Comparative Advantage, Monopolistic Competition, and Heterogeneous Firms in a Ricardian Model with a Continuum of Sectors

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Motivation

- It is widely known that only a small fraction of firms can export their product (Bernard et al. 2007; Mayer and Ottaviano, 2007; Tomiura, 2007; Lu, 2010):
  - The fraction of firms that export varies drastically across sectors

Exporting by U.S. manufacturing firms

Ranking	Sector	% of exporting firms
1	Computer and electronic product	38
2	Electrical equipment	38
3	Chemical manufacturing	36
...	...	...
19	Apparel manufacturing	8
20	Furniture and related product	7
21	Printing and related product	5
Ave		18

Source: Bernard et al. (2007)

Extensive margin vs intensive margin

- Fraction of exporting firms:

$$\frac{M_{ij}(z)}{M_{ii}(z)} = \frac{\text{Mass of exporting firms in sector } z \text{ from country } i \text{ to country } j}{\text{Mass of domestic firms in sector } z \text{ of country } i}$$

- Total export sales:

$$R_{ij}(z) = \underbrace{M_{ij}(z)}_{\text{Extensive margin}} \times \underbrace{\left(\frac{R_{ij}(z)}{M_{ij}(z)}\right)}_{\text{Intensive margin}}$$

- Total domestic sales:

$$R_{ii}(z) = \underbrace{M_{ii}(z)}_{\text{Extensive margin}} \times \underbrace{\left(\frac{R_{ii}(z)}{M_{ii}(z)}\right)}_{\text{Intensive margin}}$$

Main result: C.A. effect on the two margins

- As i's C.A. is stronger, the following holds (relative to j's counterparts):
  - $R_{ij}(z)$ (total export sales) $\uparrow\uparrow$
  - $R_{ii}(z)$ (total domestic sales) $\uparrow$
  - $M_{ij}(z)$ (mass of exporting firms) $\uparrow\uparrow$
  - $M_{ii}(z)$ (mass of domestic firms) $\uparrow$
  - $\frac{R_{ij}(z)}{M_{ij}(z)}$ (average export sales) $\rightarrow$
  - $\frac{R_{ii}(z)}{M_{ii}(z)}$ (average domestic sales) $\rightarrow$

Setup

- Two countries: $i = 1, 2$
- Preference:

$$U_i = \int_0^1 b_i(z) \ln Q_i(z) \mathrm{d}z$$

where

$$b_i(z) = \frac{P_i(z) Q_i(z)}{Y_i} = \frac{R_i(z)}{w_i L_i}, \qquad \int_0^1 b_i(z) \mathrm{d}z = 1$$

- Demand in sector z:

$$q_{ij}(v, z) = R_i(z) P_i(z)^{\sigma - 1} p_{ij}(v, z)^{-\sigma}$$

Setup (cont.)

- Production:

$$\begin{cases} l_{ii}(\varphi, z) = f_{ii} + \frac{q_{ii}(\varphi, z)}{\theta(\varphi, z, \mu)} = f_{ii} + \frac{q_{ii}(\varphi, z)}{\varphi \mu_i(z)} & \text{for domestic production} \\ l_{ij}(\varphi, z) = f_{ij} + \frac{\tau_{ij} q_{ij}(\varphi, z)}{\theta(\varphi, z, \mu)} = f_{ij} + \frac{\tau_{ij} q_{ij}(\varphi, z)}{\varphi \mu_i(z)} & \text{for exporting} \end{cases}$$

  where $\theta(\varphi, z, \mu) = \varphi \mu_i(z)$ is labor productivity

- Country-specific productivity $\mu_i(z)$ is given by

$$\mu_i(z) = \frac{1}{a_i(z)}$$

  where $a_i(z)$ is the unit labor requirement

Setup (cont.)

- Thus, its ratio

$$\frac{\mu_1(z)}{\mu_2(z)} = \frac{a_2(z)}{a_1(z)}$$

is the relative labor productivity (labor requirement) in country 1

- Without loss of generality, we assume that country 1 (country 2) has a relatively bigger cost advantage in high-z (low-z) sectors:

$$\frac{\mu_1(z)}{\mu_2(z)} \leq \frac{\mu_1(z')}{\mu_2(z')}$$

for any $z \leq z'$

Setup (cont.)

