On the Challenges of Estimating the Gains from Multinational Production

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Core Ideas in Multinational Production Literature

- Dunning’s Ownership, Location, Internalization framework embraces Horizontal, Vertical, or Complex MP

- Multinationals create intangible assets (innovation) that can then be used abroad (production) and in multiple plants simultaneously
  - Increasing returns inherent in such a framework

- Once geographic frictions come into play: comparative advantage versus home market effects.

- Historically, insights illustrated with special frameworks (two or three countries)

- With general geography and general equilibrium, estimating the gains from multinational production is a difficult task.
Net MP and R&D: OECD countries specialize in innovation

**Figure:** R&D and Net MP in 1999

Note: R&D to local value added and outward and inward affiliates sales
Innovation and Production of US firms: Increased Specialization

Figure: R&D and Employment of U.S. manufacturing firms and their affiliates

Note: Sources OECD STAN, US Bureau of Economic Analysis. The employment share of US firms at their foreign affiliates is defined as total employment of US majority-owned, manufacturing affiliates abroad divided by total US manufacturing employment plus US majority-owned, manufacturing affiliates abroad minus the employment of the affiliates of foreign-owned manufacturing affiliates operating in the US.
Multinational production involves many geographic tradeoffs.
Plan of the Talk

- Describe an example of the current frontier of the literature
  - Show how main ideas of literature can be simplified for quantitative work
  - Illustrate the implications of such a framework

- Discuss insights from the existing theory literature than remain unincorporated into a computational framework
Innovation versus Production in the Global Economy

Arkolakis, Ramondo, Rodriguez-Clare, and Me
Notation

- $N$ countries.
  - $i$: origin of idea, $l$: production location, $n$: destination market

- $X_{iln}$: aggregate sales of firms from $i$, producing in $l$, selling to $n$

- $Y_l$: total production by all firms in location $l$
  - $\sum_{i,n} X_{iln} = Y_l$

- $X_n$: total spending of country $n$
  - $\sum_{i,l} X_{iln} = X_n$
Model Environment: Trade and MP

- Build on Melitz: monopolistic competition, heterogeneous firms
  - Firm: owner of idea to produce a good (blueprint, tacit knowledge etc)

- Representative consumer:
  - Measure of $\overline{L}_i$ consumers (work in production, $w_i$, or innovation, $w_i^e$)
  - Worker type is given by efficiency units of innovation and production labor $v = (v^e, v^p)$
  - Dixit-Stiglitz preferences, elasticity of substitution $\sigma$

- Firms:
  - Entry cost $w_i^e f^e$ (inclusive of effort to increase productivity)
  - Firms face iceberg and marketing trade costs, $\tau_{ln}$ and $w_n F_n$
  - In addition: Firms can produce abroad; face MP efficiency loss
Model Environment: to incorporate MP, we add

- To incorporate MP we assume:
  - Firms can produce anywhere using linear production fcn with labor
    - Firms from $i$ get productivity vector $\mathbf{z} = (z_1, \ldots, z_N) \sim G_i(z_1, \ldots, z_N)$
  - Firms face iceberg MP costs, $\{\gamma_{il}\}$

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

$$C_{iln} = \frac{\gamma_{il} W_l \tau_{ln}}{z_l}$$
Model with MP
Firm’s problem (proximity vs CA)

- Firm chooses cheapest production location for $n$:
  \[ l = \arg \min_v C_{ivn} \]

- Firm $i$ serves market $n$ if
  \[ \pi_n (C_{iln}) = \frac{(\tilde{\sigma} C_{iln})^{1-\sigma}}{\sigma P_n^{1-\sigma}} X_n - w_n F_n \geq 0 \]

- Characterize prob. with a MV distribution
Firm Productivities: MV-Pareto distribution

- Productivity \((z_1, \ldots, z_N)\) is drawn from

\[
G_i(z_1, \ldots, z_N) = 1 - \left( \sum_{l=1}^{N} \left[ T_i^e T_l^p z_l^{-\theta} \right]^{\frac{1}{1-\rho}} \right)^{1-\rho},
\]

with \(\rho \in [0, 1)\), and \(\theta > \sigma - 1\).

