Multinationals Corporations and Productivity

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Why should we care about MNCs?

- Largest and most innovative firms
- Most of their employment, VA and innovation in source country
- USA 2020 (BEA):
  - US parents = 23% private employment
  - US parents = 20% private value added
  - US parents = 64% business R&D

MNCs shape foreign sales

- U.S. multinationals are large exporters and importers

$$\frac{\text{P total exports}}{\text{U.S. exports}} = 57\% \qquad \frac{\text{P total imports}}{\text{U.S. imports}} = 35\%$$

- Intra-firm flows are large as share of P total trade

$$\frac{\text{Shipments from P to A}}{\text{P total exports}} = 40\% \qquad \frac{\text{Shipments from A to P}}{\text{P total imports}} = 49\%$$

- Intra-firm flows are small relative to A's activity

$$\frac{\text{Shipments from P to A}}{\text{Total A sales}} = 10\% \qquad \frac{\text{Shipments from A to P}}{\text{Total A sales}} = 9\%$$

- A sales are large relative to U.S. trade

$$\frac{\text{Total A sales}}{\text{U.S. exports}} = 2.3 \qquad \frac{\text{Total A sales}}{\text{U.S. imports}} = 1.9$$

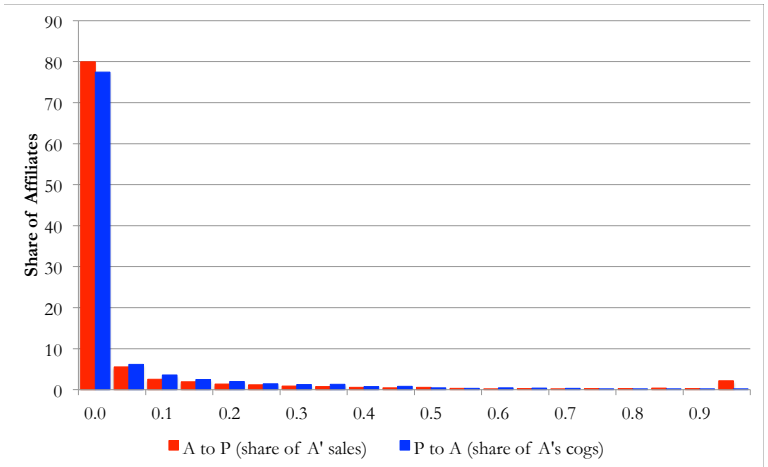
Today: Affiliates as Production Units for Foreign Sales (Horizontal)

- Most Affiliates sale directly to unaffiliated parties

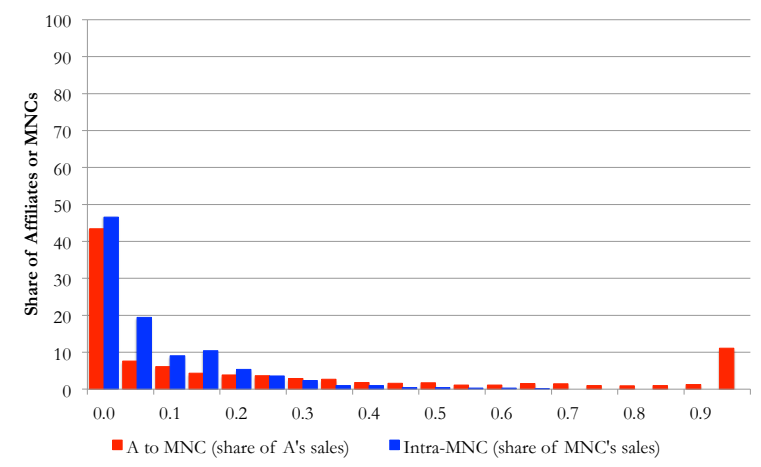
  Ramondo, Rappoport & Ruhl (2016)

  ... but some affiliates sale exclusively inside the MNC

Figure: Distribution of As and MNCs by intra-firm sales



(a) Affiliate-Parent



(b) Intra-MNC trade

How do International Activities affect Productivity?

- Effect of Exports on Innovation
  - Selection and reallocation effect
    Melitz (2003), Pavcnik (2002)
  - Natural Experiment: Causal effect of change in tariffs on firms' innovation
    Bustos (2011), Lileeva & Trefler (2010), Verhoogen (2008)
  - Complementarities: joint process of R&D, trade and productivity
    Costantini & Melitz (2007), Atkenson & Burstein (2008), Aw, Roberts & Xu (2011)
- Do these lessons apply to multinational activities?

Multinationals and Productivity

- Selection into multinational activities
  - Basic framework: CES demand+ monopolistic competition
    Helpman, Melitz & Yeaple (2004)
- MNCs and cross-country productivity
  - Macro-accounting
    Alviarez, Cravino & Ramondo (2020)
- Transmission of technology within the MNC?
  - Structural IO
    Bilir & Morales (2020)
- How does that feed back into MNC's incentives to innovate?
  - Calibrated model
    Goldman, Guadalupe, Rappoport & Roerig (2023)
- Are Affiliates better just because they adopt Parent's technology?
  - Applied Micro
    Guadalupe, Kuzmina & Thomas (2012)

Selection

- Heterogeneous firms and fixed/entry cost

  Melitz (2003), Helpman et al. (2004),...

  - Cost structure: fixed/sunk and variable costs: $C(q,\varphi) = f + q\frac{w}{\varphi}$
  - Monopolistic competition and CES demand with elasticity σ

$$p(\varphi)q(\varphi) = \underbrace{(PQ)}_{Y} \underbrace{\left(\frac{P}{p(\varphi)}\right)^{\sigma-1}}_{mkt\ \ share} \qquad p_j(\varphi) = \frac{\sigma}{\sigma-1}\frac{w_n}{\varphi_j} \qquad j \in \{d,x,f\}$$

