	(0.003)	(0.005)	(0.004)	(0.005)
Constant		2.780		0.742
		(0.190)		(0.083)
Longevity		0.061		0.742
		(0.023)		(0.069)
Number of HS10 transactions		-0.240		-0.019
		(0.019)		(0.011)
Multiple HS10 dummy		0.080		0.190
		(0.026)		(0.025)
Lagged outside option		-0.188		-0.237
		(0.017)		(0.021)
None	Yes	Yes	No	No
$FE_h + FE_t + FE_j$	No	No	Yes	Yes
Observations		6,143,000		
Panel C: Implied Bargaining Powers ($\hat{\phi}$)				
Mean	0.762	0.896	0.636	0.848
	(0.005)	(0.068)	(0.005)	(0.112)
Median	–	0.913	–	0.878
	–	(0.068)	–	(0.112)

Notes: This table presents model estimates based on a sample that includes all Broad Economic Categories (BEC), including consumption goods, for the period 2001-2016. Panel A reports calibrated parameters: the elasticity of demand (ν), the elasticity of costs with respect to foreign input prices (γ), and the elasticity of substitution across foreign varieties (ρ). We set $\varrho = 1$, so that $\eta = 2.5$. Panel B presents GMM estimates. Columns (1) and (3) impose a constant ϕ across bilateral pairs, while Columns (2) and (4) estimate the full vector $\boldsymbol{\kappa}$ to allow for heterogeneity in bargaining power. Specifications differ in the inclusion of fixed effects. Controls include: (i) the log of relationship longevity between exporter i and importer j; (ii) the log of the number of transactions between i and j in a given year; (iii) the log of the relative outside option, defined as the ratio of exporter i's sales to other U.S. buyers (excluding j) over importer j's purchases from other suppliers (excluding i), both in year $t-1$; and (iv) a dummy variable equal to one if the i–j pair transacts in more than one HS10 product. Panel C reports the mean and median of the implied bargaining power. Standard errors are robust; those in Panel C are computed using the delta method. The set of instruments includes the number of exporters and importers at the HS10 level, as well as lagged bilateral shares (excluding the focal pair). The number of observations is rounded to four significant digits in accordance with U.S. Census Bureau disclosure guidelines. Source: FSRDC Project Number 2109 (CBDRB-FY25-P2109-R12520).

Table D.5: Robustness of Model Estimates

	$\rho = 5$	$\varrho = 0.5$	Related Party Trade LFTTD	
	(1)	(2)	(3)	(4)
Rel. bargaining power: $\ln \widehat{\frac{\phi}{1-\phi}}$	1.455	1.838	1.618	0.892
	(0.038)	(0.052)	(0.062)	(0.047)
Returns to scale (θ)	0.427	0.473	0.453	0.381
	(0.004)	(0.003)	(0.005)	(0.007)
Mean $\hat{\phi}$	0.811	0.863	0.835	0.709
	(0.006)	(0.006)	(0.009)	(0.010)
Median $\hat{\phi}$	0.811	0.863	0.835	0.709
	(0.000)	(0.000)	(0.000)	(0.000)
None	Yes	Yes	Yes	No
$FE_h + FE_t + FE_j$	No	No	No	Yes
Observations		3,120,000		

Notes: This table reports robustness checks for the main model estimates. The columns explore sensitivity to changes in key calibrated parameters and sample definitions. Column (1) varies the elasticity of substitution across foreign varieties (ρ); Column (2) changes the downstream returns to scale parameter (ϱ). Columns (3)–(4) use a sample based on related-party indicators from LFTTD (RPT), without and with fixed effects for buyer, product, and time. The number of observations is rounded to four significant digits in accordance with U.S. Census Bureau disclosure guidelines. Source: FSRDC Project Number 2109 (CBDRB-FY25-P2109-R12520).

D.4 Additional Results on Model Fit

Sensitivity to alternative parameter values. Table D.6 presents IV-based goodness-of-fit tests as in equation (4.5) for an alternative set of calibrated parameters of the model and two alternative sets of fixed effects. The results show that models incorporating bargaining and decreasing returns to scale (Columns (1) and (5)) have coefficients closer to one, indicating empirical alignment, consistent with the results in Figure 3.

Quantity responses and relationship heterogeneity: data vs. model. Table D.7 compares how quantities respond to tariffs in the data (Panel A) and in the model (Panel B). Columns (1) and (2) use baseline fixed effects; Columns (3) and (4) add more demanding fixed effects. Columns (2) and (4) include interactions with supplier and buyer shares.

The table shows that the model generates sizable average quantity declines and predicts heterogeneity across relationships. In contrast, the interaction terms with supplier and buyer shares for the quantity responses in the data are statistically imprecise, suggesting inconclusive evidence of heterogeneity in the data.

Testing the model-predicted quantity changes. Panel A in Table D.8 presents IV-based tests comparing observed quantity changes to those predicted by the model under alternative parameterizations. The model-predicted change in quantity is given by:

$$\widehat{\Delta \ln q_{ijht}} = -\varepsilon_{ijht} \widehat{\Delta \ln p_{ijht}},$$

where ε_{ijht} is the match-specific demand elasticity and $\widehat{\Delta \ln q_{ijht}}$ is as in equation (4.5). Although formal tests reject all models, the baseline model with bargaining and decreasing returns (Columns (1) and (2)) demonstrates the strongest fit, indicating that this specification best captures the underlying mechanisms of tariff-induced quantity adjustments.

