Supplemental Lecture: Trade, Foreign Direct Investment, and Development

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STEG Virtual Course

Definitions

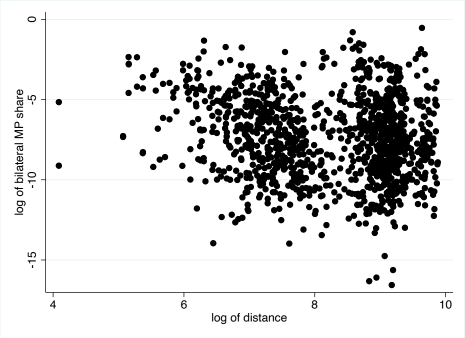
- Multinational Enterprise (MNE)
  - A firm with operations in more than one country, with 10% or more ownership
  - Parent and affiliate firms
- Foreign Direct Investment (FDI)
  - A (financial) flow in the Balance of Payment of countries
  - Equity stake of 10% or more
- Multinational Production (MP)
  - The activity of parents and affiliates (e.g., sales, employment)
  - MP by country i in l = sales of affiliates belonging to parents in i operating in l

Outline

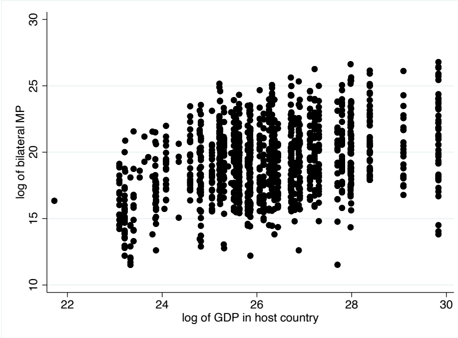
- Some facts
- Models of trade and MP
  - Melitz/Chaney: Helpman, Melitz & Yeaple (04)
  - EK: Ramondo & Rodríguez-Clare (13)
  - Krugman/Melitz/Chaney/EK: Arkolakis, Ramondo, Rodríguez-Clare & Yeaple (18)
  - Subsequent literature
  - Not today: MNE boundaries and contracts (Ántras's work)
- Empirical evidence on spillovers: state-of-the-art
  - Greenstone, Hornbeck, & Moretti (10)
  - Setzler & Tintelnot (21); Alfaro-Ureña, Manelici, & Vasquez (19, 20); Van Patten (20)

Fact I: Bilateral MP, Market Size, and Bilateral Distance

Distance: OLS coef = -0.38 (0.065)

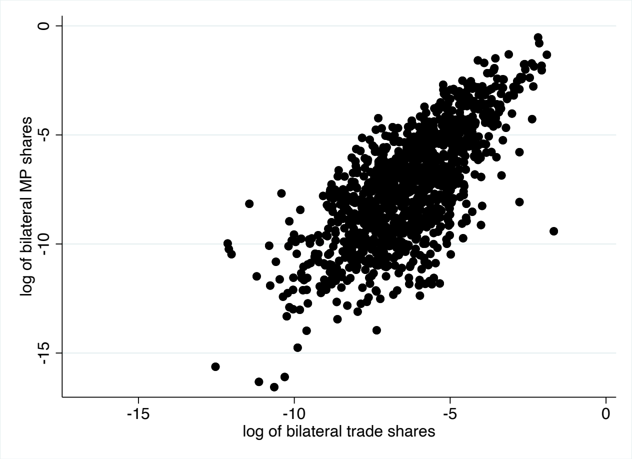


Size: OLS coef = 0.64 (0.047)



Source: Ramondo, Rodríguez-Clare, & Tintelnot (15).
Bilateral MP share = MP by i in l as a share of l's gross output. Non-financial sectors.

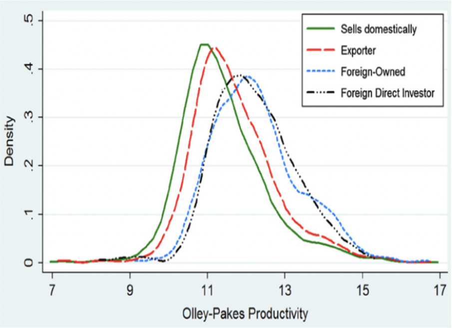
Fact II: Trade and MP



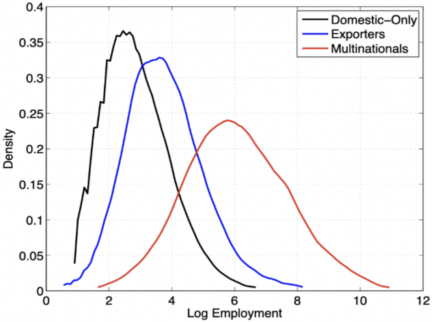
Source: Ramondo, Rodríguez-Clare, & Tintelnot (15). Correlation is 0.72.

Fact III: MNE Advantage

Spain. 2007.



United States. 2007.