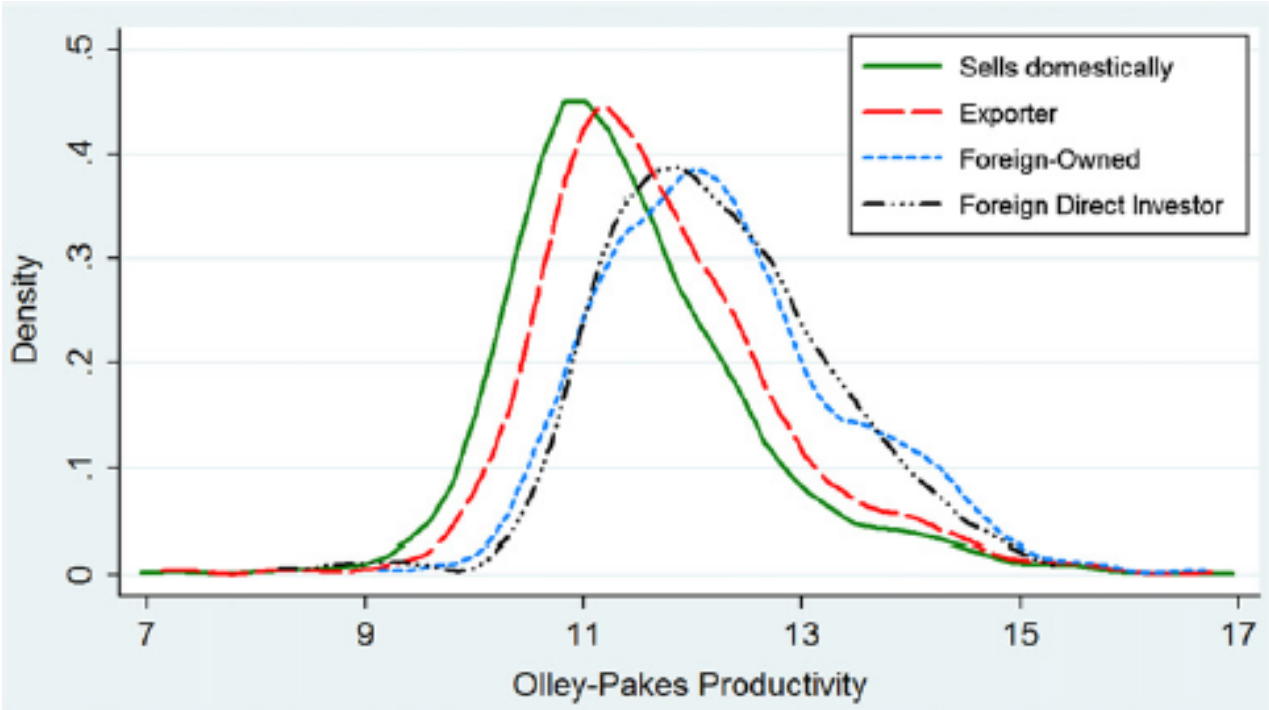
  - Profit maximization

$$\begin{aligned}
\varphi_d = \varphi \quad &: \quad \pi^d(\varphi) = \tfrac{(1-\sigma)^{1-\sigma}}{\sigma}\varphi^{\sigma-1}\left(\tfrac{P}{w}\right)^{\sigma-1} Y - f \\
\varphi_x = \varphi\cdot\tau_x^{-1} \quad &: \quad \pi^x(\varphi) = \tfrac{(1-\sigma)^{1-\sigma}}{\sigma}\varphi^{\sigma-1}\left[\left(\tfrac{P}{w}\right)^{\sigma-1} Y + \tau_x^{1-\sigma}\left(\tfrac{P^*}{w}\right)^{\sigma-1} Y^*\right] - f - f_x \\
\varphi_f = \varphi\cdot\kappa_f^{-1} \quad &: \quad \pi^m(\varphi) = \tfrac{(1-\sigma)^{1-\sigma}}{\sigma}\varphi^{\sigma-1}\left[\left(\tfrac{P}{w}\right)^{\sigma-1} Y + \kappa_f^{1-\sigma}\left(\tfrac{P^*}{w^*}\right)^{\sigma-1} Y^*\right] - f - f_m
\end{aligned}$$

- Positive Cross-Derivative (Supermodularity): $\frac{\partial^2\pi(Y,\varphi)}{\partial\varphi\ \partial Y} > 0$

Selection into International Activities

- Variable vs. Fixed/Sunk cost: proximity-concentration trade off



Source: Antras & Yeaple (2014) - Spanish firms

- Still to answer:
  - Is it true that Parent productivity is transfered to foreign Affiliates?
  - How does FDI affect productivity in host countries?
  - Do best firms become MNCs and/or MNC makes them better?

MNCs
and
Cross-Country Productivity

MNCs and cross-country productivity

- A macro-accounting approach: Alviarez, Cravino & Ramondo (2020)
  - Productivity of MNC from s in n: $\varphi_{s,n} = Z_n \; \varphi \; \kappa_{s,n}^{-1}$

$$y_{s,n}(\varphi) = Y_n \underbrace{\left(\frac{P_n}{p_{s,n}(\varphi)} \right)^{\sigma-1}}_{mkt \;\; share} \qquad p_{s,n}(\varphi) = \frac{\sigma}{\sigma-1} \frac{w_n}{Z_n} \frac{\kappa_{s,n}}{\varphi}$$

  - No-trade in intermediates. All n-output is produced in n

$$P_n = \frac{\sigma}{\sigma-1} \frac{w_n}{Z_n} \underbrace{\left[\sum_s \int_{\varphi \in M_{s,n}} \varphi_{s,n}^{\sigma-1} d\varphi \right]^{\frac{1}{\sigma-1}}}_{\Phi_n}$$

  - Productivity from market shares of MNCs across countries:

$$MarketShare_{s,n}(\varphi) = \left(\frac{\varphi}{\kappa_{s,n} \Phi_n} \right)^{\sigma-1}$$

MNCs and cross-country productivity

- Data:
  - MNCs: Ultimate parent, revenues by location-industry of affiliate (Orbis)
  - Macro: Revenues by country-industry (Klems) and IncomePW (PennTables)

- Recovering country's firm-embedded productivity from market shares

$$\begin{aligned} \log\ MktShare_{s,n}(\varphi) &= (\sigma-1)(\log\varphi - \log\kappa_{s,n} - \log\Phi_n) \\ &= FE_i - [\beta_l lang_{s,n} + \beta_d dist_{s,n}] - \widetilde{\Phi}_n \end{aligned}$$

- What is aggregate TFP?

$$\frac{Y_n}{L_n} = Z_n \times \Phi_n$$

Z_n Country-n's general productivity: institutions? markets? (residual)