Testing the model-predicted sales changes. Panel B in Table D.8 provides analogous IV-based tests for observed sales changes computed as:

$$\widehat{\Delta \ln r_{ijht}} = (1 - \varepsilon_{ijht}) \widehat{\Delta \ln p_{ijht}}.$$

The baseline specification (Columns (1) and (2)) shows superior alignment between predicted and observed sales, reinforcing the conclusion that the bargaining model with decreasing returns most effectively matches empirical patterns in the data.

Table D.6: IV-Based Goodness-of-Fit Test, Alternative Parameters

Panel A: Baseline Fixed Effects

Dependent variable:	$\Delta \ln p_{ijht}$							
	$\rho = 5$				$\varrho = 0.5$			
	Baseline	$\phi = 0$, $\theta = 1$	$\theta = 1$	$\phi = 0$	Baseline	$\phi = 0$, $\theta = 1$	$\theta = 1$	$\phi = 0$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta \widehat{\ln p_{ijht}}$	1.211	0.781	0.735	1.368	1.247	0.871	0.740	1.544
	(0.343)	(0.220)	(0.207)	(0.387)	(0.352)	(0.246)	(0.209)	(0.437)
$FE_{ht} + FE_{cs}$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Panel B: Stringent Fixed Effects

Dependent variable:	$\Delta \ln p_{ijht}$							
	Baseline	$\phi = 0$, $\theta = 1$	$\theta = 1$	$\phi = 0$	Baseline	$\phi = 0$, $\theta = 1$	$\theta = 1$	$\phi = 0$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta \widehat{\ln p_{ijht}}$	1.000	0.648	0.612	1.132	1.047	0.720	0.615	1.302
	(0.351)	(0.227)	(0.214)	(0.398)	(0.368)	(0.252)	(0.216)	(0.458)
$FE_{ht} + FE_{ct} + FE_{jt}$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	249,000							

Notes: Each column reports the coefficient from an IV regression of the observed change in log price on the corresponding model-predicted change $\Delta \widehat{\ln p_{ijht}}$, using statutory tariff changes as instruments. Columns (1)-(4) use predicted prices using a $\rho = 5$ instead of $\rho = 10$ as in the baseline. Columns (5)-(8) use predicted prices using a $\varrho = 0.5$ instead of $\varrho = 1$ as in the baseline. Notice that in each case, we re-estimate the calibrated parameters ϕ and θ, reported in Appendix D.3 In Panel A, all columns include product-time and country-sector fixed effects ($FE_{ht} + FE_{cs}$). In Panel B, all columns include product-time, country-time, and buyer-time fixed effects ($FE_{ht} + FE_{ct} + FE_{jt}$). Standard errors are clustered at the product and exporter-country level. The number of observations is rounded to four significant digits in accordance with U.S. Census Bureau disclosure guidelines. Source: FSRDC Project Number 2109 (CBDRB-FY25-P2109-R12520).

TABLE D.7: *Quantity* Responses and Relationship Heterogeneity: Data vs. Model

	Panel A: Data			
	(1)	(2)	(3)	(4)
$\Delta \ln(1+\tau_{cht})$	-0.568	0.006	-1.021	-0.761
	(0.249)	(0.331)	(0.185)	(0.237)
$\Delta \ln(1+\tau_{cht}) \cdot s_{ijht-1}$		-0.511		-0.278
		(0.323)		(0.276)
$\Delta \ln(1+\tau_{cht}) \cdot x_{ijht-1}$		-0.201		-0.130
		(0.229)		(0.242)
R-squared	0.06	0.10	0.32	0.36
	Panel B: Model			
	(1)	(2)	(3)	(4)
$\Delta \ln(1+\tau_{cht})$	-1.962	-3.967	-2.169	-3.984
	(0.080)	(0.201)	(0.108)	(0.230)
$\Delta \ln(1+\tau_{cht}) \cdot s_{ijht-1}$		2.441		2.420
		(0.409)		(0.551)
$\Delta \ln(1+\tau_{cht}) \cdot x_{ijht-1}$		2.993		3.270
		(0.229)		(0.316)
R-squared	0.28	0.38	0.44	0.51
$FE_{ht} + FE_{cs}$	Yes	Yes	No	No
$FE_{ht} + FE_{ct} + FE_{jt}$	No	No	Yes	Yes
Observations	249,000			

Notes: This table reports the pass-through of tariffs to quantities at the exporter–importer–product level. Panel A presents reduced-form estimates from the data. Panel B shows corresponding pass-through estimates generated by the model. Columns (2)–(4) interact tariff changes with lagged supplier share (s_{ijht-1}) and lagged buyer share (x_{ijht-1}). Columns (1) and (2) use baseline fixed effects ($FE_{ht} + FE_{cs}$), while Columns (3) and (4) employ a more stringent specification with product–year, country–year, and buyer–year fixed effects ($FE_{ht} + FE_{ct} + FE_{jt}$). Standard errors are clustered at the HS8 product and exporter-country level. Observation counts are rounded to four significant digits per U.S. Census Bureau disclosure guidelines. Source: FSRDC Project Number 2109 (CBDRB-FY25-P2109-R12520).

