The Margins of Multinational Production and the Role of Intrafirm Trade

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Fact 1: The cross-country pattern of MP fits the gravity relationship well, e.g. Navaretti and Venables (2000). But not clear that gravity is a valid theoretical specification.
Fact 2: Strong support in favor of the horizontal FDI model (HFDI), e.g. Markusen and Maskus (2001, 2002), Chor, Manova & Watt (2008)....But the vanilla HFDI model gives opposite of gravity. FC constant ⇒ No Norwegian MP in Denmark but lots in Japan. Opposite in data.

Puzzle: How to reconcile facts (1)-(2) ?

Our answer: *Intrafirm trade* from headquarter to affiliate.

- Intra-firm exports relative to total exports for US MNEs: 30 – 40% (Bernard et al 2005)
- The direction of intrafirm trade: 11% of affiliate costs are accounted for by imports of intermediate inputs from U.S. parent (Hanson et al 2003)

Alternative answer: FC of MP are increasing in distance
Questions

- Q1: Can geographical differences in fixed costs alone explain the geography of MP?
- Q2: Intrafirm trade ($\alpha$) is unobserved but maybe it’s possible to identify it, given coefficient estimates?
- Q3: Perform counterfactuals accounting for general equilibrium effects.
Model

- N potentially asymmetric countries - homogeneous good (numeraire) - continuum of differentiated goods (CES)
- Marginal costs of supplying one unit of the good for a firm based in country $i$ with productivity $z$,
  - $w_i/z$ for domestic market $i$
  - $w_i \tau_{in}/z$ for exports to market $n$
  - (NEW) $(w_i \tau_{in})^{1-\alpha} w_n^\alpha/z$ for MP to market $n$
- Both exports and MP require the firm to sustain a fixed cost ($f_E$ and $f_I$).
- (NEW) Introduce firm-destination-specific sales and entry cost shocks. Shocks are lognormal. Entry and sales shocks to destination $n$ can be correlated, otherwise $iid$ over firms $j$ and destinations $n$. 
Profit Functions and Cutoffs

\begin{align*}
F_D & (z) \\
E & (z) \\
\bar{z}_I & \\
\bar{z}_E & \\
\end{align*}

\text{Irarrazabal, Moxnes and Opromolla}
Gravity for MP?

The MP cutoff is increasing with variable trade costs (≈distance), i.e. the elasticity $\chi_I > 0$, iff

$$\left( \frac{w_i \tau_{in}}{w_n} \right)^{(\sigma - 1)} (1 - \alpha) > 1. \quad (1)$$

So the number of MP firms decreases with distance if

- intrafirm trade $(1 - \alpha)$ is high
- distance $(\tau_{in})$ or input costs differential $\omega_{in}$ (home vs. abroad) is high
- goods are highly substitutable (high $\sigma$)

Intuition: "MP revenue” > ”Export revenue” but the latter is more sensitive to variable trade costs
General equilibrium

- Assume firm productivity is Pareto with shape parameter $\gamma > \sigma - 1 \Rightarrow$ then possible to calculate the price index $P_n$ in closed form.
- We derive micro-founded gravity equations for total exports, total affiliate sales, number of exporters, number of affiliates.
- Extensive and Intensive margins (for total affiliate sales)

\[
\frac{d \ln S_{inl}}{d \ln \tau_{in}} = -\frac{(1-\alpha)(\sigma-1)}{\chi_I} - \frac{\gamma-\sigma+1}{\chi_I}
\]

where $\chi_I$ is the elasticity of the FDI cutoff to variable trade barriers.
Estimation: Entry

Entry ⇒ Ordered Probit

- Define the cutoffs

\[ M_{nl} \equiv \ln \sigma - \kappa_n + \ln \Omega_n \quad \text{and} \]
\[ M_{nE} \equiv \ln \sigma - \kappa_n + \ln f_{nE} \]
\[ \kappa_n \equiv \ln \left( \frac{Y_n}{Y_H} \right) + (\sigma - 1) \ln \left( \frac{P_n}{P_H} \right) - \rho_1 (\sigma - 1) \ln d_n \]

- A firm \( j \) export/conduct MP in market \( n \) if

\[ M_{nl} > \ln s_H (j) + \nu_n (j) > M_{nE} \]
\[ \ln s_H (j) + \nu_n (j) > M_{nl} \]

where \( s_H (j) \) are domestic sales, \( \nu_n (j) \equiv \ln \eta^*_n (j) + \ln \epsilon_n (j), \]
\[ \eta^*_n = \eta_n (j) / \eta_H (j). \]

- Entry hurdles \( M_{nl} \) and \( M_{nE} \) are identified as fixed effects.
Estimation: Sales

