Model Solutions, Exam 2023-12-08.

Multiple choice questions.

1. d 2. b 3. d 4. e[1] 5. b[2] 6. d 7. b 8. e[3]

Text questions.

I (a) **Moral hazard** occurs when one side to a contract has an incentive to behave inefficiently, usually because the inefficient behavior is hidden from the other side. For example, a fully insured sawmill owner does not have the incentive to take all cost-effective actions to reduce the risk of fire; moral hazard afflicts those actions that the insurance company cannot verify.[4]

(b) A **pecuniary externality** occurs when a market transaction affects others only through changes in prices or incomes rather than through a physical effect. Pecuniary externalities redistribute surplus but do not cause inefficiencies. For example, if a new cafe opens and draws customers away from existing cafes it conveys a negative pecuniary externality on the existing cafes.

(c) The **grim strategy** is possible in repeated situations where it is in individual players' short run interest to not cooperate although everyone would be better off if everyone cooperated. It involves a player initially cooperating but permanently switching to non-cooperation if other players ever fail to cooperate. For example, firms may "cooperate" by setting a high price but then switch to a low price forever if a competitor ever undercuts them.

II A CO_2 tax fixes the price of emissions and lets the amount of emissions adjust. Selling a limited amount of emissions rights ("Cap-and-trade") fixes the amount of emissions and lets the price of emissions adjust. Both policies can be used to achieve the exact same combination of emissions and government revenue; the differences are mainly administrative and terminological. Both policies are in essence equivalent ways of achieving any desired level of emissions reductions. Any real argument for or against one policy could just as well be used for or against the other policy.

[1]This is the revenue equivalence theorem.

[2]If the capacity that was built for entry deterrence becomes useful for something else then this increases its opportunity cost in its original intended use, making it less credible as deterrence.

[3]For quantity choice, it is advantageous to pre-empt the competitor and produce more, for price choice it is better to move last to slightly undercut the competitor.

[4]Definition from the The Economy 1.0 by CORE: https://www.core-econ.org/the-economy/v1/book/text/50-02-glossary.html#glossary-moral-hazard: "**Moral hazard** refers to any situation in which one party to an interaction is deciding on an action that affects the profits or wellbeing of the other but which the affected party cannot control by means of a contract, often because the affected party does not have adequate information on the action."

Problem solving questions.

III (a) The profit function of country A is

$$\begin{aligned}\Pi_A(q_A, q_B) &= \big(P^d(q_A + q_B) - \text{MC}\big) \times q_A \\ &= \big(300 - 0.5(q_A + q_B) - 60\big)q_A \\ &= 240q_A - 0.5q_Aq_B - 0.5q_A^2\end{aligned}$$

If B produces 120 tons then A's profit function becomes

$$\Pi_A(q_A, 120) = 240q_A - 0.5 \times 120q_A - 0.5q_A^2 = 180q_A - 0.5q_A^2.$$

Take the first-order condition and solve for A's profit-maximizing output choice:

$$\frac{\partial \Pi_A(q_A, 120)}{\partial q_A} = 180 - q_A = 0 \implies q_A^* = 180$$

Country A would produce 180 tons of unobtanium and expect profits $\Pi_A(180, 120) = 180^2 - 0.5 \times 180^2 = 16200$ €m.

(b) Both countries have the same costs and face the same demand, so B's profit function is symmetric with A's. The problem facing country B is the same that A faced in part IIIa, with the only difference that it believes A will produce $q_A = 180$. Therefore B's profit function is now

$$\Pi_B(q_B, 180) = 240q_B - 0.5 \times 180q_B - 0.5q_B^2 = 150q_B - 0.5q_B^2.$$

Take the first-order condition and solve for B's profit-maximizing output choice:

$$\frac{\partial \Pi_B(q_B, 180)}{\partial q_A} = 150 - q_B = 0 \implies q_B^* = 150$$

Country B would produce 150 tons and expect profits $\Pi_B(150, 180) = 150^2 - 0.5 \times 150^2 = 11250$ €m.

