Market Size, Trade and Productivity

Melitz and Ottaviano
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Anahí Francis-Osorio

Universidad Carlos III

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Introduction

Observations

- **Monopolistically Competitive Model** of trade is developed with **heterogenous firms** & **endogenous differences** in the **toughness** of competition across countries
- Model Predictions: "Trade forces the least productive firms to exist and reallocate market share towards more productive exporting firms"
- Market size and trade affect the toughness of competition in a market.

Introduction

Relevant Questions

- How the **toughness of competition** (larger number of sellers and lower average price -higher productivity-) varies across not perfectly integrated markets of **different size**?
- What are the effects of different trade **liberalization policies** in this framework?

Motivation (Why is this important? Differences with other papers)

- Modeling Structure: **Monopolistic Competition** with **Free Entry** & **Product Differentiation**.
- This paper provides a useful **modelling framework for the analysis of trade** and liberalization policies.
- In previous modeling, the distribution of markups is invariant to country characteristics and to geographic barrier. Here, **endogenous determination of the mark-ups**.

The Model of Closed Economy

- **Utility** of a representative consumer is given by:

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

- where
  - $i \in \Omega = \{$continuum of differentiated varieties$\}$
  - q_0^c & q_i^c individual consumption level of a homogenous good chosen as numerarie & each variety i
  - γ is an index of product differentiation
  - α, η govern the **substitutability of varieties with the numeraire good**.

- Then, **linear inverse demand for all varieties**:

$$p_i = \alpha - \gamma q_i^c - \eta Q^c \qquad where \qquad Q^c = \int_{i\in\Omega} q_i^c \; di$$

The Model of Closed Economy

- With L consumers, **total demand for a differentiated variety**:
  $q_i = Lq_i^c$

  $(by\ integrating): \ Q^c = \frac{N(\alpha - \overline{p})}{\gamma + \eta N}$ where $\overline{p} = \frac{1}{N} \int_{i \in \Omega^*} p_i \ di$

  $N =$ measure of comsumed varieties

- Marginal utilities are bounded, so there exists a **threshold price level** over which demand is zero

  $$q_i > 0 \qquad iff \qquad p_i \leq \frac{\alpha\gamma + \eta N \overline{p}}{\eta N + \gamma} \equiv p_{\max}$$

  - this threshold goes down with tougher competition $(\uparrow N \ or \ \overline{p} \downarrow)$.

  - $\varepsilon_i \equiv \left[\frac{p_{\max}}{p_i} - 1 \right]^{-1}$ increases with tougher competition ($\overline{p} \downarrow or \uparrow N$).

The Model of Closed Economy

- Indirect utility of each consumer c :

$$U = I^c + \frac{1}{2}(\eta + \frac{\gamma}{N})^{-1}(\alpha - \overline{p})^2 + \frac{1}{2}\frac{N}{\gamma}\sigma_p^2$$

where $\sigma_p^2 = \frac{1}{N}\int_{i\in\Omega}(p_i - \overline{p})^2 di$

- Then Welfare rises with:
  - a **decrease in average prices**, $\overline{p}$
  - an **increase in the variance of price**, $\sigma_p^2 = \frac{1}{N}\int_{i\in\Omega^*}(p_i - \overline{p})^2\ di$ (consumers reoptimize their consumption across varieties)
  - an **increase in the number of varieties** ($\uparrow$N $\downarrow p_{\max} \uparrow \varepsilon_i \implies$ tougher competition)

The Model of Closed Economy

Production & Firm Behavior

- One unit of homogenous good is produced by one unit of labor$\Rightarrow$ wage=1.
- Numeraire good is produced CRS at unit cost
- Entry in the differentiated product sector is costly:
  - pay sunk investment cost $f_E \longrightarrow$ draw c from a common & known distrib $G(c)$, $c \in [0, c_M]$
- A firm with cost level c maximize profits based on their **linear residual demand curve**, taking N and $\overline{p}$ as **given**:

$$\max_{q(c)\geq 0} \pi(c) = \left[\left(\alpha - \frac{\gamma}{L}q(c) - \eta Q^c\right) - c\right] q(c)$$

