Relationship Specificity, Market Thickness and International Trade

— Keio University —

Tomohiro Ara and Taiji Furusawa

Fukushima Univ & Univ of Tokyo

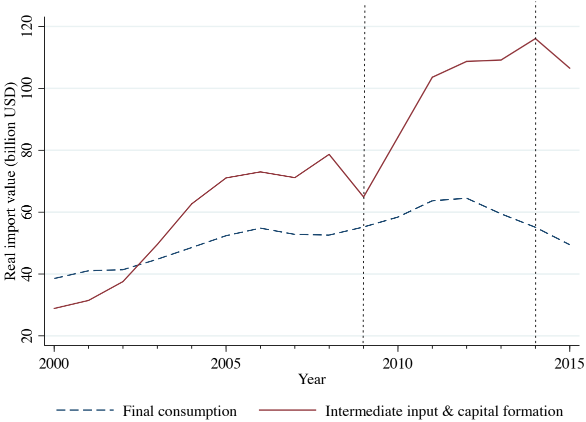
January 16, 2020

Motivation

- Intermediate inputs have a large and growing share of international trade relative to final goods:
  - "Offshoring"
  - "Outsourcing"
  - "Vertical specialization"
  - "Fragmentation of production processes"

- Issues to be addressed:
  - Vertical linkages between upstream and downstream sectors
  - Welfare gains from trade associated with vertical linkages

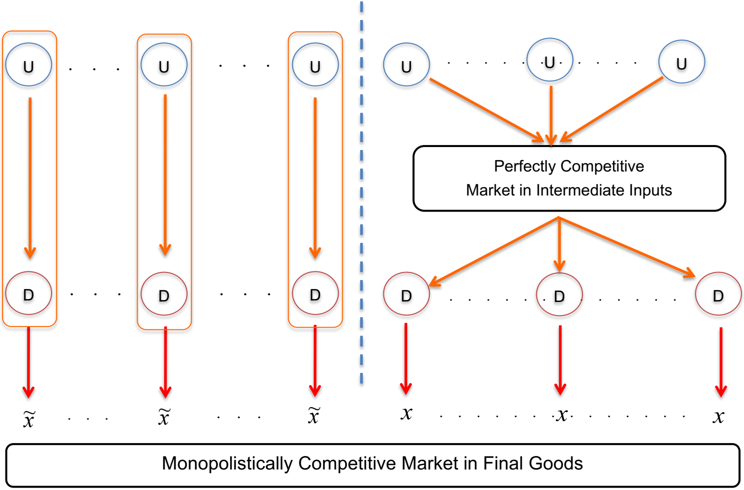
Motivation (cont.)



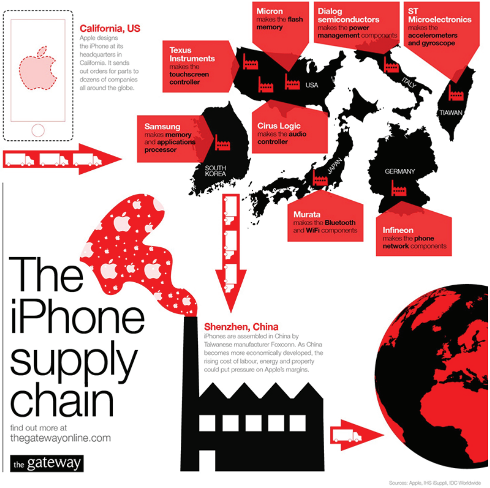
Japan's imports from China in 2000–2015

Source: Ito (2018)

Two types of input transactions



Example: smartphones



Non-market transaction

Example: smartphones (cont.)

Online Marketplace | Trade Shows | Smart Sourcing | Other Services

global sources
Reliable exporters: find them and meet them

Products | Enter English keyword to search products

Path: All Categories >> Mobile Electronics >> Mobile Phone Accessories & Parts >> Mobile Phone Parts >> Mobile phone LCDs – Update me on new products

Smartphone parts LCD screen module for Moto E3

US$ 9.5 / Piece Get Freight Cost

50 Pieces Minimum Order

1 - 3 days Lead Time

Small Orders: Accepted

Sample Price (USD): $15.00 Request Sample

Inquire Now

Request Latest Price | Add to Basket

Market transaction (reference priced)

Market thickness

- Three ways for input procurement (Rauch, 1999; Nunn, 2007):
  - Sold on an organized exchange
  - Reference priced
  - Neither

