On the Challenges of Estimating the Gains from Multinational Production

> Stephen Yeaple Penn State and NBER

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Core Ideas in Multinational Production Literature

- Dunning's **O**wnership, **L**ocation, **I**nternalization 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.

Complex and Export Platform MP



Note: This figure displays the share of output that is exported to countries outside the boxt country by US multitational "majority-owned foreign adfinition in the manufacturing sector. For the European countries displayed in the figure, typically only about 5 percents of the output is sold back to the US. An exception is leduad, for which foreign affinises in the manufacturing acceler relative to the two stars in the manufacturing integration of the stars of the stars foreign affinises in the manufacturing acceler and the protein of their output to countries outside theory of South Source 180. The stars of the star 2004. Source 180. The stars of the stars of

• 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 quantitiative 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, I: 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 $\mathbf{v} = (v^e, v^p)$
- Dixit-Stiglitz preferences, elasticity of substitution $\boldsymbol{\sigma}$

• Firms:

- Entry cost $w_i^e f^e$ (inclusive of effort to increase productivity)
- Firms face iceberg and marketing trade costs, τ_{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 $\mathbf{z} = (z_1, ..., z_N) \sim G_i(z_1, ..., z_N)$
 - Firms face iceberg MP costs, $\{\gamma_{il}\}$
- Assumptions imply unit cost for firm **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:

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

• Firm *i* serves market *n* if

$$\pi_{n}(C_{iln}) = \frac{\left(\widetilde{\sigma}C_{iln}\right)^{1-\sigma}}{\sigma P_{n}^{1-\sigma}} X_{n} - w_{n}F_{n} \ge 0$$

• Characterize prob. with a MV distribution

Firm Productivities: MV-Pareto distribution

• Productivity $(z_1, ..., z_N)$ is drawn from

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

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

- heta regulates across-firms, ho within-firm heterogeneity of productivities
- Country *i* has CA in innovation if T_i^e / T_i^p is relatively high

Firm Productivities: Correlation



As ρ is reduced

- Countries become less substitutiable 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

$$\lambda_{in}^{E} = \frac{M_{i}\Psi_{in}}{\sum_{j}M_{j}\Psi_{jn}},$$

$$\Psi_{in} \equiv \left[\sum_{v} \left(T_{i}^{e} T_{v}^{p} (\gamma_{iv} w_{v} \tau_{vn})^{-\theta}\right)^{\frac{1}{1-\rho}}\right]^{1-\rho},$$
$$\psi_{iln} = \left(\frac{T_{i}^{e} T_{l}^{p} (\gamma_{il} w_{l} \tau_{ln})^{-\theta}}{\Psi_{in}}\right)^{1/(1-\rho)}$$

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 *I* (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

$$r_i = rac{1}{\widetilde{\sigma}} rac{X_i - Y_i}{X_i} + \eta > \eta \; \; ext{where} \; \widetilde{\sigma} = \sigma / \; (\sigma - 1)$$

•
$$\eta = \left[\widetilde{\sigma} heta
ight]^{-1}$$
 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

$$GO_n \equiv \frac{X_n/P_n}{X_n^{AUT}/P_n^{AUT}}$$

• 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

$$GO_n = \underbrace{\left(\frac{\sum_{l} X_{nln}}{X_n}\right)^{-\frac{\rho}{\theta}} \left(\frac{X_{nnn}}{\sum_{l} X_{nln}}\right)^{-\frac{1-\rho}{\theta}} \left(\frac{1-r_n}{1-\eta}\right)^{\frac{1}{\kappa} \left(\frac{\sigma-1-\theta}{\theta(\sigma-1)}-1\right)} \left(\frac{r_n}{\eta}\right)^{\left(1-\frac{1}{\kappa}\right)\frac{1}{\theta}}}_{\text{Direct Effect}}$$

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, λ_{ln}^T , λ_{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 Counterfactural

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

MP Liberalization

% change:	r	X/P	w/P	w ^e /P
BNL	13.45	6.09	4.60	10.62
BRA	-4.57	0.31	0.60	-1.26
CAN	-4.47	3.50	3.76	1.93
CHN	-4.64	0.29	0.58	-1.29
CYP	-1.98	0.37	0.51	-0.30
FRA	1.71	2.71	2.58	3.26
GBR	3.80	3.93	3.64	5.20
GER	1.31	2.98	2.87	3.41
GRC	-3.15	0.13	0.40	-1.18
IRL	13.74	5.47	4.91	10.04
ITA	-3.39	1.18	1.43	-0.05
JPN	1.60	1.11	0.98	1.60
KOR	-1.08	0.63	0.73	0.19
MEX	-9.17	0.69	1.20	-2.49
PRT	-10.76	3.20	3.61	-0.78
ROM	-4.50	0.04	0.35	-1.49
TUR	-3.57	0.04	0.30	-1.23
USA	2.22	1.65	1.38	2.54
average	-1.48	2.18	2.20	1.58

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 occuring? (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
- Empirical evidence: Head and Mayer (2004), Yeaple (2008)

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
 - Antras (2003), Antras and Helpman (2004), Antras and Chor (2015)
 - 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!!