VII - The Standard Models of Trade Theory Under Imperfect Competition

- **Purpose of this chapter:**

  → to present the standard trade models under imperfect competition

  → to illustrate the various effects of free trade under imperfect competition presented in chapter 7

- **Two different approaches presented here:**

  → 1 : monopolistic competition *à la* Dixit-Stiglitz (Krugman [1980])

  → 2: Cournot competition on homogenous products and segmented markets (Brander [1981])

Part 2. Cournot Competition with Homogenous Goods

- **Introduced by Brander [1981]**
- **Role of strategic interactions (a player strategy depends on the other player ones)**
- **Allow to consider the pro-competitive and efficiency effects of trade (mark-up are not constant) under imperfect competition, contrary to the DSK model**
- **2 country model that can be generalized to N countries and to non-homogenous products.**

1.1 The Equilibrium Under Autarky

- **1 homogenous good, no product differentiation**
- **Produced by n_i identical firms in country i**
- **Firm technology (same assumptions as in DSK)**

  → **constant labor productivity: g_i**

  $\Rightarrow$ **production: $q_i = g_i l_i$, where l_i is labor per firm**

  → **fixed cost: f_i**
- **Factor and good price: labor cost: w_i ; good price: p_i**
- **Firm profit:** $\pi_i = p_i q_i - w_i l_i - f_i = \left(p_i - \frac{w_i}{g_i} \right) q_i - f_i$

Marginal cost

- **Consumer preferences: quasi linear / quadratic by (simplifying) assumption (many other possibilities)**

  $$U_i = z_i + a_i * q_i^d - \frac{(q_i^d)^2}{2}.$$

  z_i **homogeneous good produced under perfect competition**

  Budget constraint is $income = z_i + p_i * q_i^d$

Max U_i **w.r.t** z_i **under budget constraint; equivalent to max :**

$$income - p_i * q_i^d + a_i * q_i^d - \frac{(q_i^d)^2}{2} \quad w.r.t.\ q_i^d.$$

⇒ **linear demand:** $q_i^d = a_i - p_i$

- ✓ a_i: **positive constant⇔ Demand size**

- ✓ **note: non constant demand elasticity that decreases with the quantity:**

$$\varepsilon = -\frac{dq/q}{dp/p} = -\frac{dq}{dp}\frac{p}{q} = \frac{p}{a-p} = \frac{a-q}{q} = \frac{a}{q} - 1$$

- **Cournot competition: imperfect competition in quantity (Nash equilibrium) on homogenous goods.**
- **Assumption: simultaneous choice.**
- **First, <u>short-run</u> equilibrium characterization: the number of firms is exogenously fixed (such that profits are non-negative).**
- **Each firm maximizes its profit w.r.t. the quantity produced, taking into account the demand elasticity, assuming that the other firms hold their quantity constant.**
- **Market equilibrium:** $q_i^d = n^i q_i \Rightarrow p_i = a_i - n_i q_i$

- **But a given firm maximizes its profits w.r.t $\tilde{q}_i$ such that $p_i = a_i - \tilde{q}_i - (n_i - 1)q_i$**

$\Rightarrow$ **firm program:** $\underset{\tilde{q}_i}{Max}\left[\left(a_i - \frac{w_i}{g_i} - (n_i - 1)q_i - \tilde{q}_i\right)\tilde{q}_i - f\right]$

- **First order condition:** $a_i - \frac{w_i}{g_i} - (n_i - 1)q_i - \tilde{q}_i - \tilde{q}_i = 0$

- **Best-response (optimal quantity for given quantities produced by competitors):** $\tilde{q}_i = \frac{1}{2}\left(a_i - \frac{w_i}{g_i} - (n_i - 1)q_i\right)$

- **Nash equilibrium (intersection of the best-responses):**

→ all firms produce the same quantity since identical

→ quantity: $$q_i = \frac{a_i - \frac{w_i}{g_i}}{1 + n_i}$$

⇒ equilibrium price: $$p_i = \frac{a_i + n_i \frac{w_i}{g_i}}{1 + n_i}$$

Note:

→ **firms produce in equilibrium, if demand is large enough compared to marginal cost** $\Leftrightarrow$

$$q_i > 0 \Leftrightarrow a_i > \frac{w_i}{g_i} \text{ (assumed)}$$

$\Rightarrow$ **non negative marginal profit:** $p_i \geq \frac{w_i}{g_i}$

$\Rightarrow$ **positive mark-up**

→ **mark-up:** $\dfrac{p_i - \frac{w_i}{g_i}}{p_i} = \dfrac{a_i - \frac{w_i}{g_i}}{a_i + n_i \frac{w_i}{g_i}}$

⇒ **variable mark-up (contrary to DSK)**

⇒ **the mark-up decreases with the firm number**

→ **strategic interactions: the best-response is not a constant function but depends on the other firm strategies (their produced quantity here)**

✓ **in DSK, the best-response is constant, independent of the variety number: no strategic interaction.**

Profits, consumer surplus and welfare

→ **aggregate firm profits:** $\Pi_i = n_i \pi_i = \dfrac{n_i \left(a_i - \dfrac{w_i}{g_i} \right)^2}{(1+n_i)^2} - n_i f_i$

→ **consumer surplus:**

For a given firm:

$$S_i = \int_0^{q_i} (a_i - u) du - p_i q_i = \int_{p_i}^{a_i} (a_i - u) du = \frac{1}{2}(a_i - p_i) q_i = \frac{1}{2}(a_i - p_i)^2$$

For n_i firmes :

$$S_i = \frac{n_i^2 \left(a_i - \dfrac{w_i}{g_i} \right)^2}{2(1+n_i)^2}$$

→ total welfare:

$$W_i = S_i + \Pi_i = \frac{n_i(2+n_i)\left(a_i - \frac{w_i}{g_i}\right)^2}{2(1+n_i)^2} - n_i f_i$$

- **Country comparisons:**

  the larger [higher a_i (demand), n_i (firm number)],

  the more efficient [higher g_i (productivity), lower f_i (fixed costs), lower w_i (wage)] the country,

  the higher the welfare under autarky.

- **<u>Long run</u> equilibrium: endogenous firm number**

→ the zero profit condition gives the firm number:

$$\pi_i = 0 \Rightarrow n_i = \frac{a_i - \frac{w_i}{g_i}}{\sqrt{f_i}} - 1$$

⇔ maximum firm number such that non-negative profits

✓ it is higher, the lower the economies of scale (low fixed cost)

→ **long-run welfare:**

$$W_i = S_i = \frac{\left(a_i - \frac{w_i}{g_i} - \sqrt{f_i}\right)^2}{2}$$

✓ **larger than the short-run welfare**

2.2 The Equilibrium Under Open Economy

- **2 countries, 1 and 2, producing exactly the same good (polar assumption compared to DSK)**
- **In each country, same preferences and technology as in the autarky case (here assume $g_i = g_j = 1$).**

- **In particular, total number of firms producing the good: $n_1 + n_2$ (short run assumption to begin with)**

- **Segmented market assumption:**

  → **firms sell the good both on local and foreign markets, but incur a trade cost when exporting (payed by the firm, contrary to DSK)**

  ✓ **the trade cost *t* is assumed to be additive.**

  → **consumers buy the good only on their local market.**

→ **firms separately choose the quantity they sell on each market:**

- ✓ **q_{ii} is the quantity produced by a firm located in country *i* and sold locally**
- ✓ **q_{ij} is the quantity produced by a firm located in country *i* and exported to *j*.**

- **Firm profit:**

$$\pi_i = p_i q_{ii} + p_j q_{ij} - t q_{ij} - w_i l_i - f_i$$
$$= (p_i - w_i) q_{ii} + (p_j - w_i - t) q_{ij} - f_i$$

- **First, <u>short-run</u> equilibrium characterization: the number of firms is exogenously fixed (such that profits are non-negative)**

- **Same Cournot-Nash equilibrium concept as under autarky:**

  ⇒ firm program: $\underset{\tilde{q}_{ii},\tilde{q}_{ij}}{Max}\left\lfloor \pi_i\left(\tilde{q}_{ii},\tilde{q}_{ij},q_{ii},q_{ij},q_{ji},q_{jj}\right)\right\rfloor$ **with**

$$\pi_i\left(\tilde{q}_{ii},\tilde{q}_{ij},q_{ii},q_{ij},q_{ji},q_{jj}\right)=$$

$$\left(a_i-w_i-(n_i-1)q_{ii}-n_jq_{ji}-\tilde{q}_{ii}\right)\tilde{q}_{ii}+$$

$$\left(a_j-w_i-t-(n_i-1)q_{ij}-n_jq_{jj}-\tilde{q}_{ij}\right)\tilde{q}_{ij}-f_i$$