Table D.8: IV-Based Goodness-of-Fit Test for Quantities and Sales

Panel A: Quantities

Dependent Variable:	$\Delta \ln q_{ijht}$							
	Baseline		$\phi = 0$, $\theta = 1$		$\theta = 1$		$\phi = 0$	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta \widehat{\ln q_{ijht}}$	0.349	0.525	0.205	0.311	0.185	0.282	0.420	0.627
	(0.144)	(0.142)	(0.084)	(0.084)	(0.076)	(0.076)	(0.174)	(0.170)

Panel B: Sales

Dependent Variable:	$\Delta \ln(p_{ijht} \cdot q_{ijht})$							
	Baseline		$\phi = 0$, $\theta = 1$		$\theta = 1$		$\phi = 0$	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta \widehat{\ln(p \cdot q)}_{ijht}$	0.176	0.426	0.102	0.250	0.092	0.228	0.212	0.509
	(0.157)	(0.154)	(0.091)	(0.090)	(0.082)	(0.082)	(0.189)	(0.184)
$FE_{ht} + FE_{cs}$	Yes	No	Yes	No	Yes	No	Yes	No
$FE_{ht} + FE_{ct} + FE_{jt}$	No	Yes	No	Yes	No	Yes	No	Yes
Observations	249,000							

Notes: Each column reports the coefficient from an IV regression of the observed change in log quantity (Panel A) or log sales (Panel B) on the corresponding model-predicted change, using statutory tariff changes as instruments. Columns (1), (3), (5), and (7) include product–time and country–sector fixed effects ($FE_{ht} + FE_{cs}$), while Columns (2), (4), (6), and (8) include product–time, country–time, and buyer–time fixed effects ($FE_{ht} + FE_{ct} + FE_{jt}$). Standard errors are clustered at the HS8 product and exporter-country level. Observation counts are rounded to four significant digits per U.S. Census Bureau disclosure guidelines. Source: FSRDC Project Number 2109 (CBDRB-FY25-P2109-R12520).

D.5 Additional Pass-Through Results

D.5.1 Pass-Through Across Samples

Panel A and Panel B in Table D.9 evaluate how tariff pass-through estimates vary under different sample restrictions using baseline fixed effects (product–time, country–sector) and more stringent fixed effects (including buyer-time), respectively. For ease of exposition, the first two columns of Table D.9 replicate the numbers of Columns (1) and (3) of Table 5. These two columns show that the baseline sample yields a pass-through estimate of around 78-85%, closely matched by the model-implied prediction with no statistically significant difference. As the sample is progressively broadened–from including single-buyer matches (Column (3)), to adding related-party transactions, energy goods, and outliers (Column (4)), and finally to the most inclusive specification (Column (5))–estimated pass-through increases steadily, reaching up to 93-95%. This pattern underscores the sensitivity of reduced-form estimates to sample composition and the role of relationship filtering in uncovering pricing patterns consistent with bilateral bargaining.

Table D.9: Tariff Pass-Through Across Different Samples

Dependent variable: $\Delta \ln p_{ijht}$	Model	Baseline	+Suppliers w/ < 2 Buyers	+ Energy/ RPT/ Outliers	+ Final Goods
	(1)	(2)	(3)	(4)	(5)
Panel A: Baseline Fixed Effects					
$\Delta \ln(1+\tau_{cht})$	-0.248	-0.151	-0.168	-0.099	-0.066
	(0.008)	(0.093)	(0.035)	(0.050)	(0.043)
$FE_{ht} + FE_{cs}$	Yes	Yes	Yes	Yes	Yes
R-squared	0.32	0.04	0.02	0.02	0.02
Panel B: Stringent Fixed Effects					
$\Delta \ln(1+\tau_{cht})$	-0.249	-0.223	-0.171	-0.123	-0.047
	(0.010)	(0.109)	(0.039)	(0.059)	(0.042)
$FE_{ht} + FE_{ct} + FE_{jt}$	Yes	Yes	Yes	Yes	Yes
R-squared	0.50	0.31	0.18	0.14	0.13
Observations	249,000	249,000	732,000	945,000	1,768,000

Notes: This table reports tariff pass-through estimates to duty-exclusive prices at the exporter–importer–product level. Panel A uses baseline fixed effects: product–time and country–sector ($FE_{ht} + FE_{cs}$). Panel B uses a more stringent specification: product–time, country–time, and buyer–time ($FE_{ht} + FE_{ct} + FE_{jt}$). Column (1) uses the model-predicted price change as the dependent variable. Column (2) uses the observed price change in the baseline sample and is identical to Column (1) of Table 3. Column (3) adds relationships in which the supplier trades with only one U.S. importer. Column (4) further expands the sample to include relationships that are either related parties, involve energy commodities, or exhibit extreme price levels or changes. Column (5) incorporates consumption goods, thus encompassing all consecutive exporter-importer-product combinations. Standard errors are clustered at the HS8 product and country level. Observation counts are rounded per U.S. Census Bureau disclosure guidelines. Source: FSRDC Project Number 2109 (CBDRB-FY25-P2109-R12520).

D.5.2 Pass-Through Using Data Aggregated at the Product-Level

To complement our main analysis, we replicate a standard pass-through specification using data aggregated at the product-country-month level. We construct the data directly from the buyer–supplier–product triplets that form the basis of our firm-level regressions. While much of the literature analyzes monthly price and tariff changes at the product–country level, such approaches reflect both intensive and extensive margin adjustments, including changes in trading partners or the entry and exit of relationships. In contrast, our aggregation focuses exclusively on consecutive transactions between the same buyer and supplier for a given product. This setup isolates price responses within ongoing relationships, capturing what is arguably the most direct expression of tariff pass-through at the micro level.

Data We measure price changes at the HS10–country–month level, using the same subset of buyer–supplier–product links as in the baseline analysis. These are links with at least one transaction in both 2017 and 2018. For each product and country, we construct monthly prices by aggregating trade values and quantities. We then relate monthly price changes to changes in statutory tariffs, controlling for product-month, country-month, and country-sector fixed effects. Standard errors are clustered at the HS8–country level.

Models Table D.10, reports results separately for all products and for the subset that excludes consumption goods. Within each group, columns reflect increasingly selective samples. Columns (1) and (4) includes buyer–supplier–product pairs observed in two consecutive calendar years. The next specification, Columns (2) and (5), excludes consumption goods and applies additional filters: energy-sector goods are dropped; transactions with extreme price levels and price changes are excluded; and related-party trade is removed. The final sample, Columns (3) and (6), is restricted to suppliers trading with at least two U.S. buyers for the same product in consecutive years.

