

The Extensive Margin of Intrafirm Trade

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Motivation

- Antràs (2003) was the first to document that there are distinct patterns in the data on the share of U.S. imports that are intrafirm.

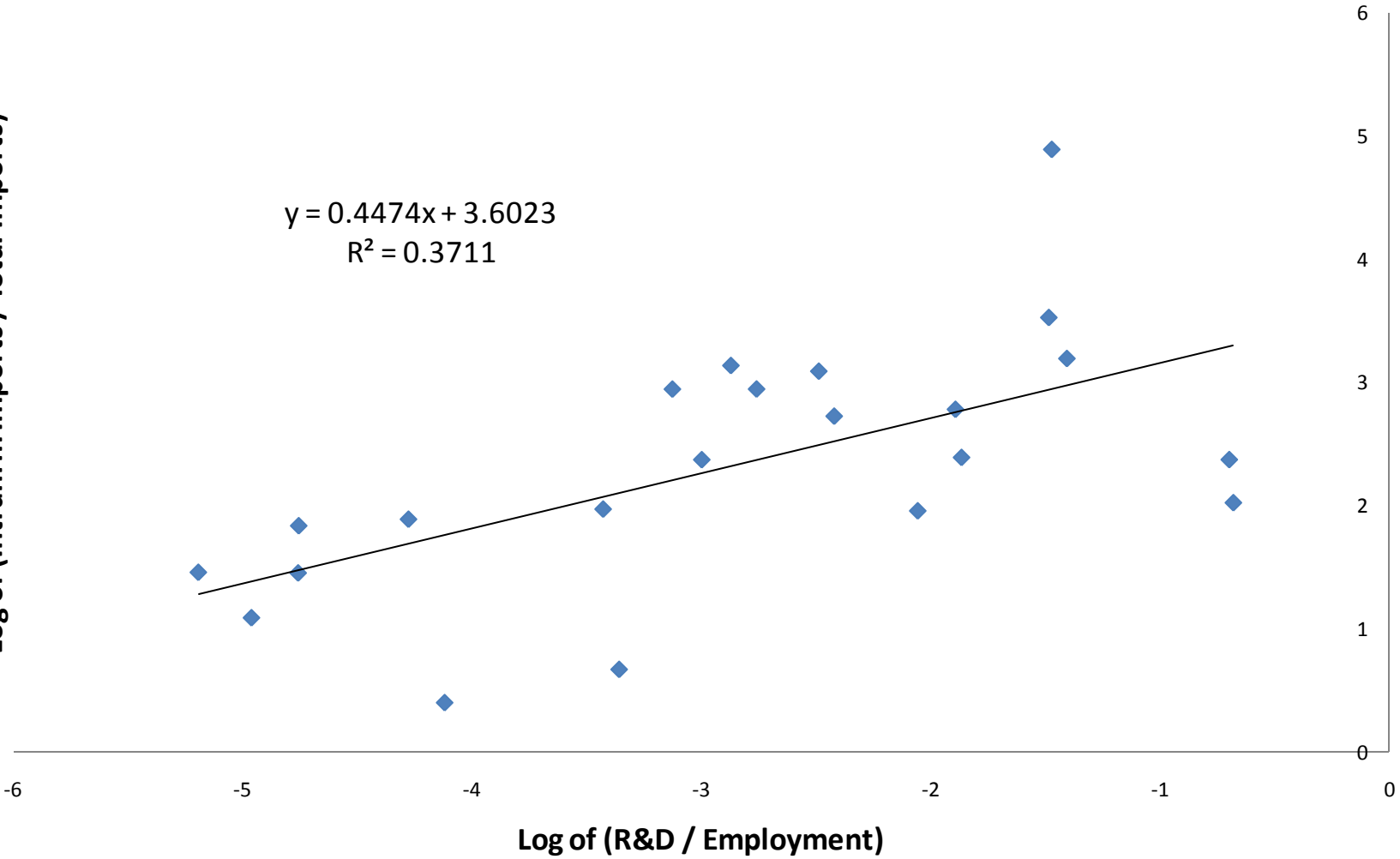
Motivation

- Fact: In a cross-section of 22 manufacturing industries, intrafirm imports as % share of total U.S. imports is found to be larger, the higher the R&D intensity of the industry.
- For Example:
 - ▶ Chemical MNC import products from affiliated foreign plants, whereas textile or agricultural machinery MNC import from independent foreign plants.

