Lecture 4: Heterogenous firms and international trade

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New New Trade Models

- Mélitz (2003):
  - First elegant model that introduces firm heterogeneity in a standard monopolistic competition model.
  - Self-selection effect: Following trade liberalization, reallocation towards more productive firms (with exit and entry of firms).
  - In a multi-country framework, more productive firms are able to enter more remote markets.
  - Limit: Dixit-Stiglitz assumption $\Rightarrow$ Very naive predictions concerning relative prices.

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  - Limit: Dixit-Stiglitz assumption $\Rightarrow$ Very naive predictions concerning relative prices.
- Mélitz & Ottaviano (2006):
  - Model of heterogenous firms with endogenous mark-ups.
  - Pro-competitive effect: Firms entry affect the competitive environment, which in turn impact pricing decisions.
  - In a multi-country framework, competition is tougher in larger markets as more firms compete and average prices are lower $\Rightarrow$ Source of PPP deviations

Stylized facts on heterogenous firms in trade

- International firms are superstars. They are rare and their distribution is highly skewed, as a handful of firms accounts for most aggregate international activity.
- International firms belong to an exclusive club. They are different from other firms.
- The pattern of aggregate exports, imports and foreign direct investment (FDI) is driven by the changes in two "margins": the intensive margin (changes in the value of bilateral flows) and the extensive margin (changes in the number of bilateral flows. The "extensive margin" is much more important.

Skewness

Table: Share of exports for top exporters in 2003, total manufacturing

Country of origin	Top 1%	Top 5%	Top 10%
Germany	59	81	90
France	44 (68)	73 (88)	84 (94)
United Kingdom	42	69	80
Italy	32	59	72
Hungary	77	91	96
Belgium	48	73	84
Norway	53	81	91

Source: EFIM. Note: France, Germany, Hungary, Italy and the UK have large firms only; Belgian and Norwegian data is exhaustive. Numbers in brackets for France are percentages.

Hypotheses of the model

- Two countries of size L^l, $\quad l = H/F$
- A continuum of differentiated varieties and a homogenous good chosen as numeraire

$$U = q_0^c + \alpha \int_{i\in\Omega} q_i^c di - \frac{1}{2}\gamma \int_{i\in\Omega} (q_i^c)^2 di - \frac{1}{2}\eta \left(\int_{i\in\Omega} q_i^c di \right)^2$$

with:

- q_0^c and q_i^c the individual consumption levels of the numeraire good and each variety i (hypothese: $q_0^c > 0$)
- α and η parameters defining the substitution pattern between the differentiated varieties and the numeraire ($\uparrow$ in α and $\downarrow$ in η shift out the demand for the differentiated varieties relative to the numeraire.)
- γ a parameter defining the degree of product differentiation between the varieties. (Limit case: $\gamma = 0 \rightarrow Q_c = \int_{i\in\Omega} q_i^c di$ perfect substitutability)

Hypotheses of the model (2)

- Perfectly competitive labor market and inelastic supply
- Numeraire produced under constant returns at unit cost, perfectly integrated international market
- Differentiated good produced under IRS (fixed production cost f). Irreversible entry cost f_E under uncertainty about future productivity. Marginal cost (ie 1/Productivity) drawn from a Pareto distribution:

$$G(c) = \left(\frac{c}{c_M}\right)^k, \quad k \geq 1$$

- Monopolistic competition
- international trade barriers τ^l, $\quad l = H/F$

Individual demand functions

$$\begin{cases} \max_{q_0^c, q_i^c} q_0^c + \alpha \int_{i\in\Omega} q_i^c di - \frac{1}{2}\gamma \int_{i\in\Omega} (q_i^c)^2 di - \frac{1}{2}\eta \left(\int_{i\in\Omega} q_i^c di\right)^2 \\ s.t. \quad q_0^c + \int_{i\in\Omega} p_i q_i^c \leq E^c \end{cases}$$

E^c is the individual nominal income.