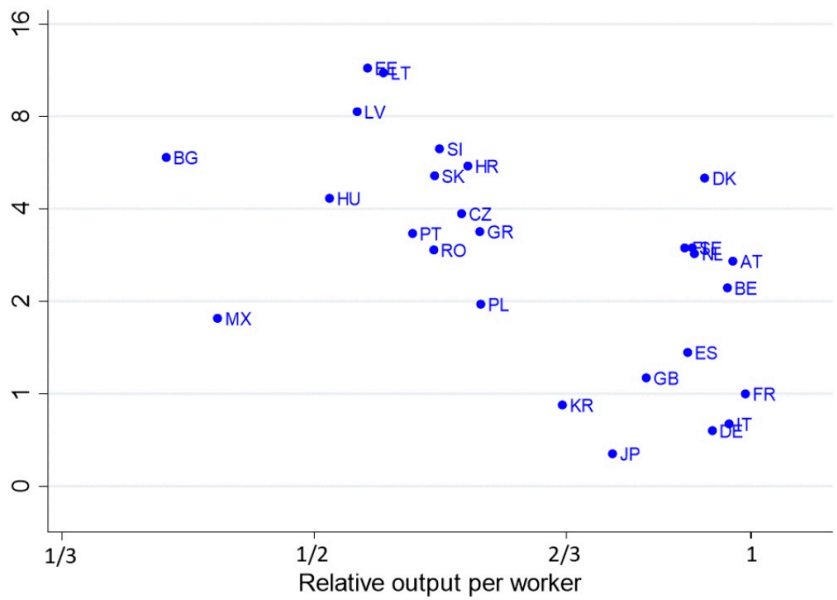
Φ_n Country-n's firm-embedded productivity

MNCs and cross-country productivity

- Intuition:
  - MNCs productivity similar across countries
  - But countries have very different domestic-firm productivities

  $\rightarrow$ MNCs have larger mkt share in countries with low firm-productivity Φ

Figure: MNCs Market Shares



Note: output per worker and market shares, expressed relative to France

MNCs and cross-country productivity

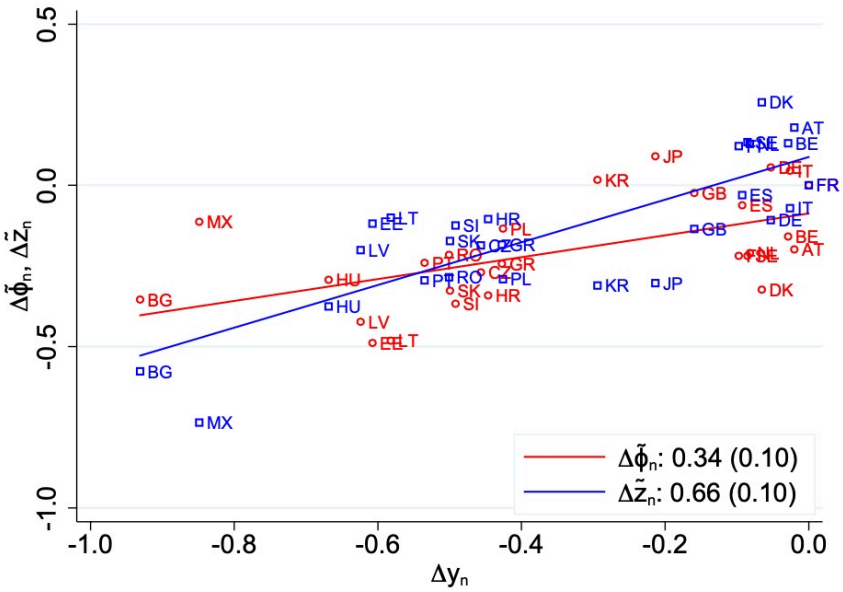


Figure: TFP Decomposition

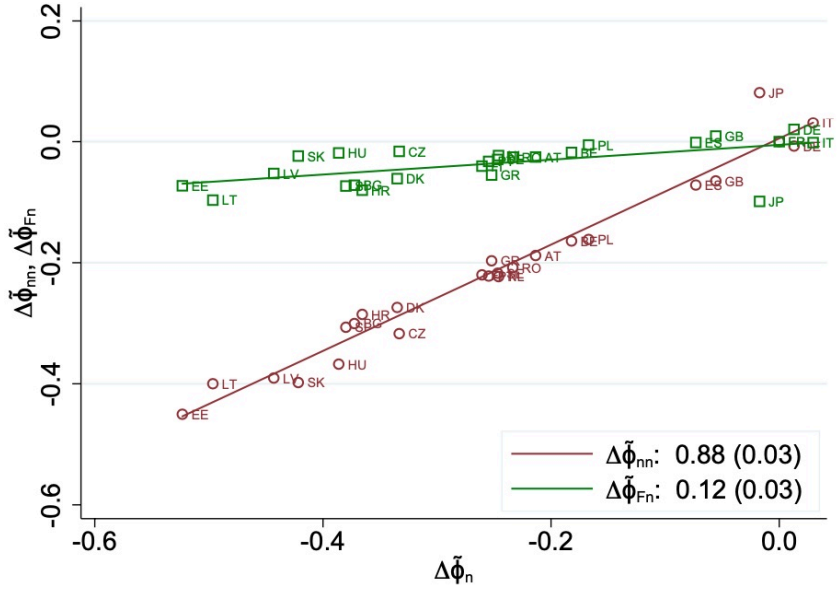


Figure: Φ Decomposition

$$\frac{Y_n}{L_n} = Z_n \times \Phi_n$$

$$\Delta y_n = \Delta z_n + \Delta \phi_n$$

$$\Delta\phi_n \approx \underbrace{MS_{nn}\Delta\phi_{nn}}_{\Delta\widetilde{\phi}_{nn}} + \underbrace{(1-MS_{nn})\Delta\phi_{Fn}}_{\Delta\widetilde{\phi}_{Fn}}$$

domestic firms *MNCs*

Beyond macro-accounting...