Input customization measure

Sector	Proportion of inputs procured by "neither"
Automobile & light truck manuf.	0.980
Heavy duty truck manuf.	0.977
Electronic computer manuf.	0.956
...	...
Petroleum refineries	0.036
Flour milling	0.024
Poultry processing	0.024

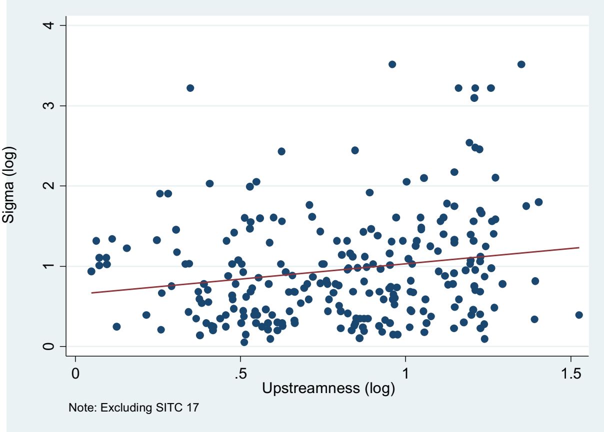
Source: Nunn (2007)

Welfare gains from trade

- Sources of welfare gains:
  - Resource reallocations from unmatched firms to matched firms
  - Market restructure in vertical linkages

- Empirically testable prediction:
  - Trade liberalization increases the proportion of inputs procured by non-market transactions

Is the input market more competitive?



Note: Upstreamness from Antràs et al. (2012)

Elasticity of substitution from Broda and Weinstein (2006)

Outline

- Baseline model
- Closed-economy equilibrium:
  - Cross-industry variations between two transactions
- Open-economy equilibrium:
  - Welfare gains from improvement in matching environments
  - Country asymmetry in size
- Summary

Model

- Preferences:

$$U = \prod_{j=1}^{J} X_j^{\delta_j}, \quad \sum_{j}^{J} \delta_j = 1, \ \delta_j > 0$$

where

$$X_j = \left[\int_{\omega \in \Omega_j} \alpha_j(\omega)^{\frac{1}{\sigma_j}} x_j(\omega)^{\frac{\sigma_j - 1}{\sigma_j}} d\omega \right]^{\frac{\sigma_j}{\sigma_j - 1}}, \quad \sigma_j > 1$$

- Demand in industry j:

$$x_j(\omega) = E_j P_j^{\sigma_j - 1} \alpha_j(\omega) p_j(\omega)^{-\sigma_j}$$

Model (cont.)

- Production:

	Unmatched	Matched
Input type	Generic	Customized
Input quality	$\alpha = 1$	$\alpha \in [\alpha_{\text{min}}, \infty)$
Input transaction	Competitive market	Within pairs
U's profit	$\pi^U = 0$	$\pi^U(\alpha)$
D's profit	π^D	$\pi^D(\alpha)$
Joint profit	$\pi = \pi^D$	$\pi(\alpha) = \pi^D(\alpha) + \pi^U(\alpha)$

  - α is randomly drawn from $G(\alpha) = 1 - \left(\frac{\alpha_{\text{min}}}{\alpha}\right)^{\gamma}$ where $\alpha_{\text{min}} > 1$
  - c is common between matched and unmatched firms

Model (cont.)

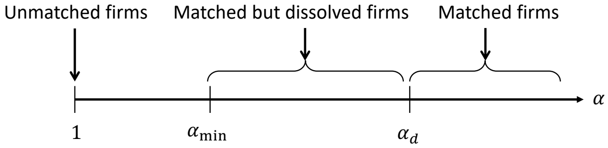
- Optimal profits:

$$\pi(\alpha) = \frac{E\alpha}{\sigma}\left(\frac{\frac{\sigma c}{\sigma-1}}{P}\right)^{1-\sigma}, \quad \pi = \frac{E}{\sigma}\left(\frac{\frac{\sigma c}{\sigma-1}}{P}\right)^{1-\sigma} \quad \Longrightarrow \quad \frac{\pi(\alpha)}{\pi} = \alpha$$

- Cutoff quality:

$$\pi(\alpha_d) - k = \pi \quad \Longrightarrow \quad \alpha_d = \frac{\pi + k}{\pi}$$

Model (cont.)



Sorting by product quality

Model (cont.)