- **Best-response (optimal quantity for given quantities produced by competitors):**

$$\begin{cases}\tilde{q}_{ii}=\frac{1}{2}\left(a_i-w_i-(n_i-1)q_{ii}-n_jq_{ji}\right)\\ \tilde{q}_{ij}=\frac{1}{2}\left(a_j-w_i-t-(n_i-1)q_{ij}-n_jq_{jj}\right)\end{cases}$$

- **Nash equilibrium (intersection of the best-responses) when interior for both countries:**

→ **quantities:**
$$\begin{cases} q_{ii} = \dfrac{a_i - w_i - n_j\left(w_i - \left(w_j + t\right)\right)}{1 + n_1 + n_2} \\ q_{ij} = \dfrac{a_j - w_i - t - n_j\left(w_i + t - w_j\right)}{1 + n_1 + n_2} \end{cases}$$

→ **equilibrium price:** $p_i = \dfrac{a_i + n_i w_i + n_j\left(w_j + t\right)}{1 + n_1 + n_2}$

- **Possible corner equilibrium:**

→ $q_{ii} > 0 \Leftrightarrow a_i - w_i - n_j\left(w_i - \left(w_j + t\right)\right) > 0$

✓ **if** $w_i < \left(w_j + t\right)$**, always true**

✓ **if** $w_i > \left(w_j + t\right) \Leftrightarrow n_j < \dfrac{a_i - w_i}{w_i - \left(w_j + t\right)}$

→ $q_{ij} > 0 \Leftrightarrow a_i - w_i - t - n_j\left(w_i + t - w_j\right) > 0$

✓ **if** $w_i + t < w_j$**, always true**

✓ **if** $w_i + t > w_j$**,** $\Leftrightarrow n_j < \dfrac{a_i - w_i - t}{w_i + t - w_j}$

- **Full equilibrium characterization:**

→ **case 1: low cost / productivity differences,**

$\Leftrightarrow w_j - t < w_i < w_j + t \Rightarrow$

✓ **firms always produce for their local market:** $q_{ii} > 0$

✓ **firms export if the number of firms located in the other region is not too large:** $q_{ij} > 0 \Leftrightarrow n_j < \dfrac{a_i - w_i - t}{w_i + t - w_j}$

→ **case 2: country *j* has a strong productive advantage ⇔** $w_j + t \leq w_i$

- ✓ **firms in country *j* always produce for both markets:**

  $q_{jj} > 0$ **and** $q_{ji} > 0$

- ✓ **firms in country *i* export if the number of firms located in the other region is not too large:** $q_{ij} > 0 \Leftrightarrow n_j < \dfrac{a_i - w_i - t}{w_i + t - w_j}$ **and may even not produce at all if this number is very large:**

  $$q_{ii} > 0 \Leftrightarrow n_j < \frac{a_i - w_i}{w_i - \left(w_j + t\right)}$$

- ✓ **note: clearly,** $\dfrac{a_i - w_i - t}{w_i + t - w_j} < \dfrac{a_i - w_i}{w_i - \left(w_j + t\right)}$

- **<u>Long-run</u> equilibrium: # of firms producing in each country is endogenously determined such that profits are zero:** $\pi_1 = \pi_2 = 0$
  - ✓ **multiple equilibria may exist, in particular when markets are perfectly integrated and countries are identical.**

- **Important conclusion: as soon as markets are segmented, $t > 0$, and the firm number is not too large, cross trade exists, even if the good is homogenous, and even if countries are identical**

  $\Rightarrow$ real intra-trade only due to imperfect competition.