Share of Intrafirm U.S. Imports & Relative HQ Intensity

Log of (Intrafirm Imports / Total Imports)

$$y = 0.4474x + 3.6023$$
$$R^2 = 0.3711$$



Motivation

- This paper breaks up total intrafirm imports into two parts,

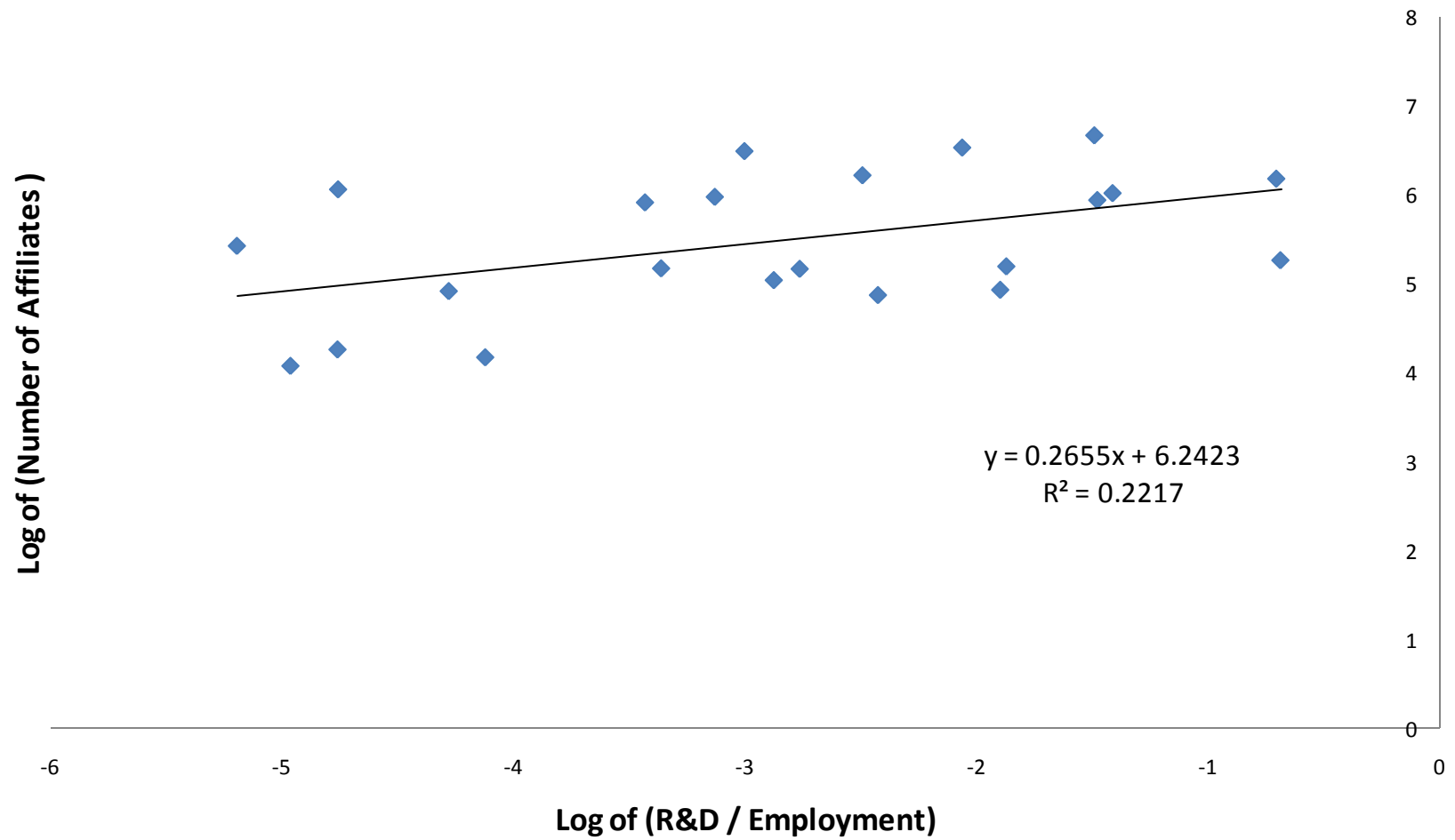
$$\text{Intrafirm Imports} = \text{Number of Foreign Affiliates} \\ \times \text{Average Imports per Affiliate.}$$

- I find that the number matters more.

