

## 4 Effects of a change in marginal cost (Extra)

Consider the same market as in the previous question. Notice that firm 1's equilibrium profit can be written as:

$$\pi_1^*(c_1, c_2) = \pi_1(q_1^*(c_1, c_2), q_2^*(c_1, c_2), c_1) = [\alpha - \beta \cdot (q_1^*(c_1, c_2) + q_2^*(c_1, c_2)) - c_1] \cdot q_1^*(c_1, c_2).$$

Assume that firm 1's marginal cost is reduced by a very small amount. Explain how firm 1's profit is affected, making explicit use of the Envelope Theorem.

### 4.1 Answer

Start out by taking the derivative of the firm's profit with respect to its own cost:

$$\frac{d\pi_1^*(c_1, c_2)}{dc_1} = \frac{\partial \pi_1}{\partial c_1} + \frac{\partial \pi_1}{\partial q_1} \cdot \frac{\partial q_1}{\partial c_1} + \frac{\partial \pi_1}{\partial q_2} \cdot \frac{\partial q_2}{\partial c_1}$$

The Envelope Theorem guarantees that

$$\frac{\partial \pi_1}{\partial q_1} = 0$$

The reason is that this is the first-order condition for the firm's choice of quantity.

Thus, we can simplify the derivative above:

$$\frac{d\pi_1^*(c_1, c_2)}{dc_1} = \frac{\partial \pi_1}{\partial c_1} + \frac{\partial \pi_1}{\partial q_2} \cdot \frac{\partial q_2}{\partial c_1}$$

Thus

$$\frac{d\pi_1^*(c_1, c_2)}{dc_1} = -q_1^* - \beta \cdot q_1^* \cdot \frac{\partial q_2}{\partial c_1} < 0$$

Interpretation:

First term: if unit cost is increased by one unit, total cost is increased in proportion to production.

Second term: When the firm's cost is increased, the competitor will start to produce more, which reduces the price for the first firm. That price reduction hits the first firm's whole production volume.

## 5 Bertrand duopoly, with different costs

Consider a market with 1000 consumers. Everybody wants to buy one unit of the good and is willing to pay at most €  $v$  for that unit. Nobody wants a second unit.

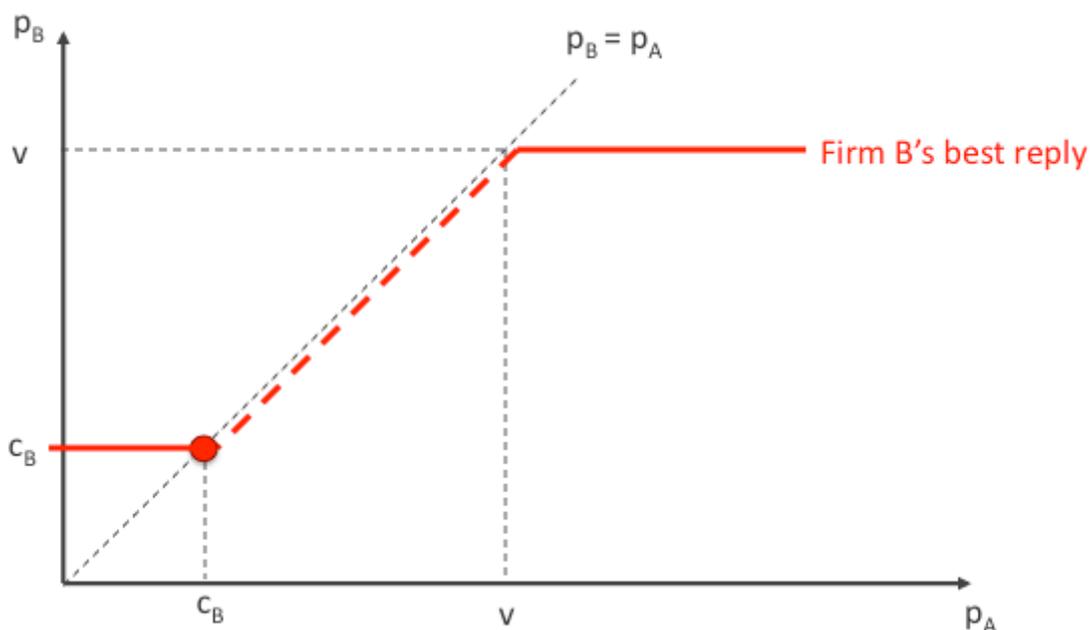
There are two firms, called A and B, producing exactly the same good. They compete a la Bertrand. The consumers only buy from the firm with the lowest price and if they charge the same price half of the consumers buy from each firm.

