

## Problem Set 2

October 25, 2011

**Due:** Tue, November 8, before 12:30pm  
**Instructor:** Marc-Andreas Muendler  
**E-mail:** muendler@ucsd.edu

### 1 Intraindustry Trade

Consider car makers that operate under monopolistic competition in symmetric equilibrium. Each monopolistic car maker produces with a total cost function

$$TC = F + c \cdot Q_C,$$

where  $F = 500,000$  and  $c = 100$ .

- What are the average and marginal cost functions of a car maker?

Each of  $n$  car makers faces residual demand of

$$Q_C^d = S \cdot [1/n - b \cdot (P_C - \bar{P}_C)],$$

where  $S = 50,000$ ,  $b = 1/1,000$  and  $\bar{P}_C$  is average equilibrium price.

- What are marginal revenues? [*Hint:* You may use the formula in the textbook. Otherwise, reformulate demand so that  $P_M = P_M(Q_M^d)$  and derive total revenue; differentiate total revenue with respect to quantity.]
- Graph the average-cost-variety ( $CC$ ) and the price-variety ( $PP$ ) schedules for this industry in a diagram that shows price, average cost and the number of firms (varieties).
- Find the number of firms (varieties) in this industry in the absence of trade. What is price in a symmetric autarky equilibrium?
- Cars can be traded across countries at not cost. Using the average-cost-variety ( $CC$ ) and the price-variety ( $PP$ ) schedules above, show how equilibrium price and the equilibrium number of firms change after trade.
- How could you measure the gains from trade? Explain briefly.

### 2 Trade with Heterogeneous Firms

Consider three car makers that can potentially operate under monopolistic competition in equilibrium. There are two completely identical countries. To start operations, a car maker  $i$  needs to pay a fixed cost of  $F = 1,250$  and can produce at a constant marginal cost of  $c_i$ . To enter the foreign market, a car

exporter needs to pay an additional fixed cost of  $F_X = 312.5$ . To ship an export, a car maker incurs an additional transport cost of  $\tau = 1$  (100 percent) on top of marginal production cost so that marginal costs for an export good are  $(1 + \tau) \cdot c_i$ .

In each country, the three car makers have constant marginal cost of production  $c_1 = 50, c_2 = 150, c_3 = 300$  (and  $c_1^* = 50, c_2^* = 150, c_3^* = 300$ ).

Every car maker  $i$  faces residual demand of

$$Q_i^d = S \cdot [1/n - b \cdot (P_i - \bar{P})]$$

under monopolistic competition, where  $S = 5,000, b = 1/100$  and  $\bar{P}$  is average equilibrium price.

Recall from class that, for this residual demand, optimal quantity and profits are

$$Q_i = \frac{Sb}{2} \left( \bar{P} + \frac{1}{b \cdot n} - c_i \right) \quad \text{and} \quad \Pi_i = \frac{Sb}{4} \left( \bar{P} + \frac{1}{b \cdot n} - c_i \right)^2.$$

The domestic marginal-cost ceiling at which the last (highest-cost) entrepreneur  $n$  just enters and the marginal-cost ceiling for exports at which the last (highest-cost) domestic firm  $n_X$  just exports are

$$c_n = \bar{P} + \frac{1}{b \cdot n} - 2\sqrt{\frac{F}{Sb}} \quad \text{and} \quad c_{n_X}^X = \bar{P}^* + \frac{1}{b \cdot n^*} - 2\sqrt{\frac{F_X}{S^*b}}.$$

- Use profits  $\Pi_i$  and fixed entry costs  $F$  to derive the domestic marginal-cost ceiling  $c_n$ .
- Use the equilibrium price-variety relationship for the average firm  $\bar{P} = 1/(b \cdot n) + \bar{c}$  to restate the marginal-cost ceilings in terms of the average markup  $1/(b \cdot n)$  and market-average marginal cost  $\bar{c}$ .
- Consider autarky (fixed export costs are prohibitively high at  $F_X = 350,000$ .) Use the marginal-cost ceiling to show that two firms will enter the domestic market, but not three.
- Consider free trade (fixed export cost of  $F_X = 312.5$ ) and suppose that wages remain unchanged. Use the marginal-cost ceiling for exports to show that exactly one domestic firm will export and that the two foreign incumbent firms remain in operation. Also show that two exporters and two foreign incumbents cannot be an equilibrium outcome, and that one home exporter and three foreign firms cannot be an equilibrium outcome.
- Continue to consider free trade and unchanged wages. How does free trade affect the average markup  $1/(b \cdot n)$  and market-average marginal cost  $\bar{c}$ ? How does market average price  $\bar{P}$  change?