Results Across specifications, we find consistent evidence of incomplete tariff pass-through to U.S. import prices. As in our firm-level regressions, the degree of pass-through incompleteness increases as we move to more selective samples, particularly those that condition on firms with multiple trading partners over consecutive years. The estimated effects are generally larger in magnitude than at the match level, suggesting that relationship-level frictions may be amplified when observed in aggregated trade flows. While this exercise remains suggestive, it helps connect the mechanisms explored in the main analysis to pricing patterns in product-level data.

Table D.10: Tariff Pass-Through Using Data Aggregated at the Product-Level

Dependent Variable:	$\Delta \ln p_{cht}$					
	All Products			Excl. Consumption Goods		
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta \ln(1 + \tau_{cht})$	-0.115	-0.136	-0.321	-0.072	-0.119	-0.700
	(0.078)	(0.058)	(0.186)	(0.136)	(0.101)	(0.164)
Consecutive obs only	Yes	Yes	Yes	Yes	Yes	Yes
(-) Energy/RPT/Outliers	No	Yes	Yes	No	Yes	Yes
(-) Suppliers with <2 buyers	No	No	Yes	No	No	Yes
Observations	800,000	540,000	180,000	510,000	320,000	100,000
R-squared	0.13	0.14	0.22	0.13	0.14	0.22

Notes: This table reports regressions of month-over-month changes in log unit values (FOB, excluding charges) on corresponding changes in statutory tariffs ($\Delta\tau_{hct}$), measured at the HS10–country–month level. The data are aggregated from the firm-level sample used in our main analysis, retaining only buyer–supplier–product triplets with consecutive transactions. Columns (1)-(3) refer to all products; Columns (4)-(6) exclude consumption goods, based on the Broad Economic Categories (BEC) classification. Each column reflects a progressively more restricted sample: Columns (1) and (4) include all consecutive transactions; Columns (2) and (5) drop energy goods, extreme price levels and changes, and related-party trade; and Columns (3) and (6) restrict to suppliers with multiple buyers in consecutive years. All regressions include product–month, country–month, and country–sector fixed effects. Standard errors are clustered at the HS8–country level and reported in brackets. The number of observations is rounded to four significant digits in accordance with U.S. Census Bureau disclosure guidelines. Source: FSRDC Project Number 2109 (CBDRB-FY25-P2109-R12520).

D.5.3 Pass-Through Results Using LFTTD RPT Indicators

As a robustness check, we re-estimate the baseline specifications using the related-party transaction (RPT) indicator provided in the LFTTD. Table D.11 shows that the pass-through estimates remain stable, and the interaction effects with supplier and buyer shares are qualitatively similar to those reported in Table 3.

Table D.11: Pass-Through and Relationship Heterogeneity–Alternative Related Party Trade

Dependent variable:	$\Delta \ln p_{ijht}$			
	(1)	(2)	(3)	(4)
$\Delta \ln(1 + \tau_{cht})$	-0.163	-0.087	-0.304	-0.253
	(0.096)	(0.100)	(0.111)	(0.114)
$\Delta \ln(1 + \tau_{cht}) \cdot s_{ijht-1}$		0.043		0.011
		(0.070)		(0.174)
$\Delta \ln(1 + \tau_{cht}) \cdot x_{ijht-1}$		-0.374		-0.222
		(0.110)		(0.148)
$FE_{ht} + FE_{cs}$	Yes	Yes	No	No
$FE_{ht} + FE_{ct} + FE_{jt}$	No	No	Yes	Yes
Observations	249,000	249,000	249,000	249,000
R-squared	0.04	0.05	0.32	0.32

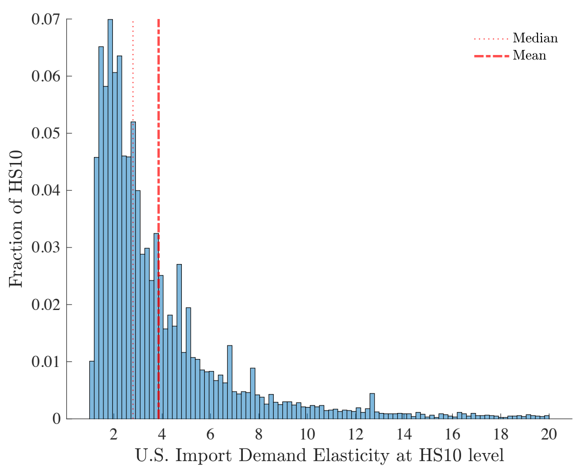
Notes: This table reports estimates of the pass-through of statutory tariffs, $\Delta \ln(1 + \tau_{cht})$, to duty-exclusive prices at the exporter–importer–product–year level, $\Delta \ln p_{ijht}$. Columns (2) and (4) include interactions between tariffs and lagged bilateral characteristics: supplier share (s_{ijht-1}), defined as supplier i's share in buyer j's imports of product h, and buyer share (x_{ijht-1}), defined as buyer j's share in supplier i's exports of product h. All regressions include the following controls: (i) $\ln \text{longevity}_{ijht}$, the number of years i and j have transacted in h; (ii) $\Delta \ln q_{i(-j)ht}$, exporter i's sales of h to U.S. buyers other than j; and (iii) $\Delta \ln p_{(-i)jht}$, the average price change charged by other suppliers of h to buyer j, using lagged shares as weights. Columns (1)–(2) include product–year and exporter country–sector fixed effects ($FE_{ht} + FE_{cs}$), while Columns (3)–(4) include a more demanding set of fixed effects: product–year, importer–year, and exporter country–year ($FE_{ht} + FE_{ct} + FE_{jt}$). Standard errors are clustered at the HS8 product and exporter-country level. Arm's length transactions are defined using LFTTD related party trade indicator. The number of observations is rounded to four significant digits in accordance with U.S. Census Bureau disclosure guidelines. Source: FSRDC Project Number 2109 (CBDRB-FY25-P2109-R12520).