$\longrightarrow$ Individual demand function: $p_i = \alpha - \gamma q_i^c - \eta Q^c$

$\longrightarrow$ Market demand function: $q_i \equiv L q_i^c = \frac{\alpha L}{\gamma} - \frac{\eta L}{\gamma} Q^c - \frac{L}{\gamma} p_i$

$\longrightarrow$ Individual demand function over all varieties: $Q^c = \frac{N\alpha}{\gamma + N\eta} - \frac{N}{\gamma + N\eta}\bar{p}$ with N the mass of varieties and $\bar{p}$ their average price.

$\Rightarrow$ Market demand function:

$$q_i = \frac{\alpha L}{\gamma + N\eta} - \frac{L}{\gamma} p_i + \frac{\eta N}{\gamma + N\eta}\frac{L}{\gamma}\bar{p}, \quad \forall i \in \Omega^*$$

$\Rightarrow$ Maximum price (defined by $q_i \geq 0$): $p_{max} = \frac{1}{\gamma + N\eta}(\gamma\alpha + \eta N \bar{p})$

Price elasticity of demand

$$\varepsilon_i = \left| \frac{\partial q_i / q_i}{\partial p_i / p_i} \right| = \frac{1}{p_{max}/p_i - 1}$$

- increasing function of p_i: given the competitive environment (ie given N and $\bar{p}$), ε_i monotonically increases with p_i along the demand curve.
- increasing function of η / decreasing function of α: ε_i is smaller when consumers have a higher preference for the numeraire good.
- decreasing function of γ, the differentiation degree (as in the CES case)
- decreasing function of $\bar{p}$ / increasing function of the number of competing varieties N. Both affect the price bound p_{max}

Close economy (1)

- Firms' behaviour:

$$\begin{cases} \max_{q_i(c)} [p_i(c)q_i(c) - wcq_i(c)] \\ s.t. \quad p_i(c) = \alpha - \eta Q - \frac{\gamma}{L} q_i(c) \end{cases}$$

$\Rightarrow$ First order condition:

$$q_i(c) = \frac{L}{\gamma}[p_i(c) - c]$$

- Cost cutoff: c_D cost of the firm who is just indifferent about remaining in the industry. This firm earns zero profit as its price is driven down to its marginal cost, $p_i(c_D) = c_D = p_{max} = \alpha - \eta Q$ and its demand level $q(c_D)$ is driven to zero. c_D summarizes the effects of both the average price and number of firms on the performance measures of all firms.

Closed economy (2)

$$
\begin{aligned}
p(c) &= \frac{1}{2}(c_D + c) \\
\mu(c) &\equiv p(c) - c = \frac{1}{2}(c_D - c) \\
q(c) &= \frac{L}{\gamma}[p(c) - c] = \frac{L}{2\gamma}(c_D - c) \\
r(c) &\equiv p(c)q(c) = \frac{L}{4\gamma}(c_D^2 - c^2) \\
\pi(c) &= \frac{L}{4\gamma}(c_D - c)^2
\end{aligned}
$$

Lower cost firms set lower prices and earn higher revenues and profits than firms with higher costs. However, lower cost firms do not pass on all of the cost differential to consumers in the form of lower prices: they also set higher markups (in both absolute and relative terms) than firms with higher costs.

Closed economy (3)

- Cost cut-off determined by the free-entry condition:

$$
\begin{aligned}
& E\pi^n et(c) = 0 \\
\Leftrightarrow \quad & \int_0^{c_D} \pi(c) dG(c) = f_E \\
\Leftrightarrow \quad & \frac{L}{4\gamma} \int_0^{c_D} (c_D - c)^2 dG(c) = f_E
\end{aligned}
$$

- Mass of surviving firms determined using c_D and the zero demand price condition:

$$
\begin{aligned}
& c_D = \frac{1}{\eta N + \gamma}(\gamma\alpha + \eta N \bar{p}) \\
\Leftrightarrow \quad & N = \frac{2\gamma}{\eta} \frac{\alpha - c_D}{c_D - \bar{c}}
\end{aligned}
$$

- Mass of entrants: $N_E = N/G(c_D)$

Closed economy (4)

- Conclusion: Average productivity will be higher:
  - when sunk costs are lower,
  - when varieties are closer substitutes (lower γ),
  - in bigger markets (more consumers L).