### 3 Monopolistic Competition and Dumping

A machinery monopolist produces with a total cost function

$$TC = F + \frac{c}{2} \cdot (Q_M)^2,$$

where  $c = 1/150$ . You may suppose that  $F = 0$ .

- What are the monopolist's average and marginal cost functions?

Demand for machines at Home is

$$Q_M^d = S - Sb \cdot P_M,$$

where  $S = 50,000$  and  $b = 1/1,000$ . World demand is perfectly elastic at a world-market price of  $P_M^* = 500$ .

- What are the monopolist's marginal revenues? [*Hint*: You may use the formula in the textbook. Otherwise, reformulate demand so that  $P_M = P_M(Q_M^d)$  and derive total revenue; differentiate total revenue with respect to quantity.]
- The monopolist chooses to export at the world-market price  $P_M^* = 500$ . Determine total output, domestic sales and exports in a suitable graph and show that the monopolist's best strategy is dumping on the world market.
- Use the graph to show that domestic consumers suffer from high monopoly price. [*Hint*: Consumer surplus is the area below the demand curve. Draw it before and after dumping.]
- Free trade in machinery exposes the domestic monopolist to perfect competition at  $P_M^* = 500$ . Show that Home consumers are better off after trade, while the monopolist is worse off. [*Hint*: Consumer surplus is the area below the demand curve. Identify consumer rents before and after free trade.]
- Can the monopolist remain in business if  $F > 0$ ?

## 4 Horizontal Foreign Direct Investment

A domestic machinery monopolist faces no competition in the Home market but can sell to the world market at some price  $P^*$ . The monopolist's total costs are

$$TC = \frac{c}{2} \cdot Q^2,$$

and domestic demand is

$$Q_M^d = S - Sb \cdot P_M,$$

where  $c = 1/150$ ,  $S = 50,000$  and  $b = 1/1,000$ .

- Calculate, and depict in a price-quantity diagram, the *effective marginal revenues* of this monopolist, considering the exporting opportunity.
- Calculate, and depict in a price-quantity diagram, the optimal amount of goods that the monopolist will choose to sell to the domestic market and the optimal amount of goods the monopolist will export in the absence of transport costs.

- Now suppose there are transport costs  $\tau = \frac{1}{2}c$  per unit shipped across borders. Calculate and depict monopoly profits from exports. [*Hint:* Note that, in contrast to the case in class, these transport costs will shift and not turn the parent company's marginal cost curve for exported goods. A useful alternative way to approach the problem is to shift down the foreign price by the transport cost.]
- Alternatively, the monopoly can open a foreign subsidiary and sell to the world market from the new location at no transport cost. Calculate and depict profits at the foreign subsidiary. If there are some fixed costs to open a foreign subsidiary, how large can they be at most to make horizontal FDI worthwhile?

## 5 Vertical Foreign Direct Investment

A domestic machinery monopolist faces no competition in the Home market and a domestic demand function

$$Q_M^d = S - Sb \cdot P_M,$$

where  $S = 50,000$  and  $b = 1/1,000$ .

The monopolist has three choices to make or buy its product for the domestic market.

1. To produce at the Home establishment under a cost function

$$TC_1 = \frac{c}{2} \cdot Q^2,$$

where  $c = 1/150$ .

2. To acquire a Foreign subsidiary and to produce at the foreign location under a cost function

$$TC_2 = \frac{c^*}{2} \cdot Q^2,$$

where  $c^* = c/2 = 1/300$ .

3. To enter a contract with Foreign suppliers but facing hold-up costs so that the effective cost function of Foreign supplies including *hold-up costs* becomes

$$TC_3 = \frac{4c^*}{3} \cdot Q^{\frac{3}{2}},$$

where  $c^* = c/2 = 1/300$ .

There are transport costs  $\tau = \frac{1}{2}c^*$  per unit shipped across borders. There are no fixed costs.

- Provide an example of a hold-up problem that deters a foreign supplier from supplying the right quality to the monopolist.
- Calculate, and depict in a price-quantity diagram, the marginal revenues of the domestic monopolist.
- Calculate, and depict in the price-quantity diagram, the marginal costs of the domestic monopolist under the three alternative make-or-buy choices.

- Calculate and depict quantities under the alternative make-or-buy choices. Which of the three choices is profit maximizing? Why? Depict profits.
- Depict a measure of the internalization advantage.