(c) Now, both countries revise their production plans until an equilibrium is reached. This amounts to finding the equilibrium of a Cournot duopoly problem. First let's find the best-response of a country to the other country's output. Let's use the profit function of country A from part IIIa, and this time take the first-order condition while keeping q_B as an unknown.

$$\frac{\partial \Pi_A(q_A, q_B)}{\partial q_A} = 240 - q_A - 0.5q_B \implies q_A = 240 - 0.5q_B$$

This defines the best response function of country A, $\text{BR}_A(q_B) = 240 - 0.5q_B$. There are no fixed costs, so we know that there is room for both countries to produce.

By symmetry, both countries have the same best response function and $q_A = q_B$ in equilibrium, so we can solve for the equilibrium[5] from $\text{BR}_A(q) = q$:

$$240 - 0.5q = q \implies q^* = 160$$

Hence, both countries end up producing 160 tons of unobtanium and earning profits $\Pi_A(160, 160) = 240 \times 160 - 0.5 \times 160^2 - 0.5 \times 160^2 = 12800$ €m.

IV The fact that GildedSpoon's coffee pods or proprietary means that it can set up a two-part tariff: anyone who wants to drink GildedSpoon's espresso will have to rent an espresso machine from them (pay the membership fee for Espas Club), and then a unit price that depends on how many cups of espresso (how many coffee pods) they actually consume.

Let's first invert the demand functions of both customer types.

$$Q_1^d(p) = 50 - 5p \Leftrightarrow P_1^d(q) = 10 - \frac{q}{5}$$
$$Q_2^d(p) = 48 - 6p \Leftrightarrow P_2^d(q) = 8 - \frac{q}{6}$$

Clearly type 1 is unambiguously the higher-demand type: its choke price is higher and its inverse demand curve is less steep.

(a) Let's devise the optimal two-part tariff where both customer types join the club. Since both customers are equally numerous we can, for convenience, assume that there is one of each.

1. Define membership fee F as a function of P that extracts the full CS of low types

$$\text{F}(p) = \text{CS}_2(p) = (8 - p) \times Q_2^d(p) = (8 - p)(48 - 6p)\frac{1}{2} = 3(8 - p)^2$$

2. Define profits as a function of price

$$\begin{aligned}\Pi(p) &= (Q_1(p) + Q_2(p)) \times (p - \text{MC}) + 2 \times (F(p) - \text{FC}_i) \Leftrightarrow \\ \Pi(p) &= (50 - 5p + 48 - 6p)(p - 3) + 2 \times (3 \times (8 - p)^2 - 25) \\ &= (98 - 11p)(p - 3) + 2 \times (192 - 48p + 3p^2 - 25) \\ &= 98p - 11p^2 - 294 + 33p + 334 - 96p + 6p^2 \\ &= 40 + 35p - 5p^2\end{aligned}$$

3. Find the profit-maximizing coffee pod price and the resulting membership fee

$$\frac{\partial \Pi(p)}{\partial p} = -10p + 35 = 0 \implies p^* = 3.5$$
$$F(p^*) = F(3.5) = 3 \times (8 - 3.5)^2 = 60.75$$

[5]You could also keep iterating the best response function, $q_{\text{new}} = \text{BR}(q_{\text{old}})$, for many many rounds until the result converges, but that is just a very laborious way of finding the Nash equilibrium.

4. Compare the profits of selling to both types or to only high types

Profits from selling to both types (with 1 customer of each type) are:

$$\Pi(3.5) = -5 \times 3.5^2 + 35 \times 3.5 + 40 = 101.25$$

Selling only to high type extracts all their consumer surplus when pods are priced at marginal cost, but gets no profits from low types:

$$\Pi_1 = (P_1^d(0) - \text{MC})Q_1^d(\text{MC})\frac{1}{2} - \text{FC}_i = (10-3)(50-5\times 3)\times 0.5 - 25 = 97.5$$

Selling to both types is more profitable. The profit-maximizing pricing scheme is to price the club membership at €60.75 per month and coffee pods at €3.5.

(b) Now that the market can be segmented by type GildedSpoon can use the optimal one-customer-type two-part tariff in each area. It captures all of consumer surplus from both types by setting coffee pod price equal to marginal cost and membership fee just high enough to extract all of the local type's consumer surplus. Compared to part IVa, consumer surplus of type 1 customers decreases to zero and that of type 2 customers remains unchanged at zero, while profits increase since this gives the highest achievable profit.

(c) In part IVb, the price of coffee pods is the same in both areas so there is no scope for a secondary market in coffee pods to change anything.