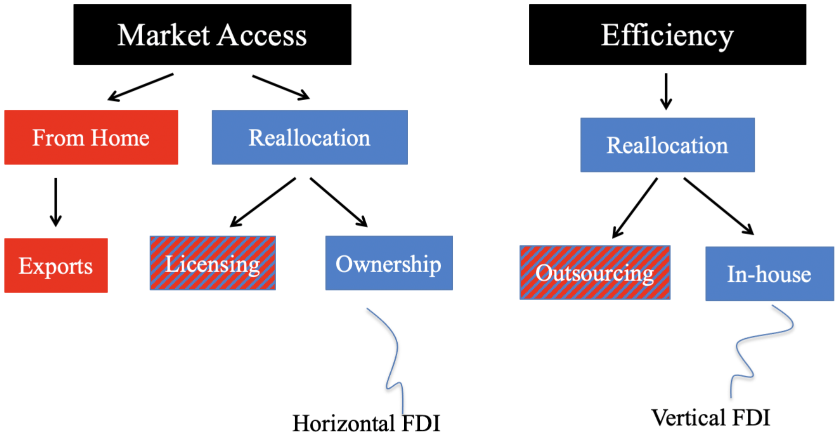


Source: Ántras and Yeaple (14) for Spain. Flaeen (15) for the United States.

Affiliate Activities: Taxonomy

- Horizontal Activities
  - Sales to the host market
  - The median US affiliate sells 66% to host market (Ramondo et al., 15)
- Export-Platform Activities
  - Sales outside the host market
  - The median US affiliate sells 34% outside host market (Ramondo et al., 15)
- Vertical Activities
  - Sales to parent company and other related parties
  - The median US affiliate sells zero to the parent (Ramondo et al., 15)

Why Do Firms Engage in International Activities?



The Proximity-Concentration Tradeoff

- How to serve a foreign market?
  - Export from domestic plant vs set up foreign affiliate
  - Exports and FDI are *substitute* ways of serving a foreign market
- Tradeoff
  - MP: High sunk and fixed of creating a new plant, but proximity to consumer
  - Exports: Concentrate production in one location, but far-away from consumer

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  - MP: High sunk and fixed of creating a new plant, but proximity to consumer
  - Exports: Concentrate production in one location, but far-away from consumer
- Evidence: Robust at the aggregate level; mixed at the firm level
  - X_{ij}: Exports from i. S_{ij}: sales of foreign affiliates of MNEs from i. Industry j.

$$\log \frac{X_{ij}}{X_{ij} + S_{ij}} = \underbrace{\alpha_1}_{(-)} \log \textit{trade costs}_{ij} + \underbrace{\alpha_2}_{(+)} \log \textit{plant scale}_j + \beta_1 Z_i + \beta_2 Y_j + u_{ij}$$

Multinational Production into Melitz-Chaney Model

- Proximity-concentration tradeoff at the firm and aggregate level
- Firms can transfer their productivity abroad (knowledge capital, Markusen 84)
  - Bloom, Sadun & Van Reenen (07); Giroud (13); Bilir & Morales (20)
- Firms are heterogenous in productivity $\rightarrow$ Most productive firms choose MP
- Firms' response to the PC tradeoff is different across firms
  - Ratio of MP to export sales increases with firm heterogeneity

Helpman, Melitz, and Yeaple (04): Set up

- N countries. Only labor.
- Continuum of varieties. CES preferences with $\sigma > 1$.
- Firm productivity drawn from Pareto distribution

$$\mathbb{P}(\Phi \leq \varphi) = 1 - \varphi^{-\kappa} \quad \text{with} \quad \varphi \geq 1 \quad \text{and } \kappa + 1 - \sigma > 0$$

- Monopolistic competition

$$p(\varphi) = \frac{\sigma}{\sigma - 1} \frac{W_i}{\varphi}$$

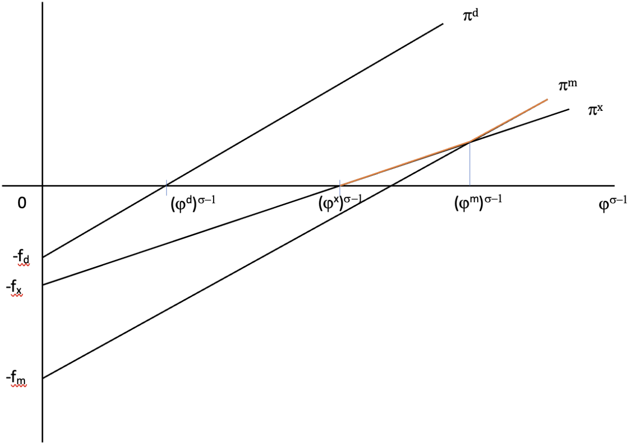
- Variable trade costs from country i to j: $\tau_{ij} \geq 1$ with $\tau_{ii} = 1$
- Fixed export costs for country j: $f_j^x > 0$. Fixed MP costs for country j: $f_j^m > 0$.
- Additionally: fixed domestic cost $f_i^d > 0$ and entry cost $f_i^e > 0$