E Estimation Appendix

E.1 Downstream Demand Elasticity (ν)

Consider a model where importer j sells its output q_j to downstream customers in different countries. A representative consumer in each country maximises utility by choosing a composite of domestic and imported goods. The sub-utility derived from the composite imported good will be given by a CES aggregation across imported varieties with a good-importer specific elasticity of substitution given by σ_g. Broda and Weinstein (2006) provide estimates of the elasticity σ_g at the HS10 good g-level in U.S. import data. The plot below shows the distribution of these elasticities. We base the calibration of the elasticity ν in our model on these estimates. We consider a value of 4 for ν, close to the mean value of 3.85, which we see as a conservative choice.

Figure E.1: Downstream Demand Elasticity



Notes: The figure displays the estimates of the import demand elasticity σ_g from Broda and Weinstein (2006). The mean and median value of σ_g^{US} is 3.85 and 2.8, respectively. Estimates are truncated above at 20, and below at 1.

E.2 Monte Carlo Simulation

Data for one replicate. Each exporter $i \in \{1, \ldots, 200\}$ belongs to a block with exactly two importers, labeled $j(i)$ and $\ell(i)$. Store the log-price difference

$$\Delta p_i = \ln p_{ij} - \ln p_{i\ell} \quad \text{and the pair } (j, \ell).$$

We set the marginal cost to 1 for all pairs for simplicity and use the parameters of $\varrho = 1, \nu = 4, \gamma = 0.5, \rho = 10$. $\phi^* = 0.827$ and $\theta^* = 0.454$. s_{ij} and x_{ij} are drawn from a $U[0,1]$ so that all shares within a block sum to 1. All Monte-Carlo exercises use 501 random replicas.

Joint estimation of ϕ and θ.

1. *Candidate markups.* For any $(\phi, \theta) \in (0,1) \times (0,1)$ compute the bilateral markup $\mu_{ij}(\phi, \theta)$ from the structural formula (2.6).

2. *Model-implied gap for exporter i:* $\Delta\mu_i(\phi, \theta) \;=\; \ln \mu_{ij}(\phi, \theta) \;-\; \ln \mu_{i\ell}(\phi, \theta)$.

3. *Non-linear least squares criterion.*

$$Q(\phi, \theta) \;=\; \sum_{i=1}^{200} \Big[\, \Delta p_i - \Delta\mu_i(\phi, \theta) \Big]^2.$$

4. *Estimation.* Minimize $Q(\phi, \theta)$ subject to the simple box constraints

$$0.01 \leq \phi \leq 0.99, \qquad 0.01 \leq \theta \leq 1.$$

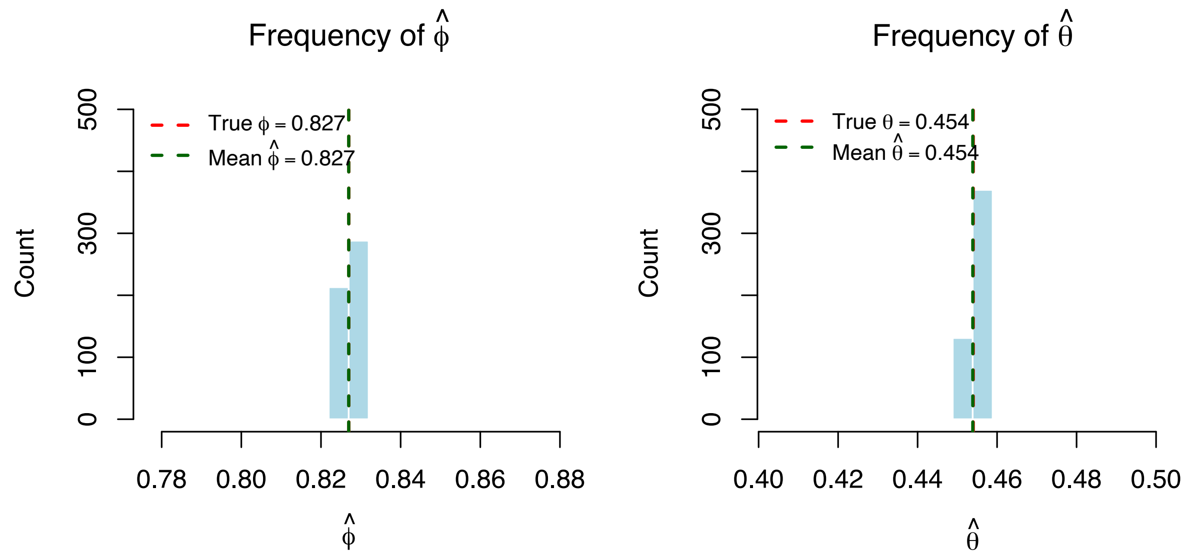
   We record the resulting estimates $\hat{\phi}, \hat{\theta}$ for each of the 500 Monte-Carlo replicates.