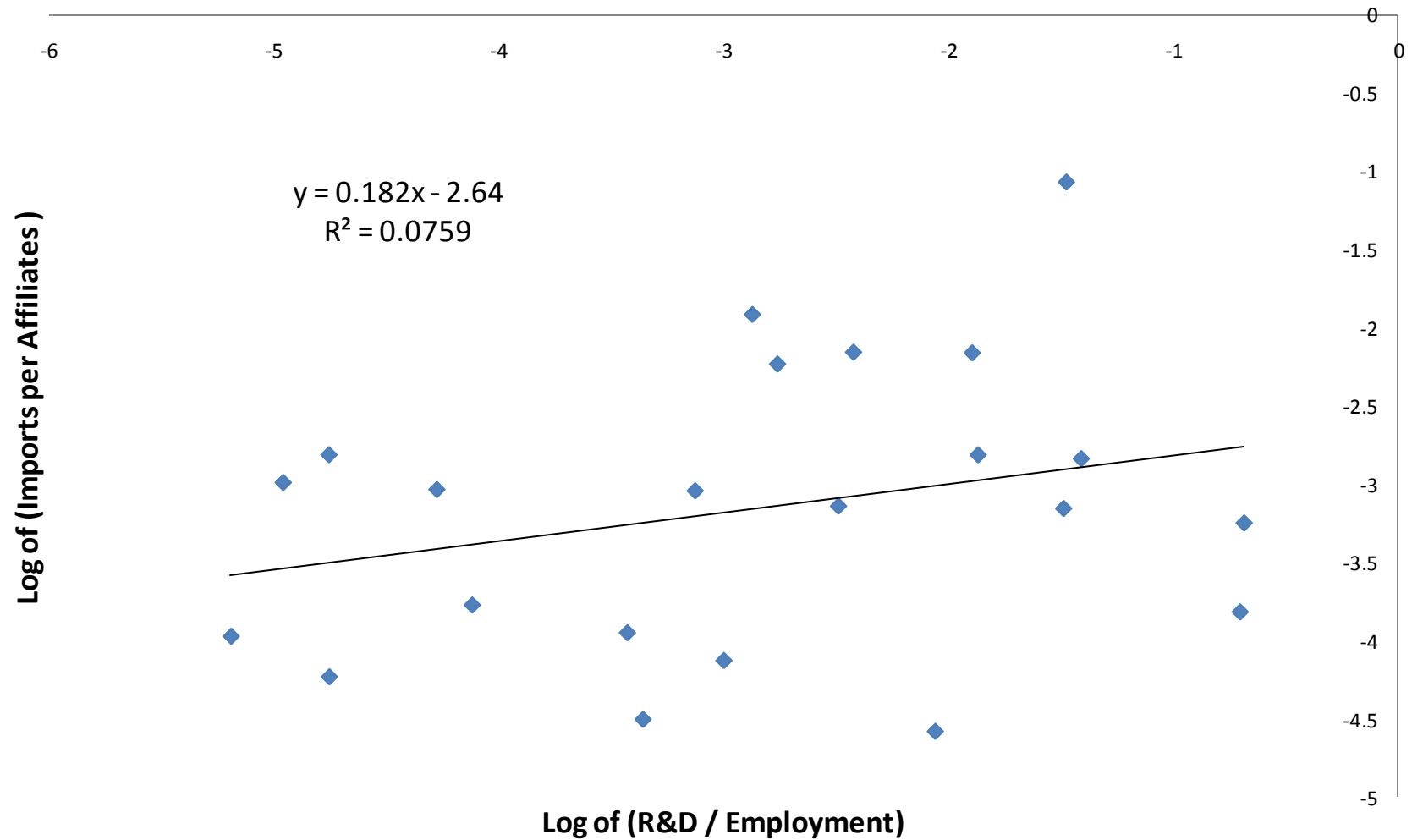
Motivation

- Fact: In the same dataset, number of foreign affiliates is larger the higher the R&D intensity of the industry, whereas the R&D intensity has no statistically significant impact on the average imports per affiliate.
- For Example:
 - ▶ Chemical MNC set up majority-owned foreign affiliates more than twice in number than either textile or agricultural machinery MNC.
 - ▶ Chemical MNC import higher volume of products per affiliate than textile MNC, but lower volume of products per affiliate than agricultural machinery MNC.