The unit cost of production is constant for both firms. But firm A is more efficient. Firm A's unit cost is and given by  $c_A = 1 < 2 = c_B$

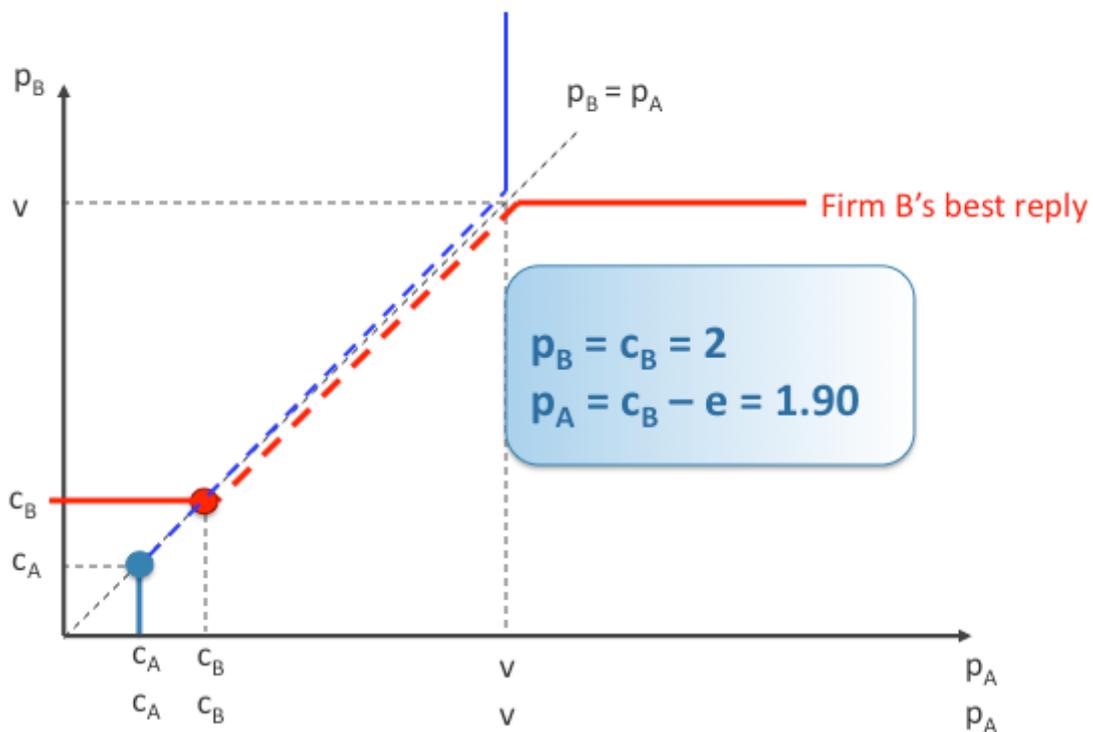
1. What prices will the two firms set?
2. How many units will they sell?

### 5.1 Answers

The easiest way to solve this question is to use graphs. Firm B's best reply function is:



Firm A's best reply function is described by the blue line:



Note that the two best-reply function intersect only at one point, namely where the high cost firm (B) sets price equal to its own cost and the low cost firm (A) charges a tiny amount below.

Note that this means that the low cost firm will be able to supply the whole market, eliminating wasteful production completely. Recall that in Cournot the high-cost firm can survive (unless its cost disadvantage is too great). The reason is that price competition is not as intense in Cournot as it is in Bertrand.

## 6 Monopoly and Bertrand Oligopoly (extra)

Consider a market with 1000 consumers. Everybody wants to buy one unit of the good and is willing to pay at most € 5 for that unit. Nobody wants a second unit. The unit cost of production is constant and given by € 2. At the outset there is only one firm serving the market. But then a second firm enters and starts to produce an identical good. The two firms compete in prices a la Bertrand. The consumers only buy from the firm with the lowest price and if they charge the same price half of the consumers buy from each firm. The smallest monetary unit is 10 cents which means that the firms can only set their prices in multiples of € 0.1, e.g. 0, 0.1, 0.2, 0.3 and so on.

### 6.1 Question 1

What is the monopoly price?

- €5

### 6.2 Question 2

How many units does the monopolist sell?

- 1000

### 6.3 Question 3

Is the outcome efficient or inefficient? Explain!

- Efficient since all consumers get the good.
- This is possible since all consumers are identical and since the firm knows their willingness to pay.

### 6.4 Question 4

What is the duopoly price? When answering this question, be careful to draw a diagram of the firm's best-reply functions. You will then see that there are:

- Two equilibria: €2.00 and €2.10

The first equilibrium €2.00 is the same as before, i.e. price equal to cost. But when there is a smallest monetary unit, there is also a second equilibrium namely: price = cost + the smallest monetary unit.

This is also easy to prove. Assume that firm A charges €2.10. Then, if B charges a higher price it will sell nothing and earn no profit. If B charges the same price it will earn a small margin and sell to half the market, which yields a small profit. If B charges price equal to cost, it will make no profit and a price below cost would imply a loss. Thus, charging the same price is the best reply.

Note that from an economic point of view these two equilibria are essentially the same. In equilibrium, price is (almost) equal to cost and profits are (almost) zero.

## 6.5 Question 5

Is competition good for welfare?

- Competition does not change consumption and production
- Competition does change the split of the surplus.