Results. Figure E.2 reports the frequencies for the jointly estimated (ϕ, θ) under the parameters noted above. The left panel refers to $\hat{\phi}$ and the right panel to $\hat{\theta}$. Similarly, Figure E.3 shows the analogous results for an alternative set of parameters of $\varrho = 1, \nu = 2.5, \gamma = 0.5, \rho = 5$. Across the figures, the true and average estimates are numerically close, and the distributions of the estimates are centered around the true parameters, showing that our estimator is *consistent*.

E.3 Estimation Under $\theta = 1$

In Section E.3.1, we first demonstrate that assuming $\theta = 1$ in the estimation leads to overestimating ϕ when the true parameters are $(\phi^*, \theta^*) \in (0,1)^2$. Further, in Section E.3.2, we show that using ϕ^* (instead of the overestimated ϕ) in the model validation exercise in Section 4.3 where θ is imposed to be 1 would yield an upper bound on the attainable correlation between model-predicted and observed price changes.

FIGURE E.2: Estimated (ϕ, θ) when $\varrho = 1, \nu = 4, \gamma = 0.5, \rho = 10$



E.3.1 Estimation Bias When Fixing $\theta = 1$ in the Estimation

In what follows, we maintain the following simplification assumptions. We assume $Cor(s_{ij}, x_{ij}) = 0$, mirroring the low correlation between the two bilateral shares (Table 1). We also impose marginal costs to be constant across firms, implying $p_{ij} = \mu_{ij}$ (can be relaxed by assuming a distribution for $\Delta k_{ij\ell}$). Finally, we assume that $\omega(\phi) = \phi$ to keep the notation clean. This assumption is without loss since ω is increasing in ϕ.

The objective function when jointly estimating ϕ and θ is:

$$\begin{aligned} \arg\min_{\phi,\theta} R(\phi,\theta) &= \mathbb{E}\big[p_{ij} - p_{i\ell} - \mu_{ij}(\phi,\theta) + \mu_{i\ell}(\phi,\theta)\big]^2 \\ &= \mathbb{E}\big[\Delta p_i - \Delta\mu_i(\phi,\theta)\big]^2 \end{aligned} \tag{E.1}$$

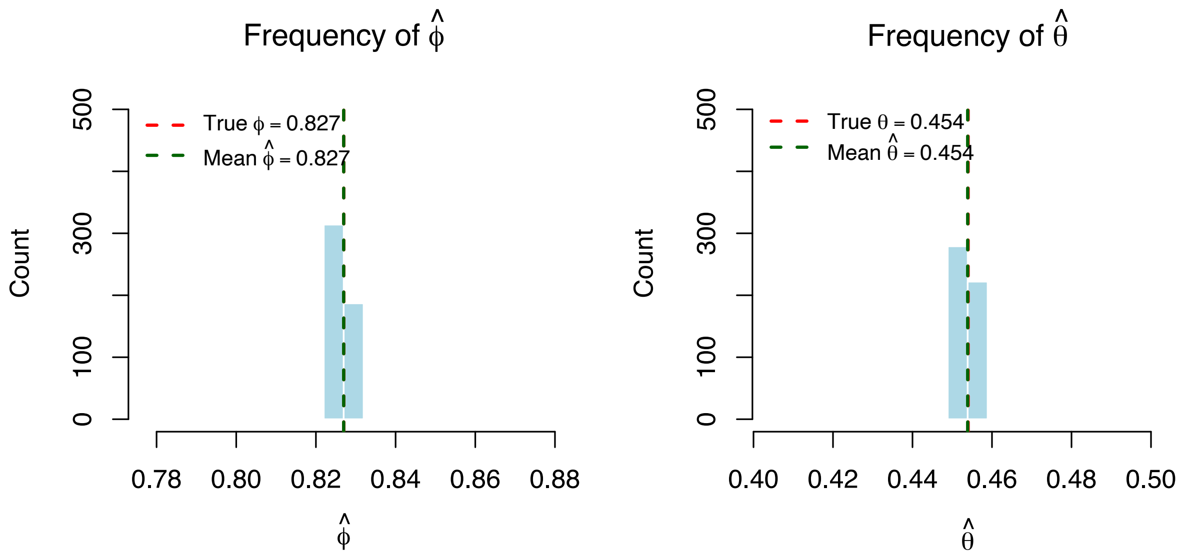
where j and ℓ are two importers to exporter i and we dropped the ln sign to simplify the notation. Under the full-rank condition, minimization of (E.1) leads to the estimation of the true parameters (θ^*, ϕ^*).

Now define $\tilde{R}(\phi) = R(\phi,\theta)|_{\theta=1}$. When fixing $\theta = 1$, the objective function (E.1) becomes:

$$\arg\min_{\phi} \tilde{R}(\phi) = \mathbb{E}\big[\Delta p_i - \Delta\mu_i(\phi;\theta = 1)\big]^2. \tag{E.2}$$

To study the bias, we can replace $p_{ij} = (1-\phi^*)\mu_{ij}^{oligopoly} + \phi^*\mu_{ij}^{oligopsony}(\theta^*)$ and rearrange

FIGURE E.3: Estimated (ϕ, θ) when $\varrho = 1, \nu = 2.5, \gamma = 0.5, \rho = 5$



equation (E.2) as follows:

$$\tilde{R}(\phi) = \mathbb{E}\left[(\phi - \phi^*)\left(\mu_{ij}^{oligopoly} - \mu_{i\ell}^{oligopoly}\right) + \phi^*\left(\mu_{ij}^{oligopsony}(\theta^*) - \mu_{i\ell}^{oligopsony}(\theta^*)\right)\right]^2,$$

where, in a slight abuse of notation, we denote the oligopsony markdown computed at the true θ^* as $\mu_{ij}^{oligopsony}(\theta^*)$ to distinguish it from the oligopsony markdown when $\theta = 1$, which is $\mu_{ij}^{oligopsony}(\theta = 1) = 1$.