No. of U.S. HQ's Foreign Affiliates & Relative HQ Intensity



Imports per Foreign Affiliates & Relative HQ Intensity



Broad Overview

- The endogenous choice of number of affiliates can be rationalized in a theoretical framework that combines 3 ingredients:
 - ▶ A multiproduct setup: each product line needs **manufactured parts** from a plant and **HQ services** from the firm
 - ▶ Antràs' property-rights model: benefits of integration outweigh its costs only in HQ-services-intensive firm
 - ▶ Melitz's productivity heterogeneity applied to plant level:
 - ① endogenous selection of foreign plants to export marketplace
 - ② integration of high **productive** plants

The Model in Words

- A single-brand multiproduct MNC consists of one HQ firm and a spectrum of plants.
- Under the same brand, each final-product requires two specially designed intermediate inputs.
- Different plants bring different productivity draws into final-good production.
- Contract incompleteness leads to ex-ante underinvestment in intermediate inputs.
- After inputs have been produced, plants unite to bargain with the HQ over sales revenue allocation.

The Model in Words

- Three possible organizational forms chosen by the HQ:
 - 1 integrating all plants
 - 2 outsource from all plants
 - 3 a mix of integration and outsourcing
- Ownership represents rights to seize some manufactured parts, which affects the outside options of the HQ and plants.
- Inefficiency in manufactured parts is relatively higher under integration than under outsourcing, and conversely for HQ services.
- This implies that HQ will choose outsourcing only when manufactured parts is relatively important in production.
- When the mixed strategy is chosen, HQ selects the fewest number of affiliates to minimize integration costs.

The Model in Words

- In a partial equilibrium open economy, manufactured parts are traded across borders, but final-products are nontradable.
- The coexistence of beachhead export costs and productivity heterogeneity implies endogenous selection of exporters.
- Export plants not only have higher productivity than domestic plants on average, but also lead to the invention of new products.
- With access to exporters, domestic HQ redraw boundaries:
 - ▶ a fraction of domestic affiliates are rearranged as independent plants to make spaces for foreign competent affiliates.

The Closed-Economy Model

Preferences

- A representative consumer faces a continuum of brands i ,

$$Q = \left(\int_{i=0}^1 q(i)^{\frac{\theta-1}{\theta}} di \right)^{\frac{\theta}{\theta-1}}, \theta > 1.$$

- Each brand i consists of a basket Ω of varieties j ,

$$q(i) = \left(\int_{j \in \Omega} q_j(i)^{\frac{\sigma-1}{\sigma}} dj \right)^{\frac{\sigma}{\sigma-1}}, \sigma > 1.$$

The Closed-Economy Model

Demands

- The demand for brand i is:

$$q(i) = QP^\theta p(i)^{-\theta}.$$

- The demand for final-good variety j under brand i is:

$$q_j(i) = QP^\theta p(i)^{\sigma-\theta} p_j(i)^{-\sigma}.$$

- P is the price index for consumption composite Q , $p(i)$ is the price index for brand output $q(i)$, and $p_j(i)$ is the unit price of variety output $q_j(i)$.

The Closed-Economy Model

Revenues

- Sales revenue for entire brand i is:

$$R(i) = p(i)q(i).$$

- Sales revenue for a single variety j under brand i is:

$$R_j(i) = p_j(i)q_j(i).$$

The Closed-Economy Model

Production

- Symmetric brands, drop i .
- The production of variety j involves two parties:
 - ▶ one HQ owns the entire brand and provides HQ services $\{h_j\}_{j \in \Omega}$
 - ▶ one plant M_j draws productivity z_j and provides manufactured parts m_j

The Closed-Economy Model

Production

- The technology is a Cobb-Douglas assembly of two inputs,

$$q_j = z_j \left(\frac{h_j}{\eta_h} \right)^{\eta_h} \left(\frac{m_j}{\eta_m} \right)^{\eta_m}, \quad \eta_h \in [0, 1], \quad \eta_m = 1 - \eta_h.$$

- η_h and η_m are, respectively, the intensity parameters for h_j and m_j .
- Therefore, this particular brand is called the HQ services intense brand if η_h is large.
- Productivity z_j is drawn by M_j from a known distribution $G(z)$ with support $[z_{\min}, z_{\max}]$.