- \(\theta\) regulates across-firms, \(\rho\) within-firm heterogeneity of productivities
- Country \(i\) has CA in innovation if \(T_i^e / T_i^p\) is relatively high
Firm Productivities: Correlation

\[ N = 2, \text{ high } \rho, \ T_{il} = T_{ii} \quad N = 2, \text{ low } \rho, \ T_{il} = T_{ii} \]

As \( \rho \) is reduced

- Countries become less substitutable as production locations
- Greater concentration of production as product level (plays role of fixed cost in proximity-concentration framework).
Structure of Production

Total expenditure by country $n$ on goods produced in $l$ by firms originated in $i$ are

$$X_{iln} = \psi_{iln} \lambda_{in}^E X_n,$$

where

$$\lambda_{in}^E = \frac{M_i \Psi_{in}}{\sum_j M_j \Psi_{jn}},$$

$$\Psi_{in} \equiv \left[ \sum_v \left( T_{i,v}^e T_{v}^p (\gamma_{iv} w_v \tau_{vn})^{-\theta} \right)^{\frac{1}{1-\rho}} \right]^{1-\rho},$$

$$\psi_{iln} = \left( \frac{T_{i,l}^e T_{l}^p (\gamma_{il} w_l \tau_{ln})^{-\theta}}{\Psi_{in}} \right)^{1/(1-\rho)}$$
Trade and MP shares

- Expenditure shares of consumers in $n$ on goods produced in $l$ (trade shares)
  \[ \lambda_{ln}^T = \frac{\sum_i X_{iln}}{X_n} \]

- Production shares of firms from $i$ in $l$ (MP shares)
  \[ \lambda_{il}^M = \frac{\sum_n X_{iln}}{Y_l} \]
Worker Productivities

Let $v^e, v^p$ be iid draws from $\exp(- (v^i)^{-\kappa})$. Then, there exists a PPF for labor efficiencies.

- $\kappa < \infty$ creates increasing opportunity cost to innovation or production.
Equilibrium

- Current Account balance
- Zero profit condition
- Labor market clears
Innovation and trade imbalances

- Define $r_i \equiv w_i^e L_i^e / X_i$

- Trade deficit, $X_i > Y_i$, is equivalent to specialization in innovation

$$r_i = \frac{1}{\tilde{\sigma}} \frac{X_i - Y_i}{X_i} + \eta > \eta \text{ where } \tilde{\sigma} = \sigma / (\sigma - 1)$$

- $\eta = [\tilde{\sigma} \theta]^{-1}$ is the share of profits net of marketing costs
Main Forces at Work

- Comparative Advantage
  - Leads innovation to concentrate in countries with large $T_i^e / T_i^p$

- Home Market Effects
  - Frictionless trade, costly MP – Large Country Specializes in Entry
  - Frictionless MP, costly trade – Small Country Specializes in Entry
Gain from openness

- The gains from openness are

\[ GO_n \equiv \frac{X_n / P_n}{X_{\text{AUT}} / P_{\text{AUT}}} \]

- As in Arkolakis, Costinot, Rodriguez-Clare ’12 without MP

\[ GO_n = \left( \frac{X_{nn}}{X_n} \right)^{-\frac{1}{\theta}} \]

- \( GO_n \) with MP is

\[ GO_n = \left( \frac{\sum_l X_{nln}}{X_n} \right)^{-\frac{\rho}{\theta}} \left( \frac{X_{nnn}}{\sum_l X_{nln}} \right)^{-\frac{1-\rho}{\theta}} \left( \frac{1 - r_n}{1 - \eta} \right)^{\frac{1}{\kappa} \left( \frac{\sigma - 1 - \theta}{\theta(\sigma - 1)} - 1 \right)} \left( \frac{r_n}{\eta} \right)^{\frac{(1 - \frac{1}{\kappa})}{\theta}} \]