- Country 1 has a comparative advantage in high-z sectors $\bar{z}_1 \leq z \leq 1$, where

$$\bar{z}_1 \equiv \mu^{-1}\left(\frac{\omega}{\tau_{21}}\right)$$

- Country 2 has a comparative advantage in low-z sectors $0 \leq z \leq \bar{z}_2$, where

$$\bar{z}_2 \equiv \mu^{-1}(\tau_{12}\omega)$$

- As long as $\tau_{ij} \geq 1$, these cutoff sectors satisfy $\bar{z}_1 \leq \bar{z}_2$

Setup (cont.)

- FOCs:
  - Pricing

$$p_{ii}(\varphi, z) = \frac{\sigma}{\sigma - 1} \frac{w_i}{\varphi \mu_i(z)}, \quad p_{ji}(\varphi, z) = \frac{\sigma}{\sigma - 1} \frac{\tau_{ji} w_j}{\varphi \mu_j(z)}$$

  - Revenue

$$r_{ii}(\varphi, z) = \sigma B_i(z) \left(\frac{\mu_i(z)}{w_i} \right)^{\sigma - 1} \varphi^{\sigma - 1}, \quad r_{ji}(\varphi, z) = \sigma B_i(z) \left(\frac{\mu_j(z)}{\tau_{ji} w_j} \right)^{\sigma - 1} \varphi^{\sigma - 1}$$

  - Profit

$$\pi_{ii}(\varphi, z) = \frac{r_{ii}(\varphi, z)}{\sigma} - w_i f_{ii} = B_i(z) \left(\frac{\mu_i(z)}{w_i} \right)^{\sigma - 1} \varphi^{\sigma - 1} - w_i f_{ii}$$

$$\pi_{ji}(\varphi, z) = \frac{r_{ji}(\varphi, z)}{\sigma} - w_j f_{ji} = B_i(z) \left(\frac{\mu_j(z)}{\tau_{ji} w_j} \right)^{\sigma - 1} \varphi^{\sigma - 1} - w_j f_{ji}$$

where

- $\tau_{ij} f_{ij} > f_{ii}$
- $B_i(z) = \frac{(\sigma-1)^{\sigma-1}}{\sigma^\sigma} R_i(z) P_i(z)^{\sigma-1}$ (proportional to $P_i(z)$)

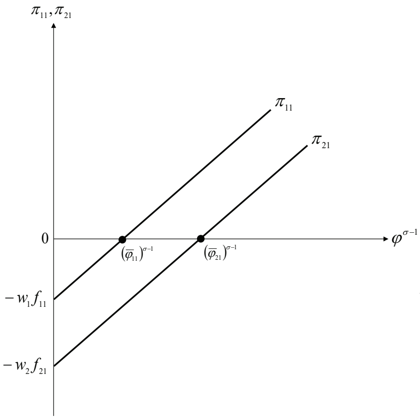
Setup (cont.)

- Note that $p_{ii}(\varphi, z) \leq p_{ji}(\varphi, z)$ and $r_{ii}(\varphi, z) \geq r_{ji}(\varphi, z)$ if country i has a comparative advantage:

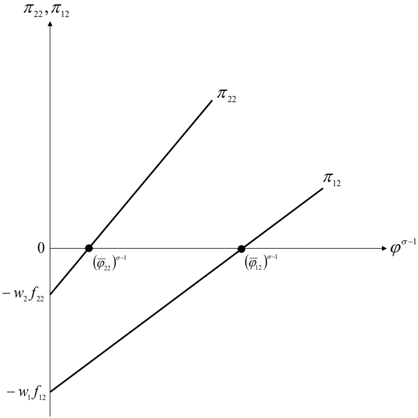
$$w_i a_i(z) \leq \tau_{ji} w_j a_j(z) \quad \Longleftrightarrow \quad \frac{w_i}{\tau_{ji} w_j} \leq \frac{\mu_i(z)}{\mu_j(z)}$$