Profits and Zero-Profit Conditions

- CES profits
  - From sales to domestic market: $\pi_i^d(\varphi) = (W_i/\varphi)^{1-\sigma} B_i - W_i f_i^d$
  - From exports to market j: $\pi_{ij}^x(\varphi) = (\tau_{ij} W_i/\varphi)^{1-\sigma} B_j - W_j f_j^x$
  - From MP sales to market j: $\pi_{ij}^m(\varphi) = (W_j/\varphi)^{1-\sigma} B_j - W_j f_j^m$
- Zero-profit conditions and cutoff productivities
  - Domestic: $(W_i/\varphi_i^d)^{1-\sigma} B_i = W_i f_i^d$ for all i
  - Export: $(W_i \tau_{ij}/\varphi_{ij}^x)^{1-\sigma} B_j = W_j f_j^x$ for all $i \neq j$
  - MP: $\left[1 - (\frac{W_i}{W_j}\tau_{ij})^{1-\sigma}\right](W_j/\varphi_{ij}^m)^{1-\sigma} B_j = W_j f_j^m - W_j f_j^x$ for all $i \neq j$

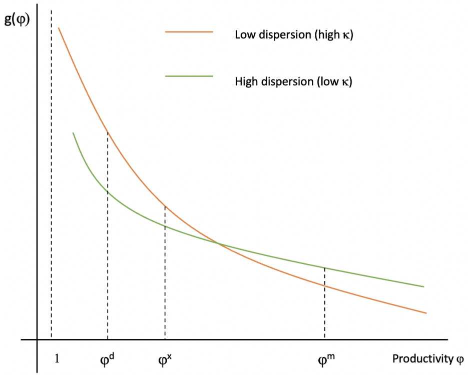
Profits Under Symmetry

Key assumptions: $f^d < \tau^{\sigma-1} f^x < f^m$. Only horizontal flows, no export-platforms.



Heterogeneity and the Proximity-Concentration Tradeoff

$$\frac{Export\ \ sales}{MP\ \ sales} = \tau^{1-\sigma}\left[\frac{V(\varphi^x)}{V(\varphi^m)} - 1\right] = \tau^{1-\sigma}\left[\left(\frac{f^m - f^x}{f^x}\frac{1}{\tau^{\sigma-1}-1}\right)^{\kappa+1-\sigma} - 1\right]$$



$$V(\varphi^m) \equiv \int_{\infty}^{\varphi^m} \varphi^{\sigma-1} dG(\varphi) \quad \text{and} \quad V(\varphi^x) \equiv \int_{\varphi^m}^{\varphi^x} \varphi^{\sigma-1}$$

Multinational Production into EK Model

- Quantitative general equilibrium EK model for trade and MP
  - Trade and MP are alternative ways to serve a market
  - Foreign affiliates import intermediates
  - A does MP in B and exports to C ("bridge" MP, BMP)
- Calibrate model to match bilateral trade and MP data
- Quantify gains from openness, trade, and MP
  - Other counterfactual exercises

EK Trade

- N countries of size L_n
- Continuum of tradable goods, $v \in [0, 1]$, CES aggregator with $\sigma > 1$
- Productivity $z_l(v)$ is independent Fréchet over v and across countries l

$$\mathbb{P}\left[Z_l(v) \leq z\right] = \exp\left[-T_l z^{-\theta}\right]$$

- Iceberg trade costs $\tau_{ln} \geq 1$, with $\tau_{ll} = 1$. Unit cost in n of good v produced in l

$$p_{ln}(v) = \tau_{ln} \frac{W_l}{z_l(v)}$$

- Lowest cost producer of good v in country n (head-to-head competition)

$$p_n(v) = \min_l p_{ln}(v)$$

Multinational Production (MP)

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$$p_{iln}(v) = \tau_{ln} \frac{c_{il}}{z_{il}(v)}$$

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- Lowest cost producer of good v in country n (head-to-head competition)

$$p_n(v) = \min_{i,l} p_{iln}(v)$$

Multinational Input Bundle: Sourcing

- Unit cost of the input bundle for MP by i in l

$$c_{il} = \left[\sum_{k \neq l} a_{kl} \left(W_k \tau_{kl} \right)^{1-\xi} + a_{ll} \left(W_l \gamma_{il} \right)^{1-\xi} \right]^{\frac{1}{1-\xi}} \quad \text{with} \quad \sum_k a_{kl} = 1$$

  - Home sourcing

$$c_{il} = \left[a \left(W_i \tau_{il} \right)^{1-\xi} + (1-a) \left(W_l \gamma_{il} \right)^{1-\xi} \right]^{\frac{1}{1-\xi}}$$

  - No sourcing

$$c_{il} = W_l \gamma_{il} \quad \rightarrow \quad p_{iln}(v) = \tau_{ln} \gamma_{il} \frac{W_l}{z_{il}(v)}$$

- 'MP cost' by i in l: $\gamma_{il} \geq 1$ with $\gamma_{ll} = 1$

Distributional Assumption (for Aggregation)

- Productivity is *symmetric multivariate Fréchet* across l, for each i

$$\mathbb{P}\left[Z_{i1}(v) \leq z_1, \ldots, Z_{iN}(v) \leq z_N\right] = \exp\left[-\left(\sum_{l=1}^{N}\left(T_{il} z_l^{-\theta}\right)^{\frac{1}{1-\rho}}\right)^{1-\rho}\right]$$