- First order Condition

$$FOC: \left[\left(\alpha - \frac{2\gamma}{L}q(c) - \eta Q^c\right) - c\right] = 0$$

$$\frac{2\gamma}{L}q(c) = \underbrace{(\alpha - \eta Q^c)}_{c_D} - c$$

where c_D is the endogenous cutoff $\Rightarrow$ *if* $\Pi(p(c_D)) = 0$

then if $c > c_D \equiv (\alpha - \eta Q^c)$ Exit $(q(c) = 0)$,

if $c < c_D$ firms earn positive profits & $q(c) = \frac{L}{2\gamma}(c_D - c)$

The Model of Closed Economy

- The endogenous cutoff c_D is a **sufficient statistic** that completely summarizes the relevant competitive environment ($L = market\ size$):

$$p(c) = \frac{1}{2}(c_D + c) \qquad \textit{prices}$$
$$q(c) = \frac{L}{2\gamma}(c_D - c) \qquad \text{quantity}$$
$$\mu(c) = p(c) - c = \frac{1}{2}(c_D - c) \qquad \textit{markups}$$

$$r(c) = \frac{L}{4\gamma}\left[(c_D)^2 - c^2\right] \qquad \textit{revenues}$$

$$\pi(c) = \frac{L}{4\gamma}(c_D - c)^2 \qquad \textit{profits}$$

- More productive firms (lower c):
    - set **lower prices** but **higher markups**
    - are **bigger**: higher output and revenue
    - have **higher profits**

Free Entry Condition

- The expected profits of a potential entrant must be driven down to zero from free entry:

$$\int_0^{c_D} \pi(c)dG(c) - f_E = 0 \qquad \textit{Free Entry Condition}$$

$$\frac{L}{4\gamma}\int_0^{c_D}(c_D + c)^2 dG(c) = f_E \Rightarrow \qquad c_D = \frac{\gamma\alpha + \eta N \overline{p}}{\eta N + \gamma}$$

This yields to the cutoff profit condition

$$N = \frac{2\gamma}{\eta}\frac{\alpha - c_D}{c_D - \overline{c}} \qquad \textit{where} \qquad \overline{c} = \frac{\int_0^{c_D} c dG(c)}{G(c_D)}$$

- Pareto dististribution on productivity $\frac{1}{c}$ with lower productivity bound $\frac{1}{c_M}$:

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

$$\int_0^{c_D} \underbrace{\frac{L}{4\gamma}(c_D + c)^2}_{\pi(c)} \underbrace{\frac{k}{c_M}(\frac{c}{c_M})^k}_{g(c)} dc = f_E \qquad \textit{Free Entry Condition}$$

- Then, the **threshold for survival** is given by:

$$c_D = \left(\frac{2\gamma(k+1)(k+2)c_M^k f_E}{L} \right)^{\frac{1}{k+2}}$$

where we assume $c_M > \sqrt{\left[2(k+1)(k+2)\gamma f_E\right]/L} \Longrightarrow c_D < c_M$

- $\downarrow c_D$ ($\uparrow$avg. productivity) as **competition is tougher**: $\uparrow L$, $\downarrow (\gamma, c_M, f_E)$

- as **competition is tougher** $\uparrow$elasticity of demand ε_i, and $\downarrow$mark-ups

$$N = \left(\frac{2(k+1)\gamma}{\eta} \right) \frac{\alpha - c_D}{c_D}$$

The Model of Closed Economy

- The previous parametrization yields simple derivation for the averages of all the firm-level performance:

$$\bar{c} = \frac{k}{k+1} c_D \qquad \text{average cost}$$

$$\bar{q} = \frac{L}{2\gamma}\frac{1}{k+1} c_D \quad \text{average quantity} \qquad \bar{r} = \frac{L}{2\gamma}\frac{1}{k+2} c_D^2 \quad \text{average revenue}$$

$$\bar{p} = \frac{2k+1}{2k+2} c_D \qquad \text{average price} \qquad \overline{\pi} = f_E \left(\frac{c_M}{c_D}\right)^k \quad \text{average profits}$$

$$\bar{\mu} = \frac{1}{2}\frac{1}{k+1} c_D \quad \text{average markups}$$

- Welfare is determined by : $U = 1 + \frac{1}{2\eta}(\alpha - c_D)\left(\alpha - \frac{k+1}{k+2} c_D\right)$ where $U \uparrow \textit{ if } c_D \downarrow \Longrightarrow N \uparrow \textit{ and } \bar{p} \downarrow$

The Model of Closed Economy Results

- Bigger markets induced tougher selection (lower cutoff c_D) , higher average productivity $(1/\overline{c})$ and lower average price.
- Under parametrization of cost draws:
  - Average markups are lower, because of increased competition on firm level.
  - Average firm size and profits are higher in larger markets
  - Average industry profitability $\overline{\pi}/\overline{r}$ does not vary with market size

The Open Economy Model

Trade as a bigger closed economy. We can see the **transition from autarky to free trade** as an **increase in market size**

- Larger markets are characterized by :
  - Lower mark-ups and prices ($\uparrow$average productivity)
  - Bigger firms and more profitable firms
  - Increase in product varieties
  - Lower variance of productivity (costs), price, and mark-ups
  - Higher variance of firm size (output and sales)

Open Economy (costly trade)

- Two economies, H and F, with respective size L^H, L^F.
- Separated by **trade barriers** modelled as **iceberg transport cost** τ.
- Cost of selling a unit to country l ($l = H, F$) is c, and $c\tau^l$,respectively.
- Price threshold:

$$p_D^l = \frac{\alpha\gamma + \eta N^l \overline{p}^l}{\eta N^l + \gamma} = c_D^l \qquad l = H, L$$

N^l total number of firms selling in country l (**domestic firms+foreign exporters**) and $\overline{p}^l$ average price (**across both local and exporting firms**) in country l.