- Cool idea: derive productivity from mkt shares of same firm across countries
- Transferability of productivity to foreign affiliates (logs)

$$\varphi_{i,sn} = \varphi_i - \kappa_{s,n}$$

with $\kappa_{s,n} = \kappa_s + \alpha_l \ lang_{s,n} + \alpha_d \ dist_{s,n}$

  - Are productivity transfers separable in firm vs. country components?
  - Are affiliates mere recipients of parent's productivity?
  - Is transferability one-way or two-way process?
  - Are there other sources of complementarities between parent-affiliate?

Transmission of technology
within
the Multinational Corporation

Transmission of technology to foreign affiliates

- A micro structural approach: Bilir & Morales (2020)

  Simplified version: no demand shocks, no capital nor materials, only labor

$$V[\{S_{it}\}_i] = \max_{\{C_{it}\}} \left\{ \sum_{i \in I_t} \Pi(S_{it}, L_{it}, P_{it}, R_{it}) + \delta E[V(\{S_{it+1}\}_i) | \{S_{i,t}, R_{i,t}\}_i] \right\}$$

  where

$$\text{State:} \quad S_{it} = [\varphi_{it}, W_{nt}, Q_{nt}, P_{nt}]$$

$$\text{Control:} \quad C_{it} = [L_{it}, P_{it}, R_{it}]$$

$$\text{Demand:} \quad Q_{it} = Q_{nt}(P_{it}/P_{nt})^{-\sigma}$$

$$\text{Prod Fn:} \quad Q_{it} = L_{it}^{\alpha} \exp\{\varphi_{it}\}$$

$$\text{Prod:} \quad \varphi_{it} = \mu_{\varphi}\varphi_{i,t-1} + g(d_{i,t-1}, r_{i,t-1}, d_{0,t-1}, r_{0,t-1}) + \eta_{it}$$

  moreover:

$$\text{Noise:} \quad Y_{it} = P_{it}Q_{it} \ \exp\{\epsilon_{it}\}$$

- Structure involves timing of effects and shocks $\rightarrow$ identification

Transmission of technology to foreign affiliates

- Step 1: Static and flexible optimization of Labor (or materials)
  - For each affiliate i:

$$\max_{L_{it}} \quad P_{it}Q_{it} - W_{nt}L_{it}$$

s.t. $P_{it}Q_{it} = P_{nt}Q_{nt}^{1/\sigma}[L_{it}^{\alpha}\exp\{\varphi_{it}\}]^{1-1/\sigma}$

$$\begin{aligned} foc(L): \quad W_{nt}L_{it} &= \left[\left(1-\tfrac{1}{\sigma}\right)\alpha\right] \cdot P_{it}Q_{it} \\ w_{it} &= \ln(\widetilde{\alpha}) + y_{it} - \epsilon_{it} \end{aligned}$$

  - All information (except noise) embedded in static flexible choices:

$$GMM: \quad E\left[y_{it} - w_{it} + \ln(\widetilde{\alpha})|L_{it}, i \in I_t\right] = 0$$

Transmission of technology to foreign affiliates

- Step 2: We are interested in μ

$$\widetilde{\varphi}_{it} = \mu_{\varphi}\ \widetilde{\varphi}_{i,t-1} + g(d_{i,t-1}, r_{i,t-1}, d_{0,t-1}, r_{0,t-1}|\mu) + \eta_{it}$$

  - Use $\hat{y}_{it}$ from Step 1 to derive affiliate-i's productivity

$$\begin{array}{rcccccc} P_{it}Q_{it} & = & P_{nt}Q_{nt}^{1/\sigma} & & [L_{it}^{\alpha} & \cdot & \exp\{\varphi_{it}\}]^{1-1/\sigma} \\ y_{it} - \epsilon_{it} & = & \nu_{nt} & + & \widetilde{\alpha}\ l_{it} & + & \underbrace{(1-1/\sigma)\,\varphi_{it}}_{\widetilde{\varphi}_{it}} \end{array}$$

$\rightarrow$ Then: $\widetilde{\varphi}_{it} = y_{it} - \underbrace{[\hat{\widetilde{\alpha}}\ l_{it} + \hat{\epsilon}_{it}]}_{\hat{y}_{it}} - \nu_{nt}$

$$GMM: \quad E\left[\eta_{it}|Z_{it-1}, \nu_{nt}\right] = 0$$

  - Z_{it-1}: factors in $\widetilde{\varphi}_{it}$ set at $t-1$ $(y_{i,t-1} - \widehat{y}_{i,t-1}, d_{i,t-1}, r_{i,t-1}, d_{0,t-1}, r_{0,t-1})$
  - ν_{nt}: n-t Fixed effects

Results: Transmission of Technology

	Affiliate and Parent	Complementarities
Persistence	0.74***	0.74***
	(0.180)	(0.018)
A's R&D elasticity		
Unconditional	0.0106***	0.0063
	(0.003)	(0.004)
P's R&D>0		0.0070
		(0.004)
P's R&D elasticity		
Unconditional	0.0122***	0.0133***
	(0.004)	(0.004)
A's R&D>0		0.026***
		(0.004)
Obs	4,008	4,008

Conclusion: Transmission of Technology

- R&D is more concentrated on Parent than production
  - R&D by the Parent increases productivity of foreign Affiliates
  - Substantially more if Affiliate complements with own R&D
  - Not shown: no cross-affiliate complementarities in R&D
- Some remaining questions
  - Is R&D specially transferable source of productivity (patent, product, technology)?
  - How do multinational activities affect P's incentives to innovate?
  - Decision to expand into foreign affiliates is also jointly determined...

Joint process of

innovation and

multinational expansion

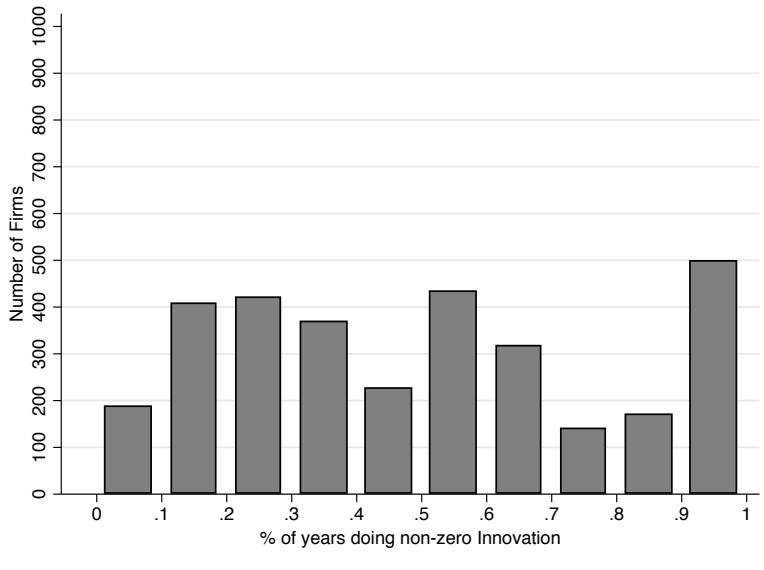
What is the difference between innovation and R&D?