- In the cutoff sector $\bar{z}_1$:
  - $\pi_{11}(\varphi, z)$ and $\pi_{21}(\varphi, z)$ are parallel for country 1's market
  - $\pi_{22}(\varphi, z)$ is steeper than $\pi_{12}(\varphi, z)$ for country 2's market

Cutoff sector $\bar{z}_1$



Country 1



Country 2

General equilibrium

- Zero profit conditions:

$$\pi_{ii}(\bar{\varphi}_{ii}, z) = 0 \iff B_i(z)\left(\frac{\mu_i(z)}{w_i}\right)^{\sigma-1}(\bar{\varphi}_{ii}(z))^{\sigma-1} = w_i f_{ii},$$

$$\pi_{ij}(\bar{\varphi}_{ij}, z) = 0 \iff B_j(z)\left(\frac{\mu_i(z)}{\tau_{ij} w_i}\right)^{\sigma-1}(\bar{\varphi}_{ij}(z))^{\sigma-1} = w_i f_{ij}$$

- Free entry conditions:

$$\int_{\bar{\varphi}_{ii}(z)}^{\infty} \pi_{ii}(\varphi, z)\mathrm{d}G(\varphi) + \int_{\bar{\varphi}_{ij}(z)}^{\infty} \pi_{ij}(\varphi, z)\mathrm{d}G(\varphi) = w_i f_i^e$$

General equilibrium (cont.)

- Labor market clearing conditions:

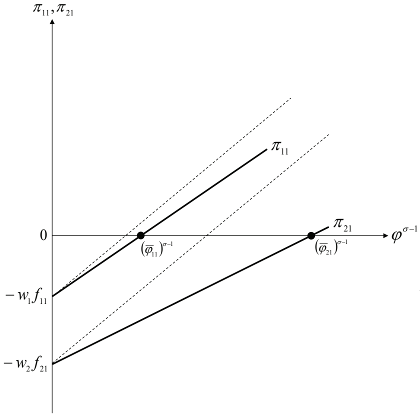
$$\int_0^1 M_i^e(z) \int_{\bar{\varphi}_{ii}(z)}^{\infty} l_{ii}(\varphi, z) \mathrm{d}G(\varphi) \mathrm{d}z + \int_0^1 M_i^e(z) \int_{\bar{\varphi}_{ij}(z)}^{\infty} l_{ij}(\varphi, z) \mathrm{d}G(\varphi) \mathrm{d}z + \int_0^1 M_i^e(z) f_i^e \mathrm{d}z = L_i$$

- These three conditions for $i = 1, 2$ have eight unknowns:

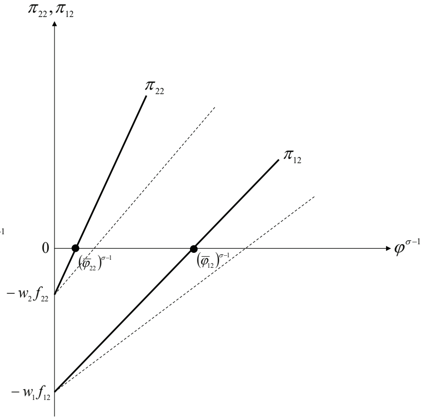
$$\bar{\varphi}_{11}(z),\ \bar{\varphi}_{22}(z),\ \bar{\varphi}_{12}(z),\ \bar{\varphi}_{21}(z),\ B_1(z),\ B_2(z),\ w_1,\ w_2$$