Export/MP sales

\[
\ln s_{nE} (j) = \kappa_n + \ln s_H (j) + \ln \eta_n^* (j)
\]
\[
\ln s_{nl} (j) = \kappa_n + \ln s_H (j) + \rho_1 \alpha (\sigma - 1) \ln d_n + \rho_2 \alpha (\sigma - 1) \ln \frac{w_H}{w_n} + \ln \eta_n^* (j)
\]

- Expected export/MP sales \( \nu_{nE} (j) \) and \( \nu_{nl} (j) \) are more complex bc \( E [\ln \eta_n^* (j) | y_{nE} (j) = 1] \neq 0 \). (entrants have better sales shocks draws than non-entrants. Since sales shocks affect both entry and sales, failing to account for this would understate trade barriers and bias intrafirm trade.)

- Sales potential \( \kappa_n \) is identified as a fixed efx in the first eq.
- Given \( \kappa_n, \alpha \rho_1 (\sigma - 1) \) and \( \alpha \rho_2 (\sigma - 1) \) are identified in the second eq.
### Results

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>Std. Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha \rho_1 (\sigma - 1)$</td>
<td>0.12</td>
<td>(0.03)</td>
</tr>
<tr>
<td>$\alpha \rho_2 (\sigma - 1)$</td>
<td>0.01</td>
<td>(0.25)</td>
</tr>
<tr>
<td>$\sigma_\eta^*$</td>
<td>3.01</td>
<td>(0.01)</td>
</tr>
<tr>
<td>$\sigma_v$</td>
<td>2.99</td>
<td>(0.01)</td>
</tr>
<tr>
<td>$\sigma_{\varepsilon \eta}^*$</td>
<td>−2.86</td>
<td>(0.01)</td>
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<tr>
<td>$l_{\text{entry}} (\vartheta_1)$</td>
<td>−42,830</td>
<td></td>
</tr>
<tr>
<td>$l_{\text{sales}} (\vartheta_2)$</td>
<td>−32,375</td>
<td></td>
</tr>
<tr>
<td>$N$</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>$J$</td>
<td>7,949</td>
<td></td>
</tr>
</tbody>
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- $\rho_1 (\sigma - 1)$ typically estimated around 0.8 – 1.0 in the literature $\rightarrow \alpha \approx 0.12$–0.15.
- The correlation between the shocks is $-0.40$. 
Passing the entry hurdle requires higher home sales in remote places. FDI requires 140 times higher home sales than exports.
Recall $M_{nE} \equiv \ln \sigma - \kappa_n + \ln f_{nE}$. Given $M_{nv}$ and $\kappa_n$, we can find fixed costs (FC) in dest. $n$ relative to FC in Sweden. A formal LR test reject the null that MP fixed costs are increasing in distance.
Finding alpha

We know that

\[ \kappa_n = \ln \left( \frac{Y_n}{Y_H} \right) + (\sigma - 1) \ln \left( \frac{P_n}{P_H} \right) - \rho_1 (\sigma - 1) \ln d_n \]

- Special case: \( P_i = P_n \): Using absorption \( Y_n \) and distance data \( d_n \) + estimates of \( \kappa_n \), we can back out \( \rho_1 (\sigma - 1) \).
- We have an estimate of \( \hat{\alpha} \rho_1 (\sigma - 1) \) (highly significant), so \( \alpha = \hat{\alpha} \rho_1 (\sigma - 1) / \rho_1 (\sigma - 1) \). Result: \( \alpha = 0.11 \).
- In general:
  We need to solve the price indices. The estimate of \( \alpha \) is unchanged.
Counterfactuals: No intrafirm trade and MP shutdown

No intrafirm trade

- Let's take actual entry and recalculate affiliate sales given $\alpha = 1$.
- Result: Even if gravity on the extensive margin, not sufficient for gravity for total MP. Var. trade costs for MP are needed.

No MP

- Assume $M_{nl} \rightarrow \infty$.
- Results: Domestic labor expenditure for switching firms falls by over 50 per cent.
  - (1) Decreased activity due to higher costs and less sales.
  - (2) Increased labor demand bc labor is reallocated from subsidiaries to the headquarter.
- (1) stronger than (2)

Flip side: MP entry positive for domestic labor market.
We’ve developed a simple but non-trivial extension of existing theory and derived micro-founded gravity equation for MP.

We’ve examined the margins of MP and exports in a coherent framework. Using unique data for both exports and MP.

After controlling for selection & bilateral fixed costs,
- we reject the standard model of no intrafirm trade
- Point estimate of affiliate’s cost share related to purchases from headquarters is $9/10 \Rightarrow$ upper bound, there must be additional forces dampening MP

Impeding FDI will reduce home employment of multinationals, even though labor is reallocated to the headquarter