We can use the price equation to transform this into a function of only prices (data) and $\mu^{oligopsony}(\theta^*)$:

$$\begin{aligned}
\tilde{R}(\phi) =& \mathbb{E}\Bigg[(\phi - \phi^*)\left(\frac{p_{ij} - \phi^*\mu_{ij}^{oligopsony}(\theta^*)}{1 - \phi^*} - \frac{p_{i\ell} - \phi^*\mu_{i\ell}^{oligopsony}(\theta^*)}{1 - \phi^*}\right) \\
& \qquad + \phi^*\left(\mu_{ij}^{oligopsony}(\theta^*) - \mu_{i\ell}^{oligopsony}(\theta^*)\right)\Bigg]^2 \\
=& \mathbb{E}\Bigg[\frac{\phi - \phi^*}{1 - \phi^*}(p_{ij} - p_{i\ell}) - \frac{\phi - \phi^*}{1 - \phi^*}\phi^*\left(\mu_{ij}^{oligopsony}(\theta^*) - \mu_{i\ell}^{oligopsony}(\theta^*)\right) \\
& \qquad + \phi^*\left(\mu_{ij}^{oligopsony}(\theta^*) - \mu_{i\ell}^{oligopsony}(\theta^*)\right)\Bigg]^2 \\
=& \frac{1}{(1 - \phi^*)^2}\mathbb{E}\left[(\phi - \phi^*)(p_{ij} - p_{i\ell}) + \left(\mu_{ij}^{oligopsony}(\theta^*) - \mu_{i\ell}^{oligopsony}(\theta^*)\right)\left((1 - \phi)\phi^*\right)\right]^2
\end{aligned}$$

$$= \frac{1}{(1-\phi^*)^2}\mathbb{E}\left[(\phi-\phi^*)\,\Delta p_i + \Delta\mu_i^{oligopsony}\Big((1-\phi)\,\phi^*\Big)\right]^2.$$

Notice that when $\phi = \phi^*$, the first term is zero, but the second term is not. The last equation above can be further rewritten as

$$\tilde{R}(\phi) = (\phi-\phi^*)^2 \cdot \left(\sigma_p^2 + \overline{\Delta p}^2\right) + \left((1-\phi)\cdot\phi^*\right)^2 \cdot \left(\sigma^2_{\Delta\mu^{oligopsony}} + \overline{\Delta\mu}^2_{oligopsony}\right)$$
$$+ 2\,(\phi-\phi^*)\cdot(1-\phi)\cdot\phi^*\cdot\left(\text{Corr}\left(\Delta p_i, \Delta\mu_i^{oligopsony}\right)\cdot\sigma_p\cdot\sigma_{\Delta\mu^{oligopsony}} + \overline{\Delta p}\cdot\overline{\Delta\mu}_{oligopsony}\right), \tag{E.3}$$

where we denote the standard deviation and average of variable z by σ_z and $\overline{z}$ respectively.

Taking derivative with respect to ϕ and setting it equal to zero yields:

$$\phi = \frac{A\cdot\phi^* + B\cdot(\phi^*)^2 - \phi^*\cdot C\cdot(1+\phi^*)}{A + B\cdot(\phi^*)^2 - 2\cdot\phi^* C} = \phi^*\cdot\underbrace{\frac{A + B\cdot\phi^* - C\cdot(1+\phi^*)}{A + B\cdot(\phi^*)^2 - 2\cdot\phi^* C}}_{>1} > \phi^*$$

where $A = \sigma_p^2 + \overline{\Delta p}^2 > 0$, $B = \sigma^2_{\mu^{oligopsony}} + \overline{\Delta\mu}^2_{oligopsony} > 0$, $C = \text{Corr}\left(\Delta p_i, \Delta\mu_i^{oligopsony}\right)\cdot \sigma_p\cdot\sigma_{\mu^{oligopsony}} + \overline{\Delta p}\cdot\overline{\Delta\mu}_{oligopsony} > 0$.

Therefore, the objective (E.2) would estimate $\phi > \phi^*$ when setting $\theta = 1$. This argument can be extended to heterogeneous marginal costs across pairs. In that case, we would replace $\Delta\mu_i$ for Δp_i.

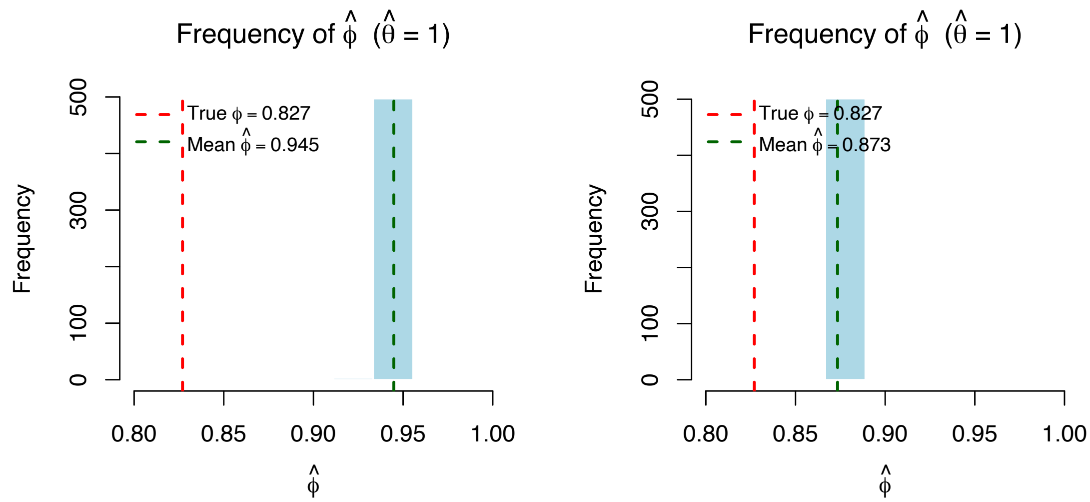
Simulation We repeat the simulations from Appendix E.2, now estimating only ϕ (with θ fixed at 1). We draw $s_{ij} \sim U[0,1]$, injecting enough within-exporter variation to identify ϕ from differences in markups. If s_{ij} varies very little for exporter i, then $\ln\mu(s_{ij},\phi) - \ln\mu(s_{i\ell},\phi) \approx 0$, so ϕ cannot be identified as the markup difference cancels out in the moment (4.1).

