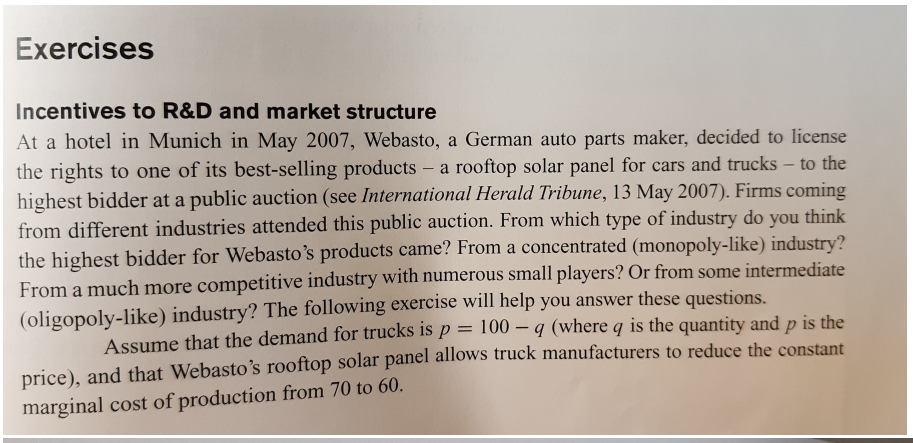
Examenreconstructie: Economics of New Technologies – 27/6/2019

It should be noted that this year only part 1 (taught by prof. Veugelers) was given.
The exam consisted of one big exercise, completely the same as exercise 18.1 from "Industrial Organization" by Belleflame and Peitz but with different numbers, hence the pictures from this exercise:

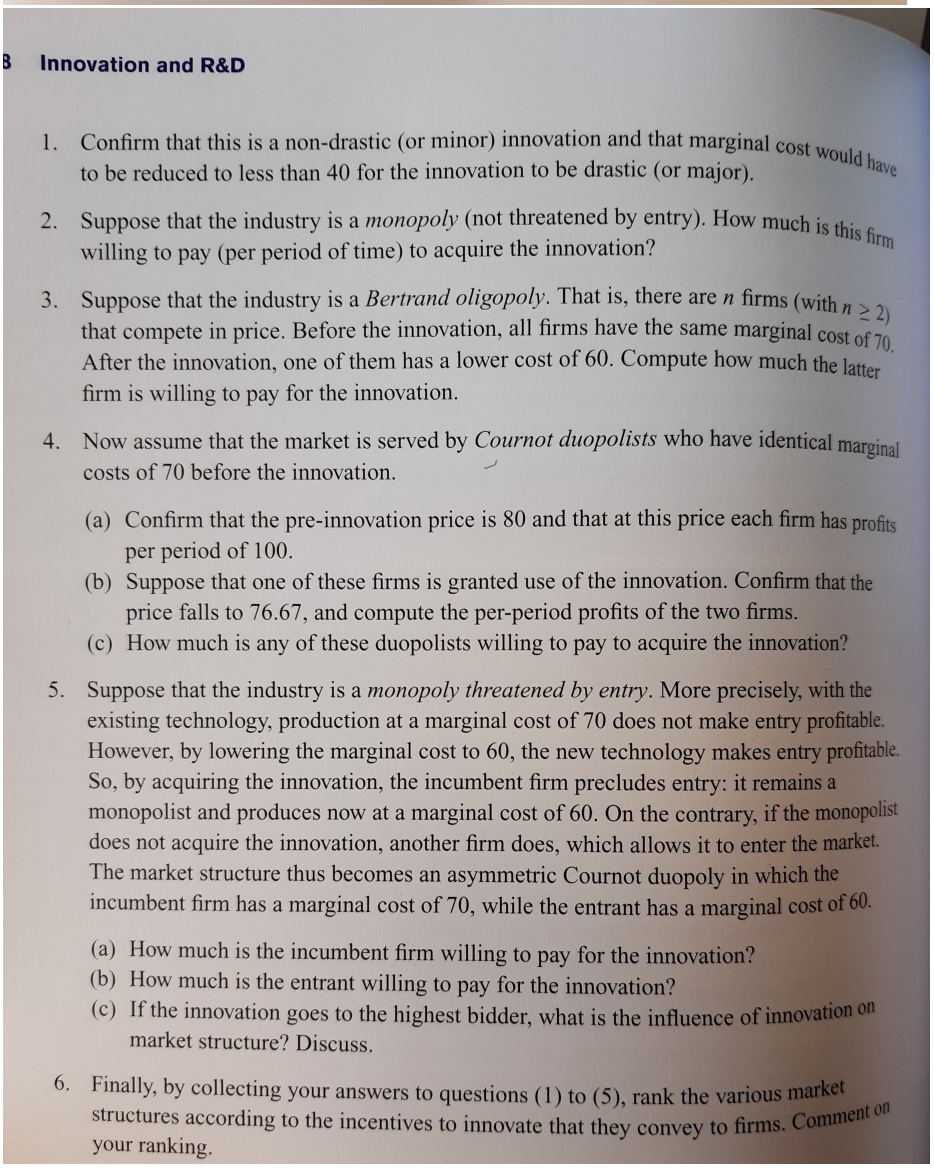


Exercises

Incentives to R&D and market structure

At a hotel in Munich in May 2007, Webasto, a German auto parts maker, decided to license the rights to one of its best-selling products – a rooftop solar panel for cars and trucks – to the highest bidder at a public auction (see *International Herald Tribune*, 13 May 2007). Firms coming from different industries attended this public auction. From which type of industry do you think the highest bidder for Webasto's products came? From a concentrated (monopoly-like) industry? From a much more competitive industry with numerous small players? Or from some intermediate (oligopoly-like) industry? The following exercise will help you answer these questions.

Assume that the demand for trucks is $p = 100 - q$ (where q is the quantity and p is the price), and that Webasto's rooftop solar panel allows truck manufacturers to reduce the constant marginal cost of production from 70 to 60.



8 Innovation and R&D

1. Confirm that this is a non-drastic (or minor) innovation and that marginal cost would have to be reduced to less than 40 for the innovation to be drastic (or major).
2. Suppose that the industry is a *monopoly* (not threatened by entry). How much is this firm willing to pay (per period of time) to acquire the innovation?
3. Suppose that the industry is a *Bertrand oligopoly*. That is, there are n firms (with $n \geq 2$) that compete in price. Before the innovation, all firms have the same marginal cost of 70. After the innovation, one of them has a lower cost of 60. Compute how much the latter firm is willing to pay for the innovation.
4. Now assume that the market is served by *Cournot duopolists* who have identical marginal costs of 70 before the innovation.
   (a) Confirm that the pre-innovation price is 80 and that at this price each firm has profits per period of 100.
   (b) Suppose that one of these firms is granted use of the innovation. Confirm that the price falls to 76.67, and compute the per-period profits of the two firms.
   (c) How much is any of these duopolists willing to pay to acquire the innovation?
5. Suppose that the industry is a *monopoly threatened by entry*. More precisely, with the existing technology, production at a marginal cost of 70 does not make entry profitable. However, by lowering the marginal cost to 60, the new technology makes entry profitable. So, by acquiring the innovation, the incumbent firm precludes entry: it remains a monopolist and produces now at a marginal cost of 60. On the contrary, if the monopolist does not acquire the innovation, another firm does, which allows it to enter the market. The market structure thus becomes an asymmetric Cournot duopoly in which the incumbent firm has a marginal cost of 70, while the entrant has a marginal cost of 60.
   (a) How much is the incumbent firm willing to pay for the innovation?
   (b) How much is the entrant willing to pay for the innovation?
   (c) If the innovation goes to the highest bidder, what is the influence of innovation on market structure? Discuss.
6. Finally, by collecting your answers to questions (1) to (5), rank the various market structures according to the incentives to innovate that they convey to firms. Comment on your ranking.

Solution:

Chapter 18. Innovation and R&D

18.1 Incentives to R&D and market structure

1. Let c denote the marginal cost. A monopolist chooses its quantity to maximize profit $\pi = (100 - q)q - cq$. The optimal quantity is easily found as $q^m(c) = (100 - c)/2$ and the corresponding price is $p^m(c) = 100 - q^m = (100 + c)/2$. Using this expression, we compute the monopoly price corresponding to the post-innovation cost of 60: $p^m(60) = 80$. As this price is larger than the pre-innovation marginal cost (i.e., 70), we check that the innovation is non-drastic. For the innovation to be drastic, one would need $p^m(c) = (100 + c)/2 < 70$, which is equivalent to $c < 40$.
2. Using the analysis of the previous question, we can compute the monopoly optimal profit for any given marginal cost: $\pi^m(c) = q^m(c)[p^m(c) - c] = \frac{1}{4}(100 - c)^2$. The incentive to innovate for the monopoly is measured by the increase in its profit due to the innovation. That is: $PI^m = \pi^m(60) - \pi^m(70) = 400 - 225 = 175$.
3. As the innovation is non-drastic, we know that the innovator's optimal price strategy is to set a price just below the marginal cost of the rival firms, that is, $p^* = 70 - \varepsilon$, where $\varepsilon > 0$ can be arbitrarily small. The innovator captures the whole demand and sells a quantity equal to $q^* = 100 - (70 - \varepsilon) = 30 + \varepsilon$. Given that the innovator's cost is equal to 60, its profit is computed as $\pi^b = (p^* - 60)q^* \simeq 300$. As the pre-innovation profit is zero, the incentive to innovate for a Bertand oligopolist is simply $PI^b = \pi^b = 300$.
4. Cournot duopoly.
   (a) Before the innovation, firm 1 chooses its quantity q_1 to maximize $\pi_1 = (100 - q_1 - q_2) - 70q_1$. The first-order condition yields $30 - 2q_1 - q_2 = 0$. We derive firm 1's reaction function from the latter expression: $q_1(q_2) = \frac{1}{2}(30 - q_1)$. As firm 2 faces the exact same conditions, it has a similar reaction function: $q_2(q_1) = \frac{1}{2}(30 - q_2)$. We find the Cournot–Nash equilibrium by solving for the system of the two reaction functions: $q_1^* = q_2^* = 10$. The equilibrium price is then equal to $p^* = 100 - 20 = 80$, meaning that each firm makes a margin of $p^* - 70 = 10$. Hence, equilibrium profits for both firms are equal to $\pi^c_{pre} = 100$.
   (b) Let the innovator be firm 1. Its profit is now written as $\pi_1 = (100 - q_1 - q_2) - 60q_1$. From the first-order condition for profit maximization, we derive firm 1's reaction function: $q_1(q_2) = \frac{1}{2}(40 - q_2)$. As for firm 2, the marginal cost has not changed and thus, we have the same reaction function as in the previous question: $q_2(q_1) = \frac{1}{2}(30 - q_1)$. Solving for the system of equations given by the two reaction functions, we find $q_1^* = \frac{50}{3}$ and $q_2^* = \frac{20}{3}$. It follows that the equilibrium price is equal to $p^* = 100 - \frac{50}{3} - \frac{20}{3} = \frac{230}{3} = 76.67$. The profits of the two firms are then computed as

$$\pi_1 = \left(\tfrac{230}{3} - 60\right)\tfrac{50}{3} = \tfrac{2500}{9} = 277.78 \equiv \pi^c_{post},$$
$$\pi_2 = \left(\tfrac{230}{3} - 70\right)\tfrac{20}{3} = \tfrac{400}{9} = 44.44.$$

   (c) We compute the incentive to innovate as the profit increase for the innovator: $PI^c = \pi^c_{post} - \pi^c_{pre} = 277.78 - 100 = 177.78$.
5. Monopoly threatened by entry.
   (a) In case the incumbent gets the innovation, it remains a monopoly with a marginal cost of 60. We know from (2) that its profit is then equal to $\pi^m(60) = 400$. In case the incumbent does not get the innovation, it will be a Cournot duopolist with a cost of 70 facing a rival firm with a cost of 60. This is the equilibrium profit of firm 2 as computed in (4b): $\pi_2 = 44.44$. Hence, the incumbent's incentive to innovate is equal to $PI^{inc} = 400 - 44.44 = 355.56$.
   (b) The entrant makes zero profit if it does not get the innovation and if it does, it makes the duopoly profit identified as $\pi_1 \equiv \pi^c_{pre} = 277.78$ as computed in (4b). Hence, the entrant's incentive to innovate is equal to $PI^{ent} = 277.78$.
   (c) It is the incumbent that will end up with the innovation, which will allow it to maintain its monopoly position through time.
6. In this example, we observe $PI^{inc} > PI^b > PI^{ent} > PI^c > PI^m$. The fact that $PI^b > PI^m$ is known as the replacement effect. The fact that $PI^{inc} > PI^{ent}$ is known as the efficiency effect. The fact that $PI^{inc} > PI^m$ shows that the threat of entry increases the incentive to innovate for a monopoly. The fact that $PI^c > PI^m$ is not a general result.