The Closed-Economy Model

Costs

- The HQ services must be supplied by the HQ, and the manufactured parts must be supplied by the plant.
- HQ services can be produced with a variable cost c_h per unit of h_j , and manufactured parts can be produced with a variable cost c_m per unit of m_j .
- The fixed fee to integrate any one manufacturing plant is f_l . There is however no such costs for outsourcing, $f_0 = 0$.

The Closed-Economy Model

Contract Incompleteness

- Contracts are incomplete: investments and revenues are not verifiable, the only item can be contracted upon is the ownership structure.
- The HQ and the plants' union will bargain over the surplus of the relationship ex post.
- Assume the generalized Nash bargaining leaves the HQ with a fraction β of the ex-post gains from co-production.
- The ex-post division of the surplus results in ex-ante under-investment

The Closed-Economy Model

Ownership Structure

- The HQ must decide:
 - 1 What level of ex-post bargaining power to build up
 - 2 Which plants to integrate
- As in Grossman and Hart (1986), the ownership structure affects the ex-post division of surplus through its effect on each party's outside option.
- Manufacturing plant M_j :
 - ▶ It is assumed that the manufactured parts are complete specific to variety j , thereby the outside option for M_j is 0 regardless of ownership structure.

The Closed-Economy Model

Ownership Structure

- The HQ:
 - ▶ Integrated single affiliate: HQ can fire M_j 's manager in case of contractual breakdown, seize the manufactured parts and produce δ fraction of final variety q_j at a lower productivity.
 - ▶ Non-integrated single affiliate: M_j is a stand-alone plant and HQ's outside option is also 0 because a contractual breach leaves H with no time to react and attract another supplier.
 - ▶ Mixed strategy k affiliates: HQ seize manufactured parts from all integrated affiliates, and produce ε_k fraction of brand output q , which translates into sales revenue of $\varepsilon_k^{\frac{\theta-1}{\theta}} R$.

The Closed-Economy Model

Bargaining Results

- The payoffs in the generalized Nash bargaining game are as follows

	HQ	Suppliers' Union
Integrate all	$\delta^{\frac{\theta-1}{\theta}} R + \beta(1 - \delta^{\frac{\theta-1}{\theta}}) R$	$(1 - \beta) \left(1 - \delta^{\frac{\theta-1}{\theta}}\right) R$
Outsource from all	βR	$(1 - \beta) R$
Integrate up to M_k	$\varepsilon_k^{\frac{\theta-1}{\theta}} R + \beta(1 - \varepsilon_k^{\frac{\theta-1}{\theta}}) R$	$(1 - \beta) \left(1 - \varepsilon_k^{\frac{\theta-1}{\theta}}\right) R$

The Closed-Economy Model

Timing

- $\forall j$, the HQ enters into a cooperation agreement with any one plant among a large number of *identical* candidates, and refers to the selected as M_j .
- A Ω set of M_j find out their productivity draws separately, and found plants' union M to fight for a more favorable bargaining result.
- The HQ chooses ex-ante bargaining powers.
- The HQ chooses which plants to integrate
- The HQ and M simultaneously choose their optimal investments in intermediate inputs $\{h_j\}_{j \in \Omega}$ and $\{m_j\}_{j \in \Omega}$, respectively.

The Closed-Economy Model

Timing

- Bargain over the incoming R begins, the HQ proposes a dividing scheme which keeps β_h fraction to itself, and offers the rest to M .
- If M rejects, M gets nothing while the HQ seizes a fraction of q_j from each integrated M_j .
- If M accepts the offer, then M transports $\{m_j\}_{j \in \Omega}$ to the HQ, where q_j amount of variety j is assembled, $\forall j$.
- Revenue R is collected, then divided according to the offer.
- M distributes its share of profit, $\beta_m R$, to all M_j in a pro rata share of their contributions— $\beta_m R_j$ to plant M_j , $\forall j$.