  where we can normalize $w_2 = 1$ by Walras's law

Country 1's C.A. sectors $z \in [\bar{z}_1, 1]$



Country 1

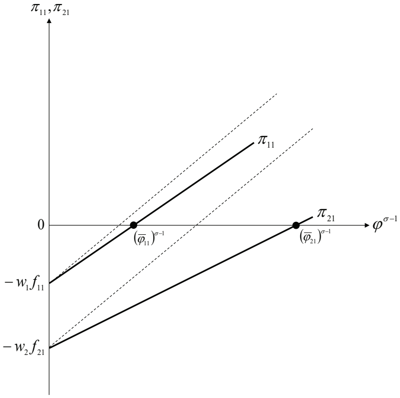


Country 2

C.A. effect

- As country i's C.A. is stronger:
  - $\frac{P_i(z)}{P_j(z)} \downarrow \Rightarrow$ The domestic market in i is relatively more competitive
    $\Rightarrow$ Only more productive firms can survive in i
    $\Rightarrow \bar{\varphi}_{ii}(z) \uparrow$
  - $\frac{P_j(z)}{P_i(z)} \uparrow \Rightarrow$ The export market in j is relatively less competitive
    $\Rightarrow$ Less productive firms can export from i to j
    $\Rightarrow \bar{\varphi}_{ij}(z) \downarrow$
  - $\frac{\bar{\varphi}_{ij}(z)}{\bar{\varphi}_{ii}(z)} \downarrow \Rightarrow$ "Productivity premia" of exporting firms decline
    $\Rightarrow$ The fraction of exporting firms rises

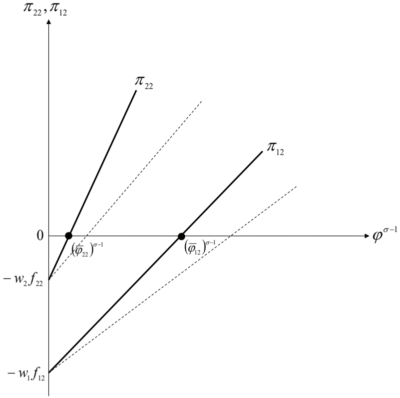
C.A. effect (cont.)



Country 1

- As i's C.A. is stronger, **domestic firms** receive two opposing effects:
  - $(+)$ Productivity cutoff ($\bar{\varphi}_{ii}(z)$) is bigger
    - $\Rightarrow$ Only more productive firms can survive in i
    - $\Rightarrow$ The intensive margin increases
  - $(-)$ Slope $(B_i(z)(\frac{\mu_i(z)}{w_i})^{\sigma-1})$ is smaller
    - $\Rightarrow$ Firms earn lower revenue from domestic production
    - $\Rightarrow$ The intensive margin decreases

C.A. effect (cont.)



Country 2

- As i's C.A. is stronger, **exporting firms** receive two opposing effects:
  - $(-)$ Productivity cutoff $(\bar{\varphi}_{ij}(z))$ is smaller
    - $\Rightarrow$ Less productive firms can export from i to j
    - $\Rightarrow$ The intensive margin decreases
  - $(+)$ Slope $(B^j(z)(\frac{\mu_i(z)}{\tau_{ij} w_i})^{\sigma-1})$ is bigger
    - $\Rightarrow$ Firms earn higher revenue from exporting
    - $\Rightarrow$ The intensive margin increases

C.A. effect (cont.)

- Recall that

$$R_{ii}(z) = M_{ii}(z) \times \left(\frac{R_{ii}(z)}{M_{ii}(z)}\right), \quad R_{ij}(z) = M_{ij}(z) \times \left(\frac{R_{ij}(z)}{M_{ij}(z)}\right)$$

- Under the special case of a Pareto distribution,

$$\frac{R_{ii}(z)}{M_{ii}(z)} = \frac{k\sigma}{k-(\sigma-1)} w_i f_{ii}, \qquad \frac{R_{ij}(z)}{M_{ij}(z)} = \frac{k\sigma}{k-(\sigma-1)} w_i f_{ij}$$

  - The two opposing effects are exactly offset and the intensive margins are independent of C.A.
  - An increase in total domestic/export sales due to C.A. is explained completely by an increase in the extensive margins

Summary

- The Ricardian model with monopolistic competition and heterogeneous firms helps to understand differences in the extensive and intensive margins

- Total domestic sales and total export sales increase with C.A. but:
  - This increase is largely explained by the extensive margins
  - Net change in the intensive margins is generally ambiguous