  - $\rho = 0$ corresponds to independent draws
  - $\rho \to 1$ corresponds to perfectly correlated draws

- Productivity is i.i.d. over v and across i

MV Max-Stable Fréchet and Correlation Function

$$\mathbb{P}[Z_1(v) \leq z_1, \ldots, Z_N(v) \leq z_N] = \exp\left[-G\left(T_1 z_1^{-\theta}, \ldots, T_N z_N^{-\theta}\right)\right]$$

- Key property: G is homogeneous of degree 1 $\implies$ max-stability

$$\mathbb{P}\left[\max_l Z_l(v) \leq z\right] = \exp\left[-G\left(T_1, \ldots, T_N\right) z^{-\theta}\right]$$

  - The conditional and unconditional probability of the max coincide
  - Key implication: probabilities equal expenditure shares

- Other properties: unboundedness; differentiability. Normalization.
- Special cases: independence (additive G); symmetry (CES G)
- MV max-stable Fréchet is equivalent to Generalized Extreme Value (GEV) expenditure

$$\frac{X_{ln}}{X_n} = \frac{T_{ln} W_l^{-\theta} G_l(T_{1n} W_1^{-\theta}, \ldots, T_{Nn} W_N^{-\theta})}{G(T_{1n} W_1^{-\theta}, \ldots, T_{Nn} W_N^{-\theta})} \quad \text{where} \quad G_l(x_1, \ldots, x_N) \equiv \frac{\partial G(x_1, \ldots, x_N)}{\partial x_l}$$

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Correlation Through Multinational Production

- Correlation function is cross-nested CES (CNCES)

$$\mathbb{P}\left(Z_{i1n}(v) \leq z_1, \ldots, Z_{iNn}(v) \leq z_N\right) = exp\left[-\sum_i \left(\sum_l (T_{iln} z_l^{-\theta})^{\frac{1}{1-\rho_i}}\right)^{1-\rho_i}\right]$$

- Relax assumptions
  - Different correlation for each home country i
  - More general MP and trade cost — not necessarily iceberg
  - Unit cost of producing good v in l with technologies from i to deliver to n

$$\frac{W_l}{Z_{iln}(v)} \quad \text{instead of} \quad \gamma_{il}\tau_{ln}\frac{W_l}{Z_{il}(v)}$$

- Keep assumptions
  - Productivity is i.i.d. over v and across i
- See Lind and Ramondo (20)

Expenditure Shares

- Expenditure in n of goods produced in l with technologies from i

$$\frac{X_{iln}}{X_n} = \underbrace{\left(\frac{P_{iln}}{P_{in}}\right)^{-\frac{\theta}{1-\rho_i}}}_{within-i\ \ expenditure} \times \underbrace{\left(\frac{P_{in}}{P_n}\right)^{-\theta}}_{between-i\ \ expenditure}$$

$$P_{iln}^{-\theta} \equiv T_{iln} W_l^{-\theta} \qquad P_{in}^{-\frac{\theta}{1-\rho_i}} \equiv \sum_l P_{iln}^{-\frac{\theta}{1-\rho_i}} \qquad P_n^{-\theta} \equiv \sum_i P_{in}^{-\theta}$$

  - Special case (RRC,13): $P_{iln}^{-\theta} \equiv T_{il}(\gamma_{il}\tau_{ln}W_l)^{-\theta}$ and $\rho_i = \rho$

- Bilateral trade: $X_{ln} = \sum_i X_{iln}$
- Bilateral MP: $X_{il} = \sum_n X_{iln}$
- Total expenditure: $X_n = \sum_i \sum_l X_{iln}$

Gains from Trade: Sufficient-Statistic Approach

- Gains from trade for GEV class

$$GT_n \equiv \frac{W_n/P_n}{W_n^A/P_n^A} = \left(\frac{X_{nn}/X_n}{G_{nn}}\right)^{-\frac{1}{\theta}} \quad \text{where} \quad G_{nn} \equiv \frac{\partial G(P_{1n}^{-\theta}, \dots, P_{Nn}^{-\theta})}{\partial P_{ln}^{-\theta}}$$

  - Gains from trade are lower than under independence
  - Under independence, $G(x_1, \dots, x_N) = \sum_l x_l$ and $G_{nn} = 1 \rightarrow$ CES-ACR

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- Gains from trade for CNCES subclass

$$GT_n = \left(\frac{\sum_i X_{inn}}{X_n}\right)^{-\frac{1}{\theta}} \left[\sum_i \left(\frac{X_{inn}}{\sum_{i'} X_{i'nn}}\right)\left(\frac{X_{inn}}{\sum_l X_{iln}}\right)^{-\rho_i}\right]^{-\frac{1}{\theta}}$$

Gains from Trade, MP, and Openness

- Gains from trade* (isolation to trade) and Gains from MP* (isolation to MP)

$$GT_n^* = \left(\frac{X_{nnn}}{\sum_l X_{nln}}\right)^{-\frac{1}{\theta}} \qquad GMP_n^* = \left(\frac{X_{nnn}}{\sum_i X_{inn}}\right)^{-\frac{1}{\theta}}$$