  - ✓ **note: in the long-run equilibrium under segmented markets, no intra-trade.**

2.3 Trade Gains and Losses

- **Assumption of an interior equilibrium (low market segmentation, low asymmetries between countries)**
- **Short-run equilibrium: fixed and exogenous firm number in both countries**

- **Consumer surplus:**

→ **surplus variation: same sign as the price variation**

$$\Rightarrow S_i^* - S_i^a = \left(a_i + \frac{p_i^* + p_i^a}{2} \right)\left(p_i^a - p_i^*\right)$$

→ **price variation**

$$\frac{p_i^*}{p_i^a} = \frac{1+n_i}{1+n_1+n_2} \cdot \left(1 + \frac{n_j\left(w_j + t\right)}{a_i + n_i w_i} \right)$$

✓ **decrease thanks to the pro-competitive effect,** $\dfrac{1+n_i}{1+n_1+n_2}$

✓ **the larger** n_j**, the larger the decrease.**

- **Firm profit variation**

→ **notation:** $\Pi_i = \Pi_{ii} + \Pi_{ij} - n_i f_i$**, where** Π_{ij} **is the variable profit on market** ***j*** **of firms located in** ***i***

$$\rightarrow \frac{\Pi_{ii}^{*}}{\Pi_{ii}^{a}} = \frac{n_i\left(a_i - w_i + n_j\left(w_j + t - w_i\right)\right)^2 \Big/ \left(1 + n_1 + n_2\right)^2}{n_i\left(a_i - w_i\right)^2 \Big/ \left(1 + n_i\right)^2}$$

$$\frac{\Pi_{ii}^{*}}{\Pi_{ii}^{a}} = \left(\frac{1 + n_i}{1 + n_1 + n_2}\right)^2 \left(1 + \frac{n_j\left(w_j + t - w_i\right)}{a_i - w_i}\right)^2$$

→ **the double effect of trade on local profit**

- ✓ **pro competitive effect:** $\frac{1+n_i}{1+n_1+n_2}$

  the firm number increases, the mark-up decreases, the profit reduces.

- ✓ **production and rent shifting effect**

$$1+\frac{n_j\left(w_j+t-w_i\right)}{a_i-w_i}$$

- ✓ **if $w_j+t<w_i$, new competitors are more productive than local producers, which decreases the local profit**
- ✓ **if $w_j+t>w_i$, new competitors are less productive than local producers, which increases the good price and next the local profit (dominated effect in general)**
- ✓ **lower profit loss (compared to autarky), the higher the trade cost (closes the market)**

→ **new export profit (if markets not too segmented)**

$$\Pi_{ij}^{*} = \frac{n_i\left(a_j - (w_i + t) + n_j\left(w_j - (w_i + t)\right)\right)^2}{(1 + n_1 + n_2)^2}$$

✓ **larger, the larger the export country, the higher the local productivity, the lower the competitors productivity, the lower the trade cost, the lower the competitor number (except if strong competitive advantage)**

- **Special cases**

→ same productivity ($w_1 = w_2 = w$)

$$\frac{\Pi_{ii}^{*}}{\Pi_{ii}^{a}} = \left(\frac{1+n_i}{1+n_1+n_2}\right)^2 \left(1+\frac{n_j t}{a_i - w}\right)^2$$

pro-competitive effect stronger (⇒ local profit loss), unless market segmentation is large

may be compensated by the export profit (if export country large etc…)

$\rightarrow$ if, moreover, same country size (demand ($a_1 = a_2$) and firm number ($n_1 = n_2$)) and perfectly integrated markets ($t = 0$):

✓ $$\frac{\Pi_i^* - n_i f_i}{\Pi_i^a - n_i f_i} = 2\left(\frac{1+n}{1+2n}\right)^2 < 1\text{: loss}$$

✓ $$\frac{sc_i^*}{sc_i^a} = 4\left(\frac{1+n}{1+2n}\right)^2 > 1\text{: gain}$$

✓ $$\frac{W_i^* - n_i f_i}{W_i^a - n_i f_i} = \frac{4(1+n)^3}{(2+n)(1+2n)^2} > 1\text{: gain}$$

$\Rightarrow$ only the pro-competitive effect (direct deadweight loss decrease + efficiency gains)

- **Conclusions**
  - → **to determinate which effects dominate when trade is liberalized under imperfect competition, one has to work on the analytics.**
  - → **do not forget: partial equilibrium analysis**
    - ✓ **e.g., if profits are zero, the country does not care on having or not firms located in**
    - ✓ **under general equilibrium: this becomes critical (no firms ⇒ no employment ⇒ no income)**
  - → **liberalization effects under imperfect competition and general equilibrium: see economic geography**

- **References**

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