$\Rightarrow$ Rise firm exit rates (ie the pre-entry probability of survival $G(c_D)$ is lower).

- α and η that index the overall level of demand for the differentiated varieties (relative to the numeraire) do not affect the selection of firms and industry productivity - they only affect the equilibrium number of firms.
- Competition is "tougher" in larger markets as more firms compete and average prices $\bar{p} = (c_D + \bar{c})/2$ are lower $\rightarrow$ Individual firms responds to this tougher competition by setting a lower markup
- Remark: under Parteo, average firm size and profits are also higher in larger markets

Closed economy and Pareto distribution

$$
\begin{aligned}
c_D &= \left(\frac{2\gamma f_E c_M^k (k+1)(k+2)}{L}\right)^{\frac{1}{k+2}} \\
\bar{c} &= \frac{1}{(c_D/c_M)^k} \int_0^{c_D} c \frac{k}{c_M} \left(\frac{c}{c_M}\right)^{k-1} dc = \frac{k}{k+1} c_D \\
N &= \frac{2\gamma}{\eta} \frac{\alpha - c_D}{c_D - \frac{k}{k+1} c_D} = \frac{2\gamma(k+1)}{\eta} \frac{\alpha - c_D}{c_D} \\
\bar{p} &= \frac{1}{2}(c_D + \bar{c}) = \frac{2k+1}{2k+2} c_D \\
\bar{\mu} &= \frac{1}{2(c_D/c_M)^k} \int_0^{c_D} (c_D - c) \frac{k}{c_M} \left(\frac{c}{c_M}\right)^{k-1} dc = \frac{c_D}{2(k+1)} \\
\bar{q} &= \frac{L}{2\gamma(c_D/c_M)^k} \int_0^{c_D} (c_D - c) \frac{k}{c_M} \left(\frac{c}{c_M}\right)^{k-1} dc = \frac{L c_D}{2\gamma(k+1)} \\
\bar{r} &= \frac{L}{4\gamma(c_D/c_M)^k} \int_0^{c_D} (c_D^2 - c^2) \frac{k}{c_M} \left(\frac{c}{c_M}\right)^{k-1} dc = \frac{L c_D^2}{2\gamma(k+2)} \\
\bar{\pi} &= \frac{L}{4\gamma(c_D/c_M)^k} \int_0^{c_D} (c_D - c)^2 \frac{k}{c_M} \left(\frac{c}{c_M}\right)^{k-1} dc = \frac{L c_D^2}{2\gamma(k+1)(k+2)}
\end{aligned}
$$

Open economy

- Market segmentation + Constant returns → The firm can independently maximize domestic and export profits:

$$q_D^l(c) = \frac{L^l}{\gamma}[p_D^l(c) - c]$$

$$q_X^l(c) = \frac{L^h}{\gamma}[p_X^l(c) - \tau^h c]$$

$$with \quad p_{max}^l = \frac{1}{\eta N^l + \gamma}(\gamma\alpha + \eta N^l \bar{p}^l)$$

N^l the total number of (domestic and foreign) firms selling in l and $\bar{p}^l$ the average price.

- Two cost cut-offs:

$$c_D^l = sup\{c : \pi_D^l(c) > 0\} = p_{max}^l$$

$$c_X^l = sup\{c : \pi_X^l(c) > 0\} = \frac{p_{max}^h}{\tau^h}$$

Open economy (2)

Firm performance indicators defined by the cost cut-offs:

$$
\begin{aligned}
p_D^l(c) &= \frac{1}{2}(c_D^l + c) \\
p_X^l(c) &= \frac{\tau^h}{2}(c_X^l + c) \\
q_D^l(c) &= \frac{L^l}{2\gamma}(c_D^l - c) \\
q_X^l(c) &= \frac{L^h}{2\gamma}\tau^h(c_X^l - c) \\
\pi_D^l(c) &= \frac{L^l}{4\gamma}(c_D^l - c)^2 \\
\pi_X^l(c) &= \frac{L^h}{4\gamma}(\tau^h)^2(c_X^h - c)^2
\end{aligned}
$$

Open economy (3)