- Gains from trade (only MP to trade and MP)

$$GT_n = \left(\frac{\sum_i X_{inn}}{X_n}\right)^{-\frac{1}{\theta}} \left[\sum_i \left(\frac{X_{inn}}{\sum_{i'} X_{i'nn}}\right)\left(\frac{X_{inn}}{\sum_l X_{iln}}\right)^{-\rho_i}\right]^{-\frac{1}{\theta}}$$

- Gains from MP (only trade to trade and MP)

$$GMP_n = \frac{GT_n}{GT_n^*} GMP_n^*$$

- Gains from openness (isolation to trade and MP)

$$GO_n = \left(\frac{X_{nnn}}{X_n}\right)^{-\frac{1-\rho_n}{\theta}} \left(\frac{\sum_l X_{nln}}{X_n}\right)^{-\frac{\rho_n}{\theta}}$$

Trade and MP: Complements or Substitutes?

- Definitions
  - Trade is MP-complement when $GT_n > GT_n^*$
  - Trade is MP-substitute when $GT_n < GT_n^*$
  - Trade is MP-independent when $GT_n = GT_n^*$
- For intuition, calculate gains in a symmetric world (with home imports)
  - For $a = 0$: $\rho = 0$: Trade is MP-independent
  - For $a = 0$: $0 < \rho < 1$: Trade is MP-substitute
  - For $a > 0$: $\rho = 0$: Trade is MP-complement
  - For $\xi \to 1$ ($\xi \to \infty$): Trade is MP-complement (MP-substitute)

Full Quantitative Model

- Tradable intermediate goods $v \in [0,1]$, CES aggregator with price index P_n^g
  - unit cost of MP by i in n is c_{in} (imports from home)
- Non-tradable final goods $u \in [0,1]$, CES aggregator with price index P_n^f
  - unit cost of MP by i in n is $c_n^f \gamma_{in}^f$ (no imports from Home), with $\gamma_{in}^f = \mu \gamma_{il}^g$
- Input-output loop

$$c_n^g = B W_n^{\beta} (P_n^g)^{1-\beta} \quad \text{and} \quad c_n^f = A W_n^{\alpha} (P_n^g)^{1-\alpha}$$

Calibration Procedure

- Bilateral trade and MP costs

Alt. 1 Trade and MP costs are functions of, e.g., distance. Target observed bil. trade and MP

Alt. 2 Set trade and MP costs to exactly match observed bil trade and MP

Alt. 3 Given MP & trade shares, unique set of Xiln. Assume symmetric costs and compute

$$\left(\sqrt{\frac{X_{inn}X_{ill}}{X_{iln}X_{inl}}}\right)^{\frac{1-\theta}{\rho}} = \tau_{ln}\tau_{nl} \qquad \left(\sqrt{\frac{X_{iin}X_{lln}}{X_{iln}X_{lin}}}\right)^{\frac{1-\theta}{\rho}} = \gamma_{li}\gamma_{il}$$

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- For θ, target 'unrestricted' gravity OLS coefficient $\beta^u \neq \theta$

$$\ln X_{ln} = I_l + I_n + \beta^u \ln \tau_{ln} + u_{ln}$$

- For ρ, target 'restricted' gravity (to origin i) OLS coefficient $\beta^r = -\frac{\theta}{1-\rho}$

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- Set $T_i = \phi_i L_i$ where ϕ_i is R&D employment share and L_i equipped labor in the data
- For CES weights in MP input bundle ($a's$), target affiliates' intermediate (intra-firm) imports
- Remaining parameters from the literature (important: MP input-bundle CES elasticity ξ)

Krugman-Melitz-Chaney Meets EK: Motivation

- Goods increasingly produced far from where ideas are created
  - Key: the rise of multinational production (MP)
- Some countries specialize in innovation; others specialize in production
  - Countries specialized in production worry about low innovation rates
  - Countries specialized in innovation worry about loss of production jobs

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- Quantitative general equilibrium model with innovation and production
  - Specialization reflects comparative advantage & home market effects
  - Expansion of production may trigger deterioration of ToT (Venables, 87)
  - Countries may lose from openness

Krugman-Melitz-Chaney Meets EK: Ingredients

- L_i workers allocated to innovation (L_i^e) vs production (L_i^p) — Roy-Fréchet

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  - Entry cost $= W_i^e f^e$. Endogenous entry of M_i firms (thus, $W_i^p = W_i^e = W_i$)
  - Firms own the idea (e.g., blueprint) to produce a good

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  - Firms own the idea (e.g., blueprint) to produce a good
- Firm outcome of innovation effort is stochastic
  - Multivariate Pareto Distribution (MVP) of firm productivity $\mathbf{z} = (z_1, ..., z_N)$
  - Countries differ in their productivity across goods (CA in goods)
  - Countries differ in their quality of ideas (CA innovation vs CA production)