The Closed-Economy Model

Investment Choices

- Given the optimal β_h and $\{m_j\}_{j \in \Omega}$, the HQ maximizes,

$$\max_{\{h_j\}_{j \in \Omega}} \beta_h R - c_h \int_{j \in \Omega} h_j dj.$$

- Similarly, M maximizes its share profit given β_h and $\{h_j\}_{j \in \Omega}$,

$$\max_{\{m_j\}_{j \in \Omega}} \beta_m R - c_m \int_{j \in \Omega} m_j dj.$$

The Closed-Economy Model

Ownership Choices I

- The HQ chooses β_h to maximize ex-ante total profit,

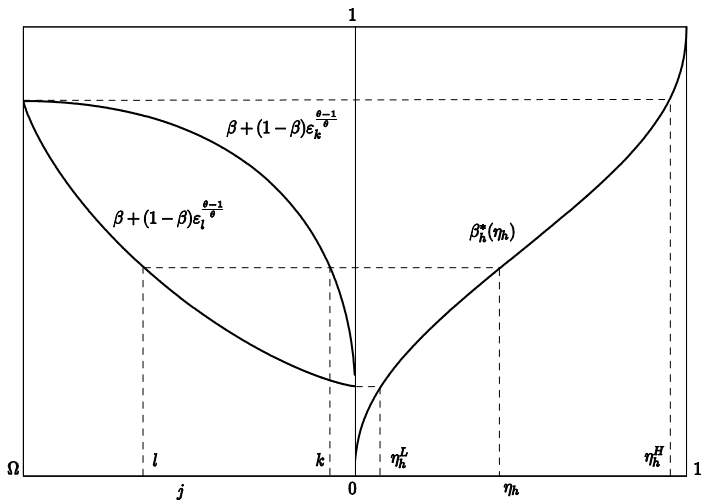
$$\begin{aligned} \max_{\beta_h} & R - c_h \int_{j \in \Omega} h_j dj - c_m \int_{j \in \Omega} m_j dj, \\ \text{s.t.} & \text{ optimal investments in } \{h_j, m_j\}_{j \in \Omega} \end{aligned}$$

- If the HQ can choose β_h freely from the $[0, 1]$ interval, then there is an unique analytical expression for the optimal share of revenue, $\beta_h^*(\eta_h)$.
- Define implicitly,

$$\begin{cases} \beta_h^*(\eta_h^L) = \beta; \\ \beta_h^*(\eta_h^H) = \delta^{\frac{\theta-1}{\theta}} + \beta(1 - \delta^{\frac{\theta-1}{\theta}}). \end{cases}$$

The Closed-Economy Model

Ownership Choices I



The Closed-Economy Model

Ownership Choices II

- Given β_h^* , the HQ picks out the fewest number of affiliates that minimizes the total costs incurred in integration,

$$\min f_j \times \text{number of integrated plants.}$$

- Rank all plants under the same brand from high to low according to their productivity draws on interval $[0, \Omega]$, i.e., $z_j \geq z_k, \forall j < k$ and $j, k \in \Omega$.
- The HQ integrate all plants lie on $[0, k]$ and outsource from others.

The Closed-Economy Model

Ownership Choices III

- The HQ of brand i will adopt the organizational form depending upon its intensity parameter of HQ services.

Proposition

- 1 *Outsource from all if $\eta_h(i) \in [0, \eta_h^L(i)]$;*
- 2 *Integrate all if $\eta_h(i) \in [\eta_h^H(i), 1]$;*
- 3 *Integrate up to M_k if $\eta_h(i) \in (\eta_h^L(i), \eta_h^H(i))$.*

The Open-Economy Model

- The world consists of two countries—home and foreign.
- Assume only manufactured parts are traded across borders, whereas varieties are nontradable.
- A new domestic variety under brand i with its manufactured parts supplied by a foreign plant is denoted as $j' \in \Omega'$. The manufactured parts for variety j' are produced by a foreign plant, $M_{j'}$, with a variable cost $c'_m < c_m$ per unit of $m_{j'}$.
- The basket of final-products becomes $\Omega \cup \Omega'$.