- Average quality of matched firms:

$$\tilde{\alpha}_d = \int_{\alpha_d}^{\infty} \alpha \frac{dG(\alpha)}{1 - G(\alpha_d)} = \frac{\gamma}{\gamma - 1} \left(\frac{\pi + k}{\pi} \right)$$

- Average profit of matched firms:

$$\tilde{\pi} = \int_{\alpha_d}^{\infty} \pi(\alpha) \frac{dG(\alpha)}{1 - G(\alpha_d)} = \frac{\gamma}{\gamma - 1} (\pi + k)$$

Model (cont.)

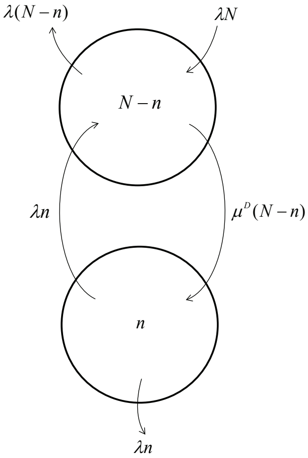
- Search technology $\nu(M-n, N-n)$:
  - CRS in matching
  - $\nu(\lambda a, \lambda b) = \lambda \nu(a, b)$
- Probabilities of a match:

$$\check{\mu}^D = \frac{\nu(M-n, N-n)}{N-n} = \nu\left(\frac{M-n}{N-n}, 1\right) \equiv s(z)$$
$$\check{\mu}^U = \frac{\nu(M-n, N-n)}{M-n} = \nu\left(1, \frac{N-n}{M-n}\right) = \frac{s(z)}{z}$$

where $z \equiv (M-n)/(N-n)$

  - $z \uparrow \Rightarrow \; \check{\mu}^D = s(z) \uparrow$
  - $z \uparrow \Rightarrow \; \check{\mu}^U = s(z)/z \downarrow$

Model (cont.)



- Search process (in steady state):

$$2\lambda n = \mu^U(M-n)$$

$$\underbrace{2\lambda n}_{\#\text{ of breakdown pairs}} = \underbrace{\mu^D(N-n)}_{\#\text{ of newly matched pairs}}$$

where

  - λ: hazard rate of bankrupt
  - $\mu^D \equiv [1-G(\alpha_d)]\check{\mu}^D$
  - $\mu^U \equiv [1-G(\alpha_d)]\check{\mu}^U$

Closed-economy equilibrium

- No-arbitrage conditions:
  - Downstream firms

$$r\tilde{V}^D = \tilde{\pi}^D - \lambda\left(\tilde{V}^D - V^D\right) - \lambda\tilde{V}^D + \dot{\tilde{V}}^D$$

$$rV^D = \pi + \mu^D\left(\tilde{V}^D - V^D\right) - \lambda V^D + \dot{V}^D$$

  - Upstream firms

$$r\tilde{V}^U = \tilde{\pi}^U - \lambda\left(\tilde{V}^U - V^U\right) - \lambda\tilde{V}^U + \dot{\tilde{V}}^U$$

$$rV^U = \mu^U\left(\tilde{V}^U - K - V^U\right) - \lambda V^U + \dot{V}^U$$

where K is a one-time relationship-specific investment

Closed-economy equilibrium (cont.)

- Assuming that $r = 0$ and setting $\dot{\tilde{V}}^D = \dot{V}^D = \dot{\tilde{V}}^U = \dot{V}^U = 0$:
  - Downstream firms

$$\tilde{V}^D = \left(\frac{\lambda + \mu^D}{2\lambda + \mu^D}\right)\frac{\tilde{\pi}^D}{\lambda} + \left(\frac{\lambda}{2\lambda + \mu^D}\right)\frac{\pi}{\lambda}$$
$$V^D = \left(\frac{\mu^D}{2\lambda + \mu^D}\right)\frac{\tilde{\pi}^D}{\lambda} + \left(\frac{2\lambda}{2\lambda + \mu^D}\right)\frac{\pi}{\lambda}$$

  - Upstream firms

$$\tilde{V}^U - K = \left(\frac{\lambda + \mu^U}{2\lambda + \mu^U}\right)\left(\frac{\tilde{\pi}^U}{\lambda} - 2K\right)$$
$$V^U = \left(\frac{\mu^U}{2\lambda + \mu^U}\right)\left(\frac{\tilde{\pi}^U}{\lambda} - 2K\right)$$

Closed-economy equilibrium (cont.)