Krugman-Melitz-Chaney Meets EK: Ingredients

- L_i workers allocated to innovation (L_i^e) vs production (L_i^p) — Roy-Fréchet
- Firms pay a fixed cost to 'innovate'
  - Entry cost $= W_i^e f^e$. Endogenous entry of M_i firms (thus, $W_i^p = W_i^e = W_i$)
  - Firms own the idea (e.g., blueprint) to produce a good
- Firm outcome of innovation effort is stochastic
  - Multivariate Pareto Distribution (MVP) of firm productivity $\mathbf{z} = (z_1, ..., z_N)$
  - Countries differ in their productivity across goods (CA in goods)
  - Countries differ in their quality of ideas (CA innovation vs CA production)
- Firms choose where to produce given geographic barriers to trade & MP
  - Iceberg trade τ_{ln} and MP costs γ_{il}. Fixed export costs, $W_n F_n$

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- Firms choose where to produce given geographic barriers to trade & MP
  - Iceberg trade τ_{ln} and MP costs γ_{il}. Fixed export costs, $W_n F_n$
- Continuum of varieties $v \in [o, 1]$. CES preferences with $\sigma > 1$. Monopolistic competition.

The Multivariate Pareto Distribution

$$\mathbb{P}\left(z_1, ..., z_N\right) = 1 - \left(\sum_{l=1}^{N} \left[T_{il} z_l^{-\theta} \right]^{\frac{1}{1-\rho}} \right)^{1-\rho}$$

$$\text{where} \quad z_l \geq \widetilde{T}_i^{1/\theta} \quad \text{and} \quad \widetilde{T}_i \equiv \left[\sum_l T_{il}^{1/(1-\rho)} \right]^{1-\rho}$$

- $\theta > \sigma - 1$ regulates heterogeneity over varieties (firms)
- $\rho \in [0, 1)$ regulates heterogeneity across locations
- $T_{il} = T_i^e T_l^p$: Country i has CA in innovation if T_i^e / T_i^p is relatively high

Firm's Problem and Aggregation

- Unit cost for firm $\mathbf{z}$ from country i serving n from l:

$$C_{iln} = \frac{\gamma_{il} W_l \tau_{ln}}{z_l}$$

- Firm i chooses cheapest production location for each n:

$$l = \arg\min_{v} C_{ivn}$$

- Firm i chooses to serve market n if

$$\pi_n \left(C_{iln} \right) - w_n F_n \geq 0 \implies C_{iln} \leq c_n^*$$

- MVP gives us closed-form for $\mathbb{P}\left(\arg\min_k C_{ikn} \middle| \min_k C_{ikn} \leq c_n^*\right)$ and (aggregate) flows

- Firm level: proximity-CA tradeoff. Aggregate level: proximity-concentration tradeoff

Innovation Shares, Specialization, and Trade Imbalances

- Innovation share

$$r_i \equiv \frac{W_i L_i^e}{X_i} = \eta + \frac{\sigma - 1}{\sigma} \frac{X_i - Y_i}{X_i}$$

  - Y_i: total production in i. X_i: total expenditure of i
  - η: sales' share of profits (net of marketing costs)
  - $r_i = \eta$ in autarky (or MP-autarky)

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  - $r_i = \eta$ in autarky (or MP-autarky)
- A trade deficit ($X_i > Y_i$) implies specialization in innovation ($r_i > \eta$)
  - Import goods to repatriate profits from MP. Innovation hub
- A trade surplus ($X_i < Y_i$) implies specialization in production ($r_i < \eta$)
  - Export goods to send profits from MP abroad. Production hub.

The Gains from Openness

$$GO_n = \underbrace{\left(\frac{\sum_l X_{nln}}{X_n}\right)^{-\frac{\rho}{\theta}} \left(\frac{X_{nnn}}{\sum_l X_{nln}}\right)^{-\frac{1-\rho}{\theta}}}_{\text{Direct Effect}} \times \underbrace{\left(1 + \theta \frac{X_n - Y_n}{Y_n}\right)^{1/\theta}}_{\text{Indirect Effect}}$$

- Indirect effect (due to innovation) can induce losses: $GO_n < 1$
  - Countries that lose innovation experience ToT deterioration
- Additional results
  - Countries can lose from more openness to trade or MP
  - Both production and innovation workers can lose from more liberalization

Useful Isomorphisms (Online Appendix in ARRY)

1. MV Pareto productivity $\equiv$ Firm-specific Pareto productivity $\times$ Firm-location-specific independent Fréchet productivity: φz_l

$$\varphi z_l : \quad \mathbb{P}(\Phi \leq \varphi) = 1 - \varphi^{-\kappa} \quad \text{and} \quad \mathbb{P}(Z_l \leq z_l) = exp\left(-T_{il} {z_l}^{-\theta}\right)$$

2. Krugman-meets-EK model of MP & trade $\equiv$ Two-sector trade model
   - Krugman free-entry monopolistic sector. EK head-to-head competition sector
3. Product innovation $\equiv$ Process innovation
   - (Uncertain) Investment to lowering unit costs of production
4. For $\rho = 0$: ARRY model $\equiv$ model with plant-level location-specific fixed costs