\( \text{Direct Effect} \quad \text{Indirect Effect of Innovation} \)
Countries CAN Lose from Openness

Indirect Effect can induce $GO, GT, GMP < 1$

- Countries that lose innovation experience ToT deterioration
- Related to Home Market Effects in Venables ’87
Calibration

- Construct Trade and MP shares, $\lambda_{ln}^T$, $\lambda_{il}^M$, using trade, MP flows & production data
  - Trade flows and output from WIOD, MP from UNCTAD
- $L_i$: equipped labor by Klenow Rodriguez-Clare ’05
- Gravity Equations imply key elasticities
Example Counterfactual

- How do changes in MP barriers affect income distribution across and within countries?
- Reduce all MP barriers, $\gamma_{il}$ for $i \neq l$, by 5%.
## MP Liberalization

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Extensions and Scope for Future Work
What are the Frictions that Discourage MP?

- Fixed versus variable MP costs (Yeaple 2009, Tintelnot 2016)
  - Foreign versus local R&D (Bilir and Morales 2015)

- Corporate taxation? (Fajgelbaum et al 2015)

- Nature of frictions depends on what the intangible assets of the firm are.
  - Local versus universal appeal of products? (Cosar, Grieco, Li, and Tintelnot, 2015)
  - Technology transfer costs? (Keller and Yeaple 2013)
  - Cultural and institutional differences? Foxconn as an intermediary between foreign technology and Chinese labor

- Demand and difficulties of access of local firms to foreign markets
  - Headquarters gravity (Wang, 2015)
The Problem of Cross Border Mergers

- Multiple intangible asset models (Nocke and Yeaple, 2007, 2008)
  - Technology, brand name, distribution network, relationship with customers
  - Where is the innovation occurring? (Head and Mayer 2015)
  - Does production technology buy brand name or does brand name buy technology?

- Potential Example: Chinese purchases of developed country assets.
Complex MP and Interdependencies (Yeaple 2003)

Assumptions

- Goods produced from intermediates that vary in factor intensity
- Comparative advantage across countries in intermediates
- **Fixed costs** of production for each plant
- Trade costs

Theory Implications

- Lower (higher) trade costs can encourage Horizontal (Vertical) MP
- MP restrictions in one country can discourage MP in another

- For empirical evidence, see Chen (2010, 2011).
Asymmetries in Production Locations

- Final goods assembled from a continuum of intermediates
- Trade costs are lower within regions than across
- Intermediates differ in the size of the fixed cost
- Assembly plants also require fixed cost
Yeaple (2008)

- Intra-firm Trade concentrates in central places
- Most affiliates export nothing
Intermediates: The Problem of External Economies of Scale

- Hollowing out concerns in developed countries
  - Steve Jobs: production is not going to come back to the United States because the supplier base has moved to Asia

- External economies of scale can give rise to multiple equilibria
  - recent work by Lyn, Kucheryavvy, and Rodriguez-Clare (2015) gives hope that these problems have a solution
  - recent work by Wang (2015) suggests that “Hollowing Out” does have the potential to shift the gains from trade away from innovative countries.
Multiproduct Firms and the Correct Unit of Observation

- **Vertical dimension: Problem of Outsourcing**
  - Are MP flows just the tip of the iceberg in measuring specialization in innovation versus production?

- **Horizontal dimension: firm heterogeneity and the scope of the firm**
  - Keller and Yeaple (2015)
  - Not obvious how to aggregate products to firms.
Conclusion

- Multinational firms in general equilibrium touch on almost all aspects of international trade theory

- Key welfare implications of international trade (i.e. trade in intangible assets, factor service trade intermediation) cannot be analyzed in the absence of MP

- There has been rapid progress incorporating the implications of thirty year old theories of MP into quantifiable general equilibrium settings (e.g. Helpman 84, Markusen 84)

- Plenty of work for the clever and bold with regard to the theories of the last twenty years!!