- Bargaining in matched pairs:

$$\left(\tilde{\pi}^D, \tilde{\pi}^U\right) = \arg \max_{\tilde{\pi}^{D'}, \tilde{\pi}^{U'}} \left(\tilde{V}^{D'} - V^D\right)\left(\tilde{V}^{U'} - K - V^U\right)$$
$$\text{s.t.} \quad \tilde{\pi}^{D'} + \tilde{\pi}^{U'} = \tilde{\pi}$$

- FOCs:

$$\frac{\tilde{\pi}^D}{\lambda} - \frac{\pi}{\lambda} = \beta\left(\frac{\tilde{\pi}}{\lambda} - \frac{\pi}{\lambda} - 2K\right)$$
$$\frac{\tilde{\pi}^U}{\lambda} - 2K = (1-\beta)\left(\frac{\tilde{\pi}}{\lambda} - \frac{\pi}{\lambda} - 2K\right)$$

where $\beta \equiv \frac{\mu^D + 2\lambda}{\mu^D + \mu^U + 4\lambda}$

Closed-economy equilibrium (cont.)

- FE conditions:

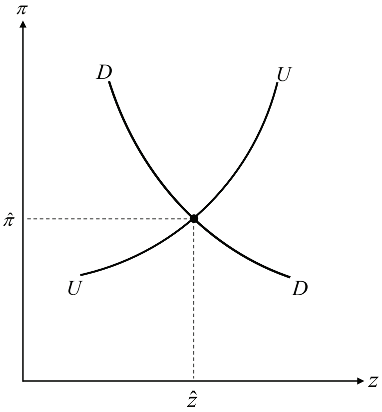
$$V^D = F^D, \quad V^U = F^U$$

which can be written as

$$\pi + \frac{n}{N}\beta\left(\tilde{\pi} - \pi - k\right) = f^D$$
$$\frac{n}{M}(1-\beta)\left(\tilde{\pi} - \pi - k\right) = f^U$$

where $f^D \equiv \lambda F^D$, $f^U \equiv \lambda F^U$, $k \equiv 2\lambda K$

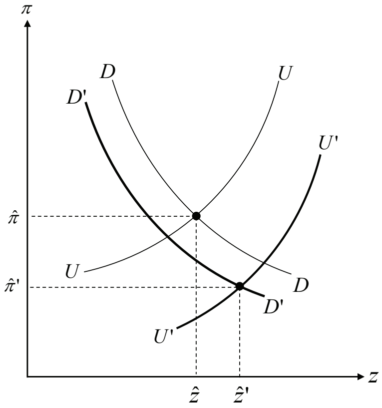
Closed-economy equilibrium (cont.)



$z = (M - n)/(N - n)$

- Unique equilibrium $\{\hat{z}, \hat{\pi}\}$:
  - *DD* curve
    $z \uparrow \Rightarrow \ \mu^D = s(z) \uparrow \Rightarrow \ \pi \downarrow$
  - *UU* curve
    $z \uparrow \Rightarrow \ \mu^U = s(z)/z \downarrow \Rightarrow \ \pi \uparrow$
  - Other endogenous variables $(M, N, n, \alpha_d, \tilde{\alpha}_d, \tilde{\pi})$ can be written as a function of $\{\hat{z}, \hat{\pi}\}$

Closed-economy equilibrium (cont.)



- Industries with $\gamma' < \gamma$:

$$\hat{z}' > \hat{z}, \quad \hat{\pi}' < \hat{\pi}$$

- Intuition:
  - An industry with lower γ has a larger rent

$$\tilde{\pi} - \pi - k = \frac{\pi + k}{\gamma - 1}$$

  - From the FE conditions,

$$\hat{\pi} = f^D - f^U \hat{z}$$

Closed-economy equilibrium (cont.)

Proposition 1

The greater the dispersion of product quality (lower γ) of the industry, the smaller the market transaction

- The market thickness is given by

$$\frac{(N-n)px}{n\tilde{p}\tilde{x}} = \frac{2\lambda}{s(\hat{z})\tilde{\alpha}_d}$$

where

$$\gamma \downarrow \implies \begin{cases} \hat{z} \uparrow \\ \hat{\pi} \downarrow \end{cases} \implies \begin{cases} s(\hat{z}) \uparrow \\ \tilde{\alpha}_d \uparrow \end{cases}$$

Open-economy equilibrium

- Suppose:
  - Two symmetric countries start costly trade
  - Trade costs allow only matched firms to export final goods
  - Firms can search for partners from a foreign country and import inputs