Quantitative GE Models of Trade and MP

- Irrarazabal, Moxnes, & Opromolla (13) — HMY with intra-firm trade
- Garetto (13) — MP sourcing
- Tintelnot (17) — plant-level fixed costs
- Alviarez (19) — many sectors
- Head & Mayer (19) — HQ gravity
- Eaton & Kortum (19) — trade in services
- Sun (20) — MP with non-neutral technologies
- Fan (21) — Offshore R&D
- Wang (21) — bounds approach

Spillovers: State-of-the-Art

'Incumbent firms increase TFP when more productive firm locates nearby'

- Traditionally, regression of domestic-firm outcome on 'nearby' MP presence
  - Many papers (80s', 90s'), mixed results
- More recently, refinements to include channels for spillovers

  e.g. Backward linkages: Javorcik (04) and literature thereafter
- Now, very detailed data allow for much better identification
  - Firm-to-firm; employer-employee; natural experiments

Large Plant Openings: Greenstone et al. (10)

- Effects of new large plants on incumbent plants across US counties
- Use information from SITE Selection magazine
  - Report counties chosen by new million-dollar plants ....
  - ... And counties that almost got chosen
- Identification strategy
  - Compare incumbent plants in winning vs almost-winning counties
  - Ex-ante: counties are similar; incumbent plants are similar
- Results
  - Incumbent plants increase TFP by 8% after a large plant locates nearby
  - Entry of new plants increases, as do local wages
  - Incumbent firms that are economically less "distant" gain most
- Abebe et al. (2018): Effects of FDI spillovers on domestic plants in Ethiopia
  - Foreign-plant openings are allocated to regions by the government

Employer-Employee Data: Setzler and Tintelnot (21)

- Corporate tax fillings merged with W-2 for the US (1999-2017)
- Effects of MNEs in the US
  - Direct effect: Identify MNE wage premium
  - Indirect effect: Identify MNE effects on domestic firms (e.g., wages)
- Identification strategy
  - Use movers from domestic to foreign firms and two-way fixed effect
  - IV based on the spatial clustering of foreign firms by origin
- Results
  - The average foreign firm wage premium is 7% — higher for skilled workers
  - One more job created by a foreign MNE generates in the same labor market:
    - approx. 0.5 jobs and 139,000$ in value added in a domestic firms;
    - avg annual aggregate wage gain for incumbent workers of approx. 13,400$
  - Tradeoff: the cost of mega-deals

The Case of Costa Rica

1. The effect of MNEs on workers (Alonso-Ureña, Manelici, and Vasquez, 19)
   - Employer-employee + firm-to-firm data for Costa Rica
   - Identify wage premium for MNEs (9%) and effects on domestic firms (1%)
     - "Movers" design and two-way fixed effects
   - Dig deeper on the mechanisms: better outside options; input-output linkages
2. The effect of MNEs on suppliers (Alonso-Ureña, Manelici, and Vasquez, 20)
   - Firm-to-firm data for Costa Rica
   - Event-study strategy to identify effects of starting supplying an MNE
     - Also: "winner vs loser" policy event; placebo strategies; survey to managers
   - Results reveal strong and persistent gains in performance by domestic firms
3. The effects of monopsony power on development (Van Patten, 20)
   - Exploit a quasi-random assignment of land to the United Fruit Co.

What's Next?

- MNE dynamics
- Taxation and MNEs
- Cross-border Mergers & Acquisitions
- Automation and MNEs
- Global value chains in production and R&D

Appendix

Property of Pareto Used for Estimation in HMY(04)

$$\mathbb{P}[Z \geq z] = \left(\frac{z}{\underline{z}}\right)^{-\gamma} \quad \rightarrow \quad \log\left(\mathbb{P}[Z \geq z]\right) = \gamma \log \underline{z} - \gamma \log z$$

- The log of the mass of the upper tail above z is linear in $\log z$

  e.g. if the number of employees in a randomly selected firm, Z, is Pareto distributed, the share of firms in the population with more than z (log) employees is linear in the (log) number of employees

- Regression of log firm size ranking on firm size identifies the shape parameter

- In this case: $\gamma = \kappa + 1 - \epsilon$

Symmetry: Set Up

- $L_n = L,\ T_n = T$; $\tau_{ln} = \tau > 1$, $\gamma_{il} = \gamma > 1$, for all $l \neq n$.
  - Wages, costs, prices are equal across countries. $W = 1$.
  - Unit cost of the multinational input bundle

$$m = \left[(1-a)\gamma^{1-\xi} + a\tau^{1-\xi}\right]^{\frac{1}{1-\xi}}$$

  - Unit cost of the multinational input bundle when $\tau \to \infty$

$$\widetilde{m} = (1-a)^{\frac{1}{1-\xi}}\,\gamma$$

Symmetry: Real Wages

- Isolation

$$T^{\frac{1}{\theta}}$$

- Only trade

$$\left[1 + (N-1)\tau^{-\theta}\right]^{\frac{1}{\theta}} \; T^{\frac{1}{\theta}}$$

- Only MP

$$\left[1 + (N-1)\widetilde{m}^{-\theta}\right]^{\frac{1}{\theta}} \; T^{\frac{1}{\theta}}$$