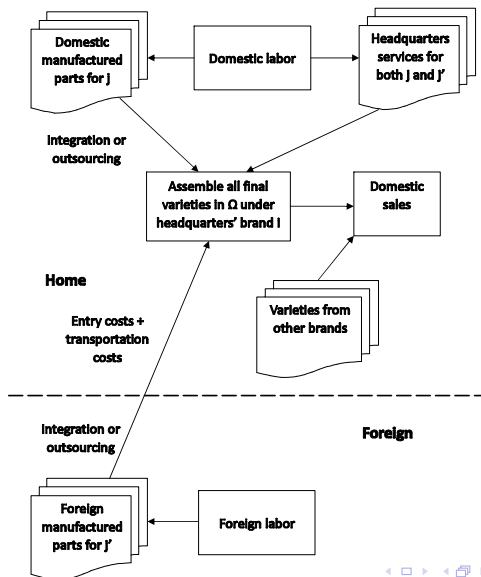
The Open-Economy Model

- Foreign plants face two types of costs when ship their manufactured parts to the home country—a fixed cost to start exporting, f , and a unit export cost, τ .
- It is only after the realization of productivity draws that foreign manufacturers decide whether to export based on the below free entry condition:

$$\beta_m R_{j'} - (\tau + c'_m) m_{j'} \geq f.$$

- A decrease in exporting costs τ and/or entry fee f raises the total amount of intrafirm imports through increasing the number of foreign affiliates.

The Open-Economy Model



The Open-Economy Model

- β_h^* stays unchanged $\Rightarrow \varepsilon_k = \varepsilon_{k'}$
- Therefore, we must have $k' < k$ in order to make the above equation satisfied.
- The total number of integrated plants is shrinking through substituting one high productive foreign affiliate for several relatively low productive domestic affiliates.
- The HQ lowers expenditures on integration, but at the same time maintains its desired bargaining power.
- Higher HQ services intensity \Rightarrow higher $\beta_h^* \Rightarrow$ more productive foreign plants are integrated as affiliates.

Empirical Studies

Theoretical Predictions

The HQ acquires a larger NUMBER of foreign affiliates in

- HQ–service-intensive industries.
- countries with lower trade barriers.

Empirical Studies

Data Description

Two cross-sectional dataset of the year 2007, looking across industries and countries, respectively.

- 114 industries with NAICS 4-digit classification by industry of affiliate.
- 109 foreign countries that import to the U.S. within a firm's boundaries.
- Source: BEA financial and operating dataset on U.S.-headquartered multinational companies and U.S. census bureau data on intrafirm imports to U.S.

Empirical Studies

Conceptual Issues

- The model is one where only intermediate inputs are traded.
- The trade data includes both intermediate inputs and final goods.
- Does this matter?

Empirical Studies

Conceptual Issues

- The model studies brands within an industry.
- The data is across industries.
- Does this matter?

Empirical Studies

Looking Across Industries

- Dependent Variables

- ▶ $\ln(\text{No. of Affiliates}_i)$: Number of foreign affiliates owned by U.S. HQ in industry i from the rest of the world
- ▶ $\ln(\text{Intrafirm Imports}_i)$: the intrafirm U.S. imports shipped by foreign affiliates to their U.S. parent firms as % share of total U.S. imports in industry i

Empirical Studies

Looking Across Industries

- Explanatory Variables

- ▶ $\ln\left(\frac{K_i}{L_i}\right), \ln\left(\frac{RD_i}{L_i}\right)$: capital and R&D expenditures divided by compensation of employees
- ▶ $\ln\left(\frac{M_i}{L_i}\right)$: expenses on materials such as property, plant, and equipment divided by compensation of employees
- ▶ $\ln\left(\frac{Q_i}{L_i}\right)$: affiliate sales divided by compensation of employees, measures the average affiliate's productivity