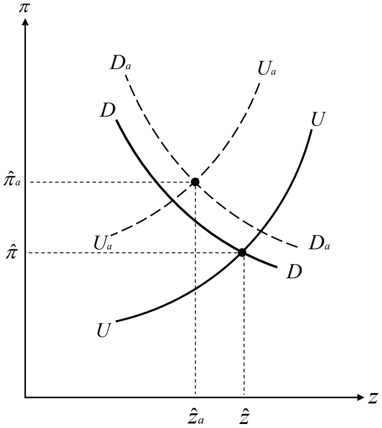
- FE conditions:

$$\pi + \frac{n}{N}\beta(\tilde{\pi} - \pi - k - \chi f_x) + \frac{n^*}{N}\beta(\tilde{\pi}^* - \pi - k - \chi^* f_x) = f^D$$

$$\frac{n}{M}(1-\beta)(\tilde{\pi} - \pi - k - \chi f_x) + \frac{n^*}{M}(1-\beta)(\tilde{\pi}^* - \pi - k - \chi^* f_x) = f^U$$

where χ is a proportion of exporting firms

Open-economy equilibrium (cont.)



- Intuition:
  - Export/import opportunity contributes to greater rents to matched pairs
- Impact of trade:

$$\begin{cases} \hat{z} > \hat{z}_a \\ \hat{\pi} < \hat{\pi}_a \end{cases}$$

Open-economy equilibrium (cont.)

Proposition 2

Social welfare is higher in the open economy than in the closed economy due to:

- *Profit reallocations from unmatched firms to matched firms*

$$\frac{\tilde{\pi}}{\pi} = \frac{\tilde{\pi}^*}{\pi} > \frac{\tilde{\pi}_a}{\pi_a}$$

- *Increase in average product quality*

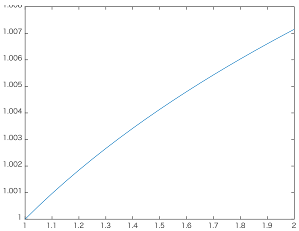
$$\tilde{\alpha}_d > \tilde{\alpha}_{da}$$

- *Increase in high-quality varieties*

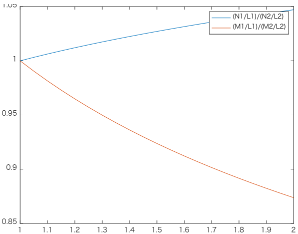
$$s(\hat{z}) > s(\hat{z}_a)$$

Country asymmetry: $L_1/L_2 \uparrow$

- Impact of country size:
  - Home market effect on wages and production patterns
  - Agglomeration of final-good (intermediate-input) production in country 1 (country 2)

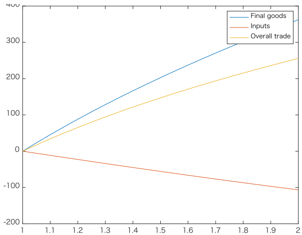


Relative wage (w_1/w_2)



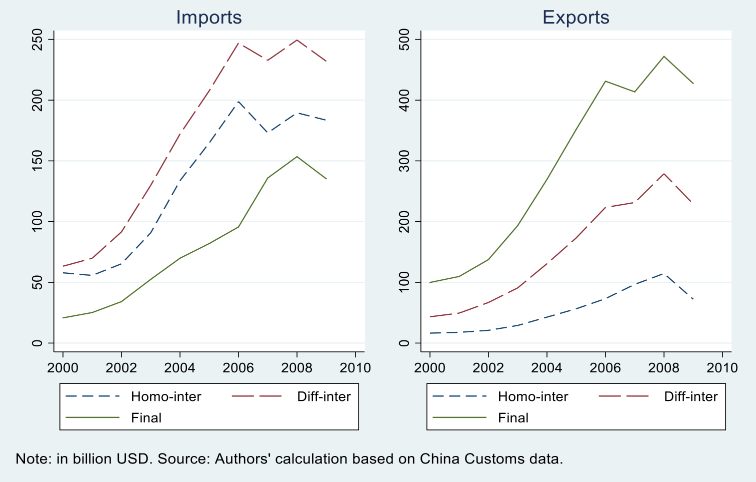
Ratio of firms (adjusted by size)

$$\frac{N_1}{N_2} > \frac{L_1}{L_2}, \quad \frac{M_1}{M_2} < \frac{L_1}{L_2}$$



Country 1's trade balance

Country asymmetry: $L_1/L_2 \uparrow$ (cont.)



China's trade in 2000-2009

Conclusion

- Main findings:
  - The higher the input customization, the greater non-market transactions
  - Trade liberalization improves matching environments in vertical linkages
- Future work:
  - Multi-country model with some empirical evidence
  - International agglomeration in vertical linkages