- Trade and MP

$$\left[\Delta_0 + (N-1)\Delta_1\right]^{\frac{1}{\theta}} \; T^{\frac{1}{\theta}}$$

$$\Delta_0 \equiv \left(1 + (N-1)(m\tau)^{-\frac{\theta}{1-\rho}}\right)^{1-\rho} \qquad \Delta_1 \equiv \left(\tau^{-\frac{\theta}{1-\rho}} + m^{-\frac{\theta}{1-\rho}} + (N-2)(m\tau)^{-\frac{\theta}{1-\rho}}\right)^{1-\rho}$$

Symmetry: Gains

$$GT = \left[\frac{\Delta_0 + (N-1)\Delta_1}{1 + (N-1)\tilde{m}^{-\theta}}\right]^{\frac{1}{\theta}}$$

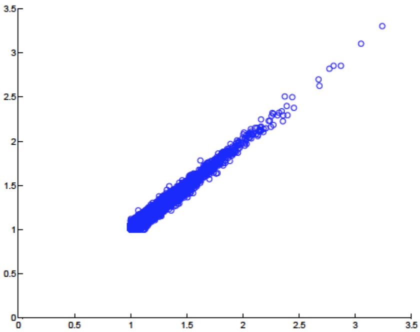
$$GMP = \left[\frac{\Delta_0 + (N-1)\Delta_1}{1 + (N-1)\tau^{-\theta}}\right]^{\frac{1}{\theta}}$$

$$GO = [\Delta_0 + (N-1)\Delta_1]^{\frac{1}{\theta}}$$

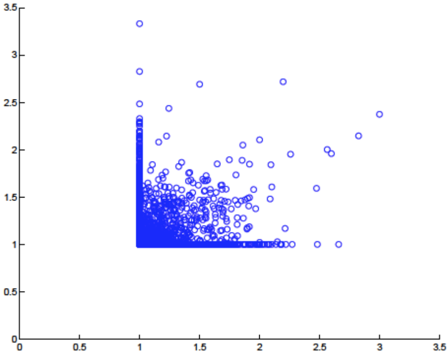
$$\Delta_0 \equiv \left(1 + (N-1)(m\tau)^{-\frac{\theta}{1-\rho}}\right)^{1-\rho} \qquad \Delta_1 \equiv \left(\tau^{-\frac{\theta}{1-\rho}} + m^{-\frac{\theta}{1-\rho}} + (N-2)(m\tau)^{-\frac{\theta}{1-\rho}}\right)^{1-\rho}$$

Multivariate Pareto Distribution: Two-Country Simulation

High ρ



Low ρ



Note: $N = 2,\ T_{il} = T_{ii}$

ARRY: Taking the Model to the Data

Sample: 26 OECD countries, including China & Brazil

- Match key trade elasticities (detailed data on MP activity)
- Match bilateral trade and MP patterns
- Match country's GDP, productive labor, and innovation share

ARRY: Estimation of Model Elasticities

- **'Unrestricted'** gravity regression does not recover θ but β^u

$$\ln X_{ln} = I_l + I_n + \beta^u \ln \tau_{ln}$$

- Same regression **'restricted'** to origin i can be used to recover $-\frac{\theta}{1-\rho}$:

$$\ln X_{iln} = \underbrace{\ln T_l^p \left(\gamma_{il} W_l\right)^{-\theta/(1-\rho)}}_{I_{il}} + \underbrace{\ln T_i^e \lambda_{in}^E \left(\Psi_{in}\right)^{-1/(1-\rho)}}_{I_{in}} - \frac{\theta}{1-\rho} \ln \tau_{ln}$$

- We use BEA data for X_{iln} for $i = US$ and selected l, n pairs
  - Model implies $\beta^u \approx -\theta > -\frac{\theta}{1-\rho}$

ARRY: Calibration of Trade and MP costs, and Technology

- **Step 1:** Given MP & trade shares, the model implies a unique set of X_{iln}
  - Trade and MP shares are constructed with data from WIOD & UNCTAD
  - Calculate *symmetric* trade and MP costs using a generalized HR index
  - Remark: the procedure is "over-identified"

$$\left(\sqrt{\frac{X_{inn}X_{ill}}{X_{iln}X_{inl}}}\right)^{(1-\theta)/\rho} = \tau_{ln}\tau_{nl}, \quad \left(\sqrt{\frac{X_{iin}X_{lln}}{X_{iln}X_{lin}}}\right)^{(1-\theta)/\rho} = \gamma_{li}\gamma_{il}$$

- **Step 2:** Set $T_l^p = L_l^{1-\rho}$
  - L_l is equipped labor (K-RC, 05) $\times$ the employment share in mfg (UNIDO)
- **Step 3:** T_i^e matches r_i constructed from data on (implied) trade imbalances

ARRY Results: CA vs HMEs

Specialization due to Comparative Advantages	
Benelux	Innovation
Canada	Production
Denmark	Innovation
Sweden	Innovation
Ireland	Production
China	Production

Specialization due to Home Market Effects	
Germany	Innovation
Mexico	Production
United States	Innovation