Panel (A) of Figure E.4 maintains 2 importers and exporters in each market, showing a large bias. In Panel (B) of Figure E.4, we increase the number of buyers and suppliers to create more cross-sectional variation. The figure confirms our argument above: The estimated value of ϕ is larger than the true ϕ^* when the estimation imposes $\theta = 1$.

E.3.2 Correlation between Pass-Through and Price Changes

In the previous section we proved that the estimated ϕ is necessarily larger than the true value of ϕ^*, when one imposes $\theta = 1$ in the estimation. In the exercise of Section 4.3, we do

Figure E.4: Estimation of the parameter ϕ while fixing $\theta = 1$



(a) 2 importers and exporters (b) 10 importers and exporters

Notes: In each similuation there are either 2 (Panel a) or 10 (Panel b) buyers and suppliers in each market. There are 100 markets. 501 simulations. We set $\varrho = 1, \nu = 4, \gamma = 0.5, \rho = 10$ and compute ϕ by minimum distance.

not re-estimate ϕ and use ϕ^* when testing the model under $\theta = 1$.

In this section, we show that the coefficients reported for $\theta - 1$ of Figure 3 are *upper bounds* on the attainable correlations between predicted and observed price changes.

In what follows, we drop ln and subscripts to simplify the notation. Call the re-estimated ϕ when setting $\theta = 1$ as ϕ^R. Then, combining equations (4.5) and (4.4) in Section 4.3, the pass-through regression for this model is

$$\Delta p \;=\; \beta^R \cdot \Phi^R \cdot \Delta T \;+\; u^R, \tag{E.4}$$

where we denoted $\Phi^R = \Phi(s, x; \phi^R, \theta = 1)$.[38] We also assume that the residual is independent from $\Phi^R \cdot \Delta T$.

From Appendix E.3.1, setting $\theta = 1$ and re-estimating ϕ, we would find $\phi^R > \phi^*$, so that

$$\tilde{\Phi} \;=\; \Phi(s, x; \phi^*, 1) \;<\; \Phi(s, x; \phi^R, 1) \;=\; \Phi^R,$$

since the pass-through increases in ϕ.

[38] We disregard the fixed effects and consider each variable as demeaned for simplicity.

Using $\tilde{\Phi}$ as an independent variable instead of Φ^R in the OLS regression (E.4),

$$\Delta p = \tilde{\beta} \cdot \tilde{\Phi} \cdot \Delta T + \tilde{u}$$

yields the following estimated coefficient:

$$\tilde{\beta} = \frac{\mathrm{Cov}(\tilde{\Phi}\,\Delta T,\ \Delta p)}{\mathrm{Var}(\tilde{\Phi}\,\Delta T)} = \beta^R \frac{\mathrm{Cov}(\tilde{\Phi}\,\Delta T,\ \Phi^R\,\Delta T + u^R)}{\mathrm{Var}(\tilde{\Phi}\,\Delta T)}.$$

From independence of ΔT from Φ^R and $\tilde{\Phi}$ we know that

$$\mathrm{Cov}(\tilde{\Phi}\,\Delta T,\ \Phi^R\,\Delta T) = \mathrm{Var}(\tilde{\Phi}\,\Delta T) + \mathrm{Cov}(\Phi^R, \tilde{\Phi}) \cdot \mathrm{Var}(\Delta T),$$

which implies

$$\frac{\mathrm{Cov}(\tilde{\Phi}\,\Delta T,\ \Phi^R\,\Delta T)}{\mathrm{Var}(\tilde{\Phi}\,\Delta T)} = 1 + \frac{\mathrm{Cov}(\Phi^R, \tilde{\Phi}) \cdot \mathrm{Var}(\Delta T)}{\mathrm{Var}(\tilde{\Phi}\,\Delta T)} > 1$$

since $\mathrm{Cov}(\Phi^R, \tilde{\Phi}) > 0$ and $\mathrm{Var}(\cdot) > 0$. Hence,

$$\tilde{\beta} = \beta^R \cdot \left(1 + \frac{\mathrm{Cov}(\Phi^R, \tilde{\Phi})\ \mathrm{Var}(\Delta T)}{\mathrm{Var}(\tilde{\Phi}\,\Delta T)}\right) > \beta^R.$$

Thus, since $\tilde{\beta}$, estimated with ϕ^* and $\theta = 1$, exceeds the pass-through coefficient β^R that would be obtained by re-estimating with $\phi = \phi^R$ and $\theta = 1$ (i.e. $\tilde{\beta} > \beta^R$), $\tilde{\beta}$ constitutes an upper bound on the pass-through coefficient in equation (E.4). Consequently, the estimates for $\theta - 1$ of Figure 3—obtained under $\phi = \phi^*$ and $\theta = 1$ via the pass-through formula—can be interpreted as *upper bounds* on the coefficients one would recover by re-estimating with $\phi = \phi^R$ at $\theta = 1$.