1. Change in technology/organization at the inside of the firm, rather than pushing industry knowledge frontier

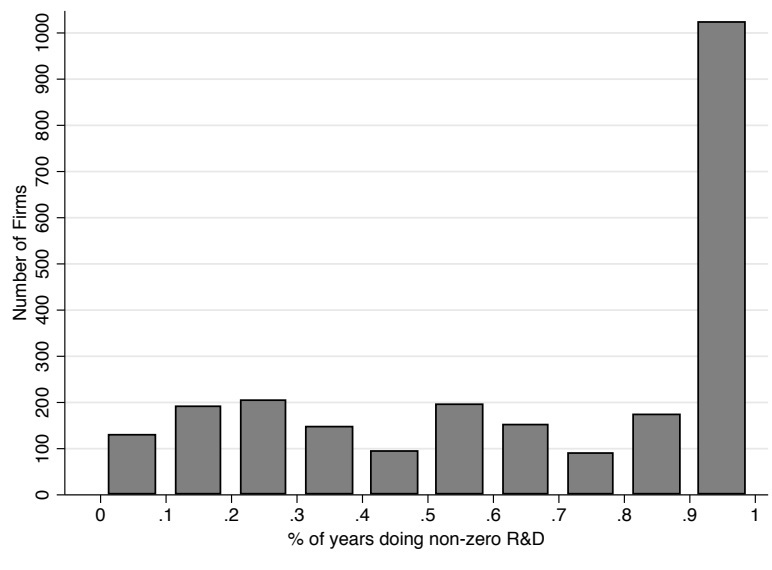
	Number of Patents$_{it}$ (Poisson Regression)		
Product Innovation Freq$_{it-1}$	0.242		0.290
	(0.312)		(0.356)
Process Innovation Freq$_{it-1}$		0.020	-0.106
		(0.294)	(0.335)
ln$(1 + R\&D\ Stock_{it-1})$	0.806***	0.828***	0.808***
	(0.151)	(0.165)	(0.154)
Year FE	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
N	8494	8494	8494

What is the difference between innovation and R&D?

2. Variations in Innovation mostly at the extensive margin, while in R&D mostly at the intensive margin



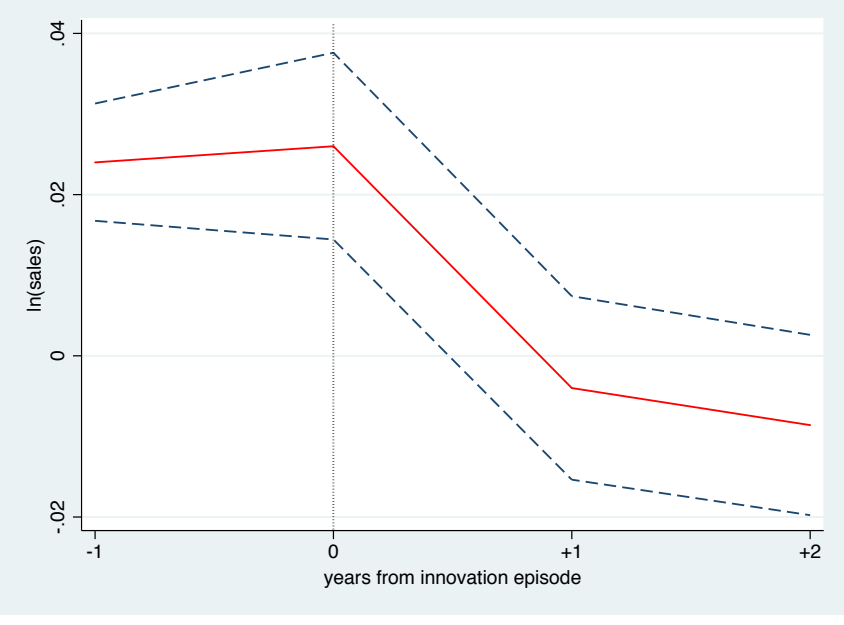
(a) Frequency of Process Innovations



(b) Frequency of R&D

How does innovation affect sales growth?

- High-growth firms innovate more often. But growth drops after innovation



	ln $DomesticSales_{it}$	
	domestic	MNC
N Inn_{it}	0.031***	0.019*
	(0.005)	(0.010)
$Trend_{i \in s}$	-0.003	0.045**
	(0.007)	(0.022)
Time FE	✓	✓
Firm FE	✓	✓
Obs	10591	1217

Joint process of innovation and MNC expansion

- Innovation, growth and FDI
  - Baby MNCs innovate more often and grow faster than domestic
  - But growth drops upon first entry into multinational activities.

	$\Delta \ln(Sales_{it})$	$\Delta \ln(DomSales_{it})$	$\Delta \ln(X_{it})$
ΔFDI_{it+1}	-0.004	-0.052	0.222
	(0.031)	(0.045)	(0.160)
ΔFDI_{it}	0.220*	0.081	0.180
	(0.122)	(0.176)	(0.251)
ΔFDI_{it-1}	-0.032	0.036	-0.174*
	(0.022)	(0.050)	(0.084)
ΔFDI_{it-2}	-0.077**	-0.078**	-0.162**
	(0.028)	(0.036)	(0.064)
Year FE	Yes	Yes	Yes
R^2	0.140	0.056	0.025

Propensity Score Matching: Industry, Initial Productivity and Size, and Export Status

How can we rationalize these facts?

- Firm-i profits at time t:

$$\pi_{it}(a, h, M) = M \underbrace{\left(a_{it}^{1/2} h_{it}^{1/2}\right)}_{\varphi_{it}^{\sigma-1}}$$

where: M :

$$\begin{cases} M_d = \frac{(1-\sigma)^{1-\sigma}}{\sigma} \left[\left(\frac{P}{w}\right)^{\sigma-1} Y + \tau^{1-\sigma} \left(\frac{P^*}{w}\right)^{\sigma-1} Y^* \right] \\ M_m = \frac{(1-\sigma)^{1-\sigma}}{\sigma} \left[\left(\frac{P}{w}\right)^{\sigma-1} Y + \kappa^{1-\sigma} \left(\frac{P^*}{w^*}\right)^{\sigma-1} Y^* \right] \end{cases}$$

- Technological capacity a_{it}: innovation = replacement

When no-innovation:	$t \in (t_n, t_{n+1})$	$a_t = a_n$
When innovation:	$t = t_n$	$a_{t_n-1} \to a_{t_n}$

- Expertise h_{it}: Continuous random process (ω *is a Brownian motion*)

$$\frac{dh_t}{h_t} = \mu \, dt + \sqrt{2} \, \sigma \, d\omega_t$$

The Model: Problem of the Firm

- MNC is absorbing state: Choose when and by how much to innovate

$$V_m(a_0, h_0) = \max_{\{\mathbf{t_N}, \mathbf{a_N}\}} E_0 \sum_{n=0}^{\infty} \left[\int_{t_n}^{t_{n+1}} \pi_m(a_n, h_t) e^{-rt} dt - a_n p \; e^{-rt_n} \right]$$

- Domestic firm: apart from innovation, also chooses if/when to enter

$$V_d(a_0, h_0) = \max_{\{\mathbf{t}, \mathbf{a}, \mathbf{t_M}\}} E_0 \sum_{n=0}^{\infty} \left[\int_{t_n}^{t_{n+1}} \left[\pi_d(a_n, h_t) + \Delta_\pi(a_n, h_t) \mathbf{1}_{\mathbf{t} > \mathbf{t_M}} \right] e^{-rt} dt - a_n p \; e^{-rt_n} \right.$$
$$\left. - e^{-rt_M} F_M \right]$$

with:

$\mathbf{t_N} = [t_1, ..., t_n, t_{n+1}, ...]$: when to replace technology

$\mathbf{a_N} = [a_1, ..., a_n, a_{n+1}, ...]$: by how much?

p : lumpiness comes from replacement of technology

t_M: when to acquire foreign unit

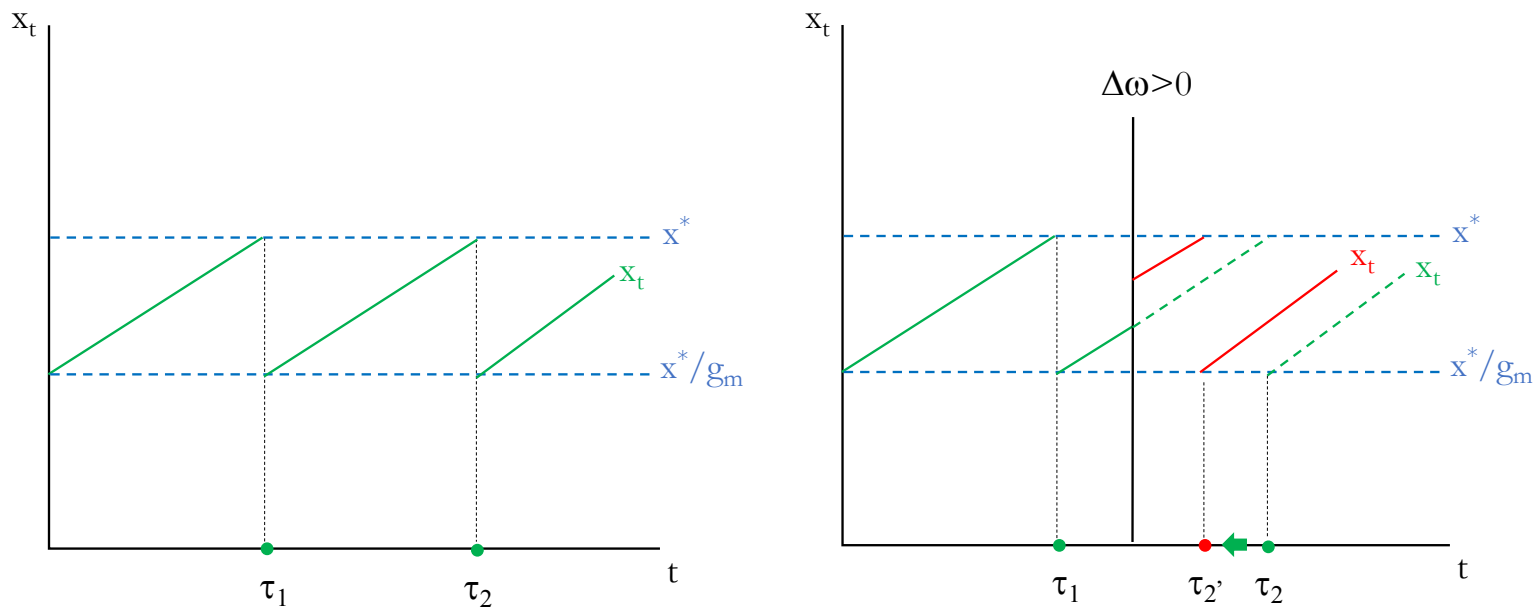
F_M: cost of multinational expansion is scale-invariant

Intuition of the Solution: Optimal Innovation once Multinational

- Accumulate expertise h until reaching h^*, then replace technology
  - Trigger capacity utilization x^* and growth rate g_m constant

$$x^* = M^2 \frac{h^*}{a} \quad \rightarrow \quad a' = a\, g_m$$

Figure: Capacity utilization ($x = M^2 h/a$)

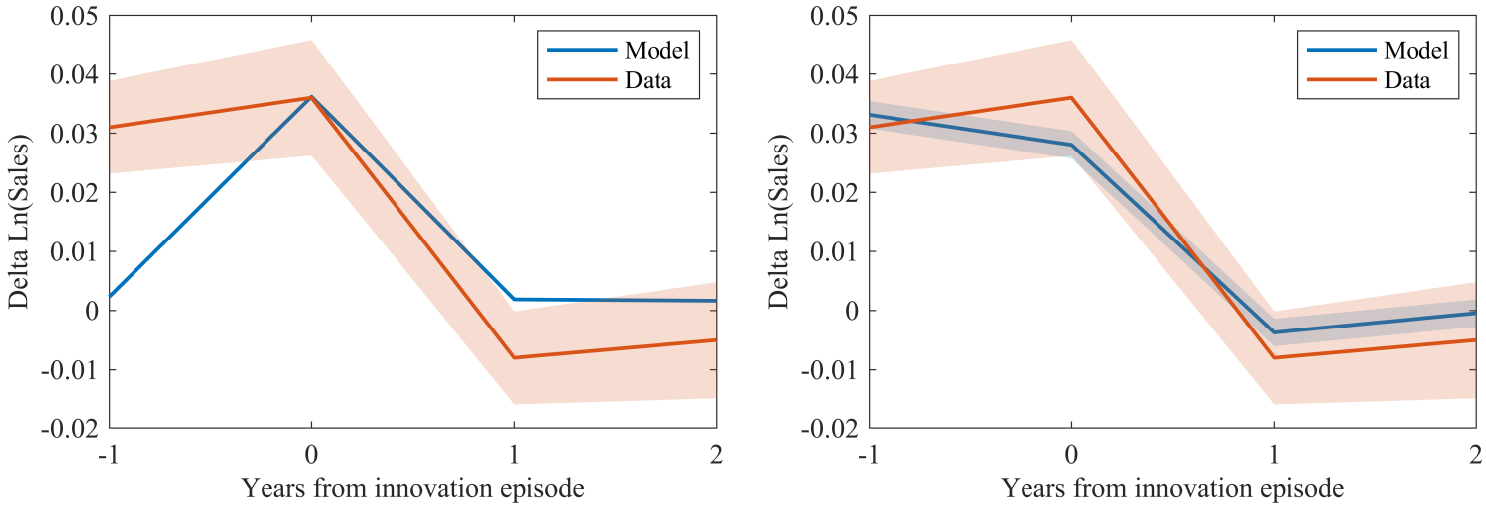


(a) No Shocks ($\Delta\omega = 0$)

(b) Positive Shock ($\Delta\omega > 0$)

Intuition of the Solution: Optimal Innovation once Multinational

- Simulated and Real Data: regression around time of innovation
  - De-trended. Propensity score matching on initial conditions



(a) No uncertainty ($\sigma = 0$)

(b) Uncertainty ($\sigma = 0.05$)

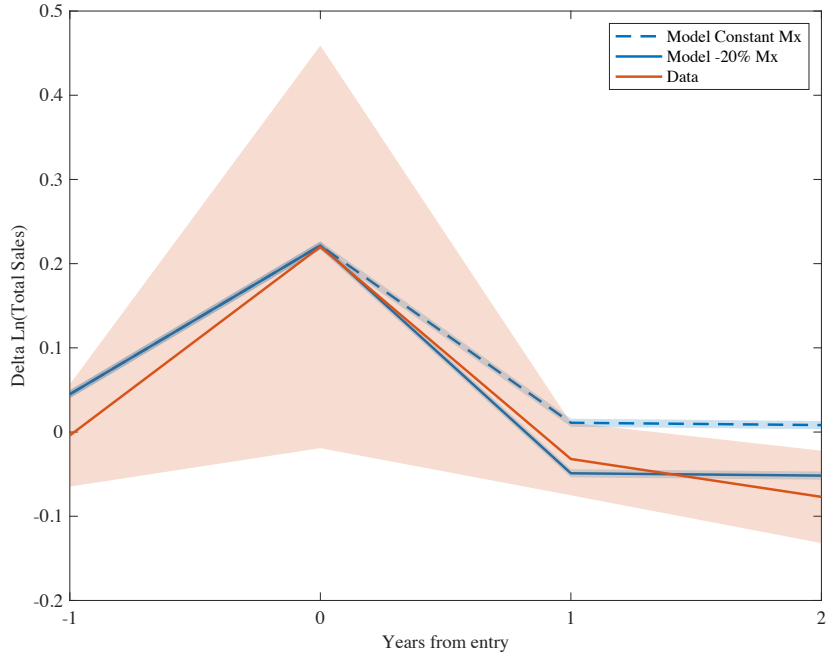
- Intuition for Calibration
  - Jump at 0: growth of technology $\rightarrow$ governs cost/profit of innovation
  - Growth before 0: selection of the lucky ones $\rightarrow$ governs volatility of shock

Intuition of the Solution: Optimal Entry into Multinational

$$M = \begin{cases} M_d = \frac{(1-\sigma)^{1-\sigma}}{\sigma} \left[\left(\frac{P}{w} \right)^{\sigma-1} Y + \tau^{1-\sigma} \left(\frac{P^*}{w} \right)^{\sigma-1} Y^* \right] \\ M_m = \frac{(1-\sigma)^{1-\sigma}}{\sigma} \left[\left(\frac{P}{w} \right)^{\sigma-1} Y + \kappa^{1-\sigma} \left(\frac{P^*}{w^*} \right)^{\sigma-1} Y^* \right] \end{cases}$$

HQ's Total Sales

- Random process & cost of innovation from MNC calibration
- Jump in growth (innovation) $\rightarrow$ 15% increase in market size for productivity improvements
- Decrease in sales growth $\rightarrow$ 20% MP substitution of exports
- From Data: median Baby MNC exports 30% of total sales



What do we learn from growth and innovation of Baby MNCs?

- Model-specific results
  - Innovation vs. R&D: Discrete options imply different performance around time of decision
  - Dynamic selection may bias naive OLS regression of FDI on productivity
- What are the GE effect? Some ideas
  - Parents become more productive
  - But split production towards foreign unit (substitute for Exports)
  - X and MP expansions have different impact on local price of inputs (and exit margin)
- Most FDI expansion in Spain (advanced economies) is M&A
  - Is export substitution the motive for foreign acquisitions?
  - Is the affiliates' superior productivity the result of transfer from Parent?
  - What do affiliates do upon acquisition?

Are Affiliates better

just because

they adopt Parent's technology?

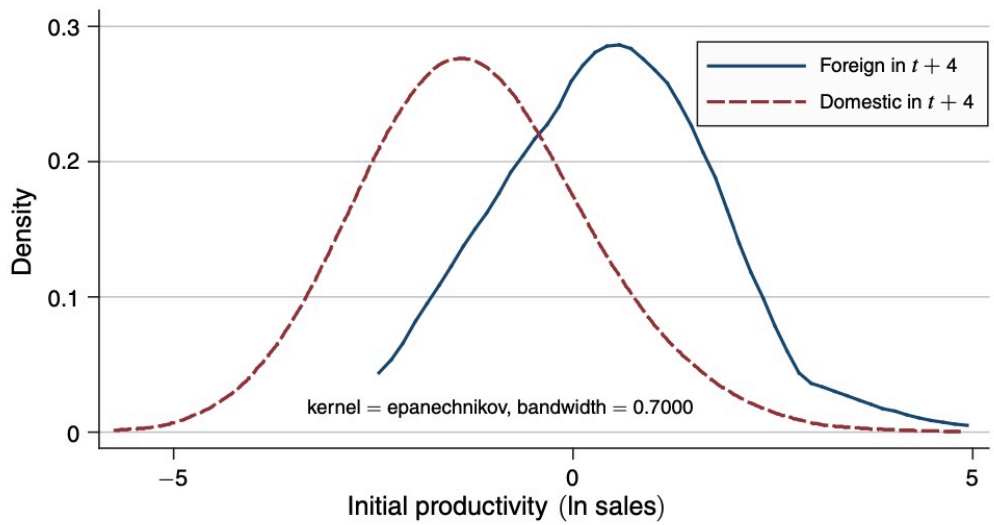
What is the Source of Affiliates' Superior Productivity?

- Guadalupe et al. (2012)
  - Foreign affiliates are more productive and larger than domestic firms
  - But developed economies 89% of MNC entry is through M&A

    Barba Navaretti & Venables (2004)

  → Target firms were cherry-picked

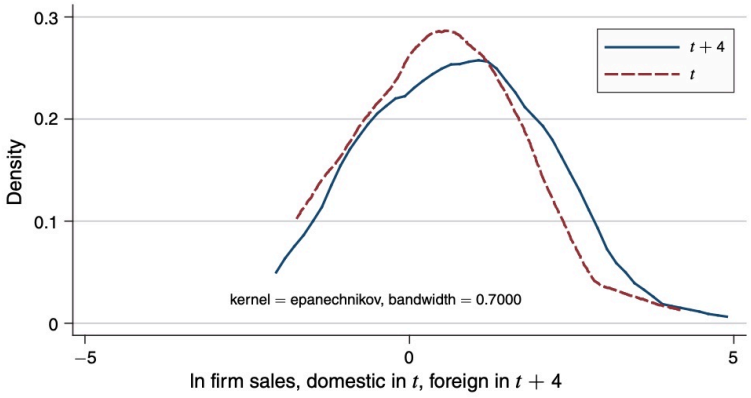
Figure: Foreign M&A: Selection of Target Firms



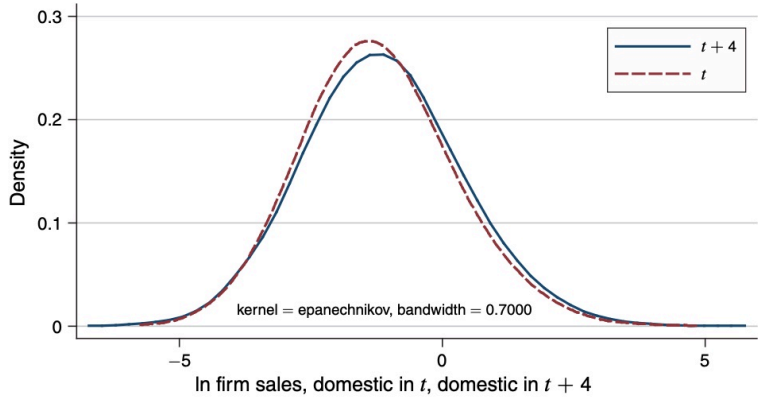
Data: Spanish manufacturing firms. Encuesta de Estrategias Empresariales

What is the Source of Affiliates' Superior Productivity?

- Target firms are originally top and become even better



(a) Acquired Firms



(b) Not-Acquired Firms

  - Do they adopt parent's superior technology?
  - Do they innovate more? Why? Lower cost of innovation? Higher benefits?

What is the Source of Affiliates' Superior Productivity?

- Innovation upon acquisition
  - Innovation in process (machinery and organization)
  - No new products nor adaptation of foreign technology

Dep. Variable	Process Inn	Product Inn	Foreign Tech
Lag Foreign	0.411***	0.219	-0.032
	(0.172)	(0.181)	(0.108)
Foreign	0.046	-0.901	0.151
	(0.109)	(0.113)	(0.110)
Forward Foreign	0.066	-0.042	0.108
	(0.149)	(0.162)	(0.075)
obs	12,767	12,767	2,886
Firm FE	✓	✓	✓
Time FE	✓	✓	✓
Selection controls	✓	✓	✓

What is the Source of Affiliates' Superior Productivity?

- Mechanism: market expansion through MNC's network

Dep. Variable	ln Exports	Exports/Sales
Lag Foreign	0.243*	0.040***
	(0.136)	(0.016)
Foreign	0.00	0.012
	(0.271)	(0.019)
Forward Foreign	0.084	0.012
	(0.174)	(0.013)
obs	12,767	7,026
Firm FE	✓	✓
Time FE	✓	✓
Selection controls	✓	✓

	Process Inn
Export via Parent	0.869***
	(0.303)
Export	0.160
	(0.119)
Lag Foreign	0.608
	(1.038)
Export × Lag Foreign	-0.248
	(1.026)
obs	4,096
Firm FE	✓
Time FE	✓
Selection controls	✓

What do we learn from Target firms?

- Selection and mechanisms
  - Selection is an equilibrium outcome given expected synergies and market for corporate control

  $\rightarrow$ Selection may bias naive estimations

  ... But we can also learn a lot from the observed matching patterns

- Firms have multiple dimensions of heterogeneity
  - Is Target firms' network also a motive for acquisition?
  - Size of network and productivity?
  - Markups?

- GE effect?
  - Cherry Picking different from *greenfield* FDI

Infinite Topic

Variety of different approaches depending on

question, application, and data

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