Empirical Studies

Estimation Equations

$$\begin{aligned} \ln(\text{No. of Affiliates}_i) &= \alpha_0 + \underbrace{\alpha_1 \ln\left(\frac{K_i}{L_i}\right) + \alpha_2 \ln\left(\frac{R\&D_i}{L_i}\right)}_{\text{HQ Services Intensity}} \\ &+ \underbrace{\alpha_3 \ln\left(\frac{M_i}{L_i}\right)}_{\text{Manufactured Parts Intensity}} + \underbrace{\alpha_4 \ln\left(\frac{Q_i}{L_i}\right)}_{\text{Ave. Affililate Prod.}} + \epsilon_i \end{aligned}$$

$$\begin{aligned} \ln(\text{Intrafirm Imports}_i) &= \rho_0 + \rho_1 \ln\left(\frac{K_i}{L_i}\right) + \rho_2 \ln\left(\frac{R\&D_i}{L_i}\right) \\ &+ \rho_3 \ln\left(\frac{M_i}{L_i}\right) + \rho_4 \ln\left(\frac{Q_i}{L_i}\right) + u_i, \end{aligned}$$

Empirical Studies

OLS Results

Indep. Var.	Dep. Var.	
	$\ln(\text{Intrafirm Imports}_i)$	$\ln(\text{No. of Affiliates}_i)$
$\ln\left(\frac{K_i}{L_i}\right)$	0.102	0.676***
$\ln\left(\frac{RD_i}{L_i}\right)$	0.342	0.262***
$\ln\left(\frac{M_i}{L_i}\right)$	-0.286	-0.839***
$\ln\left(\frac{Q_i}{L_i}\right)$	0.372	0.317***
No. of Obs.	30	114
Adj. R^2	0.15	0.22

Empirical Studies

Looking Across Countries

- Dependent Variables

- ▶ $\ln(\text{No. of Affiliates}_c)$: the overall number of foreign affiliates operating in country c owned by U.S. HQ
- ▶ $\ln(\text{Related Party Imports}_c)$: the related party imports as percentage shares of total imports from all foreign affiliates in country c to their parent firms in the U.S.

Empirical Studies

Looking Across Countries

- Explanatory Variables

- ▶ $\ln(\tau_c)$: exporting costs per standard container shipped out of country c (Doing Business Data: Trading Across Borders)
- ▶ $\ln(f_c)$: expenses to start a business in country c (Doing Business Data: Starting a business), to proxy the fixed fee of entering into exporting marketplace
- ▶ $\ln(Enf_c)$: contract enforcement costs in country c (Doing Business Data: Enforcing Contracts)
- ▶ $\ln\left(\frac{L_c}{K_c}\right)$: foreign affiliate's compensation on employees divided by capital expenditures, measures labor costs in country c

Empirical Studies

Estimation Equations

$$\begin{aligned} \ln(\text{No. of Affiliates}_c) &= \alpha'_0 + \underbrace{\alpha'_1 \ln(\tau_c) + \alpha'_2 \ln(f_c)}_{\text{Trade Barriers}} \\ &+ \underbrace{\alpha'_3 \ln(Enf_c)}_{\text{Contract Incompleteness}} + \underbrace{\alpha'_4 \ln\left(\frac{L_c}{K_c}\right)}_{\text{Labor Costs}} + \epsilon'_c \end{aligned}$$

$$\begin{aligned} \ln(\text{Related Party Imports}_c) &= \rho'_0 + \rho'_1 \ln(\tau_c) + \rho'_2 \ln(f_c) \\ &+ \rho'_3 \ln(Enf_c) + \rho'_4 \ln\left(\frac{L_c}{K_c}\right) + u'_c \end{aligned}$$

Empirical Studies

Results

Indep. Var.	Dep. Var.	
	$\ln(\text{Related Party Imports}_c)$	$\ln(\text{No. of Affiliates}_c)$
$\ln(\tau_c)$	-0.126	-0.208**
$\ln(f_c)$	-0.281**	-0.388***
$\ln(\text{Enf}_c)$	-0.228**	-0.113
$\ln(\frac{L_c}{K_c})$	-0.094	-0.17
No. of Obs	109	109
Adj. R^2	0.22	0.29

Empirical Studies

Conclusion

- Across industries, higher extensive margin in industries with higher HQ services intensity.
- Across countries, higher extensive margin in countries with lower trade barriers.
- Volume of intrafirm imports is a combination of extensive margin and intensive margin, in which the extensive margin plays a much more important part.