- Free entry condition:

$$\int_0^{c_D^l} \pi_D^l(c)dG(c) + \int_0^{c_X^l} \pi_X^l(c)dG(c) = f_E$$

$$\Rightarrow \quad L^l \, {c_D^l}^{k+2} + L^h \, {\tau^h}^2 \, {c_X^l}^{k+2} = 2\gamma c_M^k(k+1)(k+2)f_E$$

$$\textit{with} \quad \phi = 2(k+1)(k+2)c_M^k f_E$$

$$\Leftrightarrow \quad L^l \, {c_D^l}^{k+2} + L^h \rho^h \, {c_D^h}^{k+2} = \gamma\phi$$

$$\textit{with} \quad \rho^l \equiv {\tau^l}^{-k} \in [0,1]$$

$$\Rightarrow \quad c_D^l = \left[\frac{\phi\gamma(1-\rho^h)}{L^l(1-\rho^h\rho^l)}\right]^{\frac{1}{k+2}}$$

Open economy (4)

- The distribution of domestic prices $(p^l_D(c) = \frac{1}{2}(p^l_{max} + c), \quad c \in [0, c^l_D])$ and of exports $(p^h_X(c) = \frac{1}{2}(p^l_{max} + \tau^l c), \quad c \in [0; c^l_D/\tau^l])$ have identical distributions, determined by $G^l(c) = (c/c^l_D)^k \rightarrow$ Average price: $\bar{p}^l = \frac{2k+1}{2k+2} c^l_D$

$\Rightarrow$ Number of firms selling in country l:

$$N^l = \frac{2(k+1)\gamma}{\eta} \frac{\alpha - c^l_D}{c^l_D}$$

$\Rightarrow$ Number of entrants in each market given by:

$$G(c^l_D) N^l_E + G(c^h_X) N^h_E = N^l$$

Implications

- Only a subset of relatively more productive firms export (the "happy few")
- Exporters set FOB export prices strictly below their prices in the domestic market (dumping)
- Matching price (and other performance measures) distributions for both domestic firms in a country and exporters to that country
- Trade openess lowers the cost cut-off $\longrightarrow$ trade increases aggregate productivity by forcing the least productive firms to exit through a pro-competitive effect ($\neq$ Mélitz, 2003, where the selection plays through scarce labor resources and real wage adjustments) $\longrightarrow$ self-selection of more productive firms + drop in average mark-ups
- Welfare gains from trade through selection, pro-competitive effect and increased product variety

Impact of market size discrepancies

- Determined by differences in the cost cutoffs
- Under symmetric trade costs, the larger country has a lower cutoff, higher average productivity and product variety, lower markups and prices.
- It attracts relatively more entrants and local producers.
- The size of a country's trading partner does not affect the cost cutoff (under these functional forms)

Trade liberalization

- Impact of a symmetric liberalization:
  - Increases competition in both countries
  - Proportional changes in the cutoffs, aggregate productivity, etc.
  - Welfare gains due to selection, pro-competitive effect and increased product variety
- Impact of a unilateral trade liberalization:
  - Only the cost cut-off of the liberalizing country increases
  - Number of entrants in the liberalizing country decreases / NUmber of entrants in the other country increases
  - Less competition in the liberalizing country / more competition in the other country

Gravity equation

- Export sales of an individual firm from country h:

$$r_X^{hl}(c) = p_X^{hl}(c)q_X^{hl}(c) = \frac{L^l}{4\gamma}\left({c_D^{lh}}^2 - {\tau^{lh}}^2 c^2 \right)$$

$\Rightarrow$ Aggregate bilateral flow:

$$Exp^{hl} = N_E^h \int_0^{c_X^{hl}} r_X^{hl}(c)dG(c) = \frac{N_e^h L^l \, {c_D^{hl}}^{k+2} \, {\tau^{hl}}^{-k}}{2\gamma c_M^k (k+2)}$$

- Explains bilateral exports as a function of bilateral trade barriers and country characteristics.
- Reflects the joint effects of country size, technology (comparative advantage), and geography on both the extensive (number of traded goods) and intensive (amount traded per good) margins of trade flows.
- Highlights how tougher competition in a country (lower average prices, reflected by a lower c_D^l) dampens exports by making it harder for potential exporters to break into that market.