Open Economy (costly trade)

- $p^l_D(c)$ and $q^l_D(c)$ are domestic level of the profits maximizing price and quantity sold for a firm of country l.
- $p^l_x(c)$ and q^l_x are the quantity and price for exports of country l
- $c^l_D = \sup\left\{c : \pi^l_D(c) > 0\right\} = p^l \max$
- $c^l_x = \sup\left\{c : \pi^l_x(c) > 0\right\} = \frac{p^h \max}{\tau^h}$ where $h \neq l$
- This implies $c^h_X = c^l_D / \tau^l$

Open Economy: Free Entry Condition

- Firms choose a **location** prior to entry and paying the sunk entry cost.
- **Free entry Cond**: a domestic firm compares the cost of entry to the **E(profits from domestic sales)**, and **E(profits from exporting)**:

$$\int_0^{c_D^l} \pi_D^l(c)dG(c) + \int_0^{c_x^l} \pi_x^l(c)dG(c) = f_E \qquad \textit{Free Entry}$$

Under pareto dist. for $\frac{1}{c}$ the cut-off and number of firms for both countries are:

$$c_D^l = \left[\frac{\alpha\phi}{L^l}\frac{1-\rho^h}{1-\rho^l\rho^h}\right]^{\frac{1}{k+2}} < c_D^{l\ autarky} \text{ where } \quad \phi = 2(k+1)(k+2)c_M^k f_E$$

$$\rho^l = (\tau^l)^{-k}$$

$$N^l = \frac{2(k+1)\gamma}{\eta}\frac{\alpha - c_D^l}{c_D^l} > N^{l\ autarky}$$

$$N^l = \underbrace{N_E^l G(c_D^l)}_{\text{domestic producers}} + \underbrace{N_E^h G(c_x^h)}_{\text{exporters selling in } l} \quad \text{(number of varieties consumed)}$$

then we can solve for the number of entrants in each country: N_E^l, N_E^h

Open Economy: Results

- Opening up to trade reduces the cost cutoff c_D $\Rightarrow$
  - only the most productive firms survive

$$c < c_D^l \begin{cases} \text{labor reallocated towards most productive firms} \\ \text{only most productive among survivors export}(c < c_x^{lh} < c_D^l) \\ \text{least productive surv. prod. for domestic mkt}(c_x^{lh} < c < c_D^l) \end{cases}$$

- Trade does not completly integrate markets. This is because size still matters: **Bigger markets attract more firms** and **induce a "tougher" competitive** environment:
  - c_D^l **cutoff is lower in bigger markets**,
  - higher average productivity (bigger firms)
  - higher product variety
  - lower mark-ups and prices (higher welfare).

Results (costly trade)

Unilateral Trade Liberalization

- Unilateral trade liberalization leads to welfare changes in **opposite directions** across countries:
  - productivity and welfare **improve** in **protected countries**
  - while they **fall** in **liberalizing countries**
- The **liberalized** country becomes a **less attractive location** relative to the protected trading partner (the latter have access to domestic markets and cheaper access to export markets).
- The **liberalized country loses more domestic firms** than it gains in new importers (because not all firms located in protected markets export).
- These forces combine to make **competition tougher in protected** countries and **weaker in the liberalized one**.

Conclusions

- The paper develops a model that predicts how industry performance measures (productivity, size, price, mark-up) respond to changes in the world trading environment.
- It incorporates
  - heterogeneous firms and endogenous mark-ups that respond to the toughness of competition in a market.
  - the important feedbacks between entry and firm selection into domestic and export markets.
- In such a setting:
  - larger markets exhibit tougher competition resulting in lower average mark-ups and higher aggregate productivity
  - costly trade does not completely integrate markets and thus preserves the important consequences of market size differences across trading partners.

Final Comments

- This paper considers the selection effect in a model with heterogeneous firms in the sense of the elimination of the least efficient firm within a country, but does not consider the possibility of **spatial relocation**.
  - Baldwin and Okubo consider the **spatial dimension of selection**
  - "**Relocating to the big region is more attractive** for the **most productive firms"**
  - the most productive firms are the ones that **moves first to the big region** (non-random selection)