How to Commit to a Future Price

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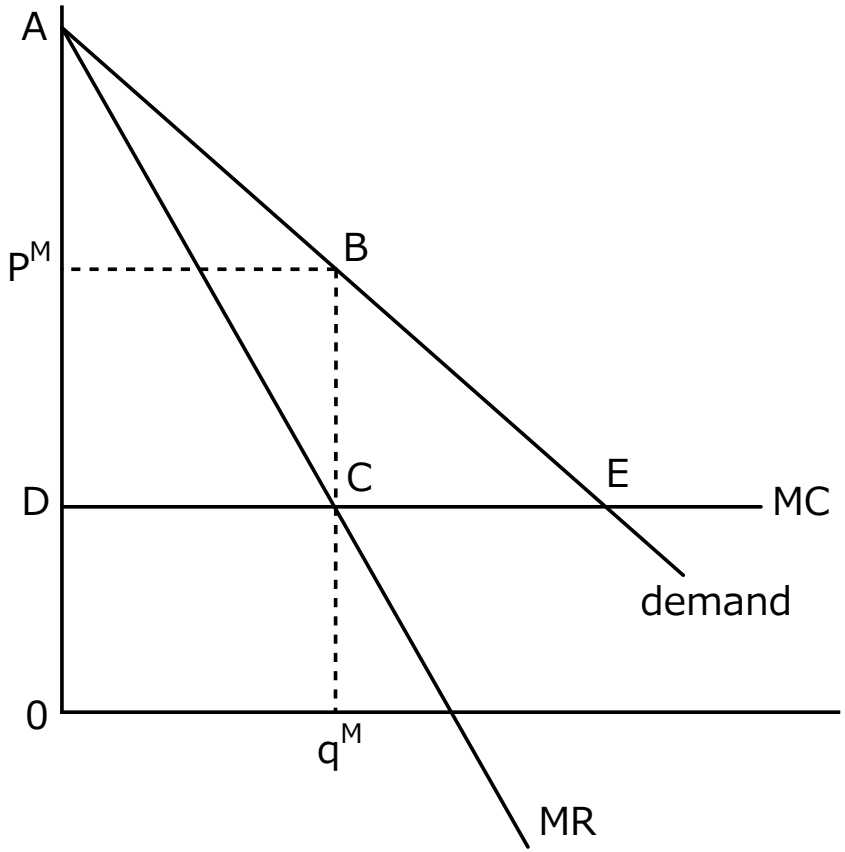
1. Introduction

- Consider a monopolist that sells a "**durable good**" and additional "**consumables**" using the durable good.
  - Xerox's copiers and toner
  - HP' printers and ink
  - Gillette's razors and cartridges
  - Boeing's plane and maintenance
- The higher the price of the consumables, the less a buyer is willing to pay for the durable.
  - The profit-maximizing solution for the seller is to price the consumable at MC, and extract CS with a high price for the durable (e.g., Apple iPod).
- The monopolist seller faces a **commitment problem**: after the durable is sold, the seller will want to charge a high price for the consumables.

1. Introduction—A Commitment Problem



Pricing Consumables

- $\square ABCD$: Profits w/o commitment
  - $\square P^M BCD$ from selling consumable
  - $\triangle ABP^M$ from selling durable
- $\triangle AED$: Profits w/ commitment
  - 0 from selling consumable
  - $\triangle AED$ from selling durable

Q. How to commit to future low price for consumables?

1. Introduction—Our Solutions

1. **Entering a financial contract with a third financial firm:**
   - Contract: a seller obtains a subsidy for each unit of consumable it sells, in exchange for a lump-sum payment to the fin. firm.
   - It increases the seller's MR from selling consumables and so induces the seller to lower the price of consumables.
2. **Allowing entry into the market for consumables:**
   - The entry will usually reduce the incumbent firm's profits, but the incumbent firm may profit from entry if it faces the commitment problem.
3. **Selling durables to low valuers by subsidizing them:**
   - The strategy increases the price elasticity of demand for the consumables.
   - This can serve as a commitment to a future low price for the consumables, which enables to charge high valuers a higher price for the durable.

2. Related Literature

- Oi (1971, QJE) "A Disneyland Dilemma: Two-part tariffs for a Mickey Mouse monopoly"
- Farrell and Gallini (1988, QJE) "Second-sourcing as a commitment: monopoly incentives to attract competition"
  - The monopolist increases profits by an ex ante commitment to competition in the post-adoption market.
  - Bornstein et al. (1995), Heubrandner and Skiera (2010), Nakamura and Steinsson (2011).
- "A firm may license its product to second-source suppliers, thereby committing itself to lower prices in the future, and so increasing demand in the first period." (Klemperer (1987))
- "Long-term contracts that reduce a firm's market power over locked-in consumers." (Farrell and Shapiro (1989))

3. Assumptions

- Two-period model: a monopolist sells durable goods (Good 1) in period 1 and additional consumable (Good 2) in period 2.
- Buyers are perfectly rational, correctly anticipating the price of consumables in period 2.
  - They knows "the seller would want to extract all the consumer surplus of buying consumables."
- No discounting over time
- Demand for consumables is $Q_2(P_2)$; its inverse is $P_2(Q_2)$.
- Seller's profits from selling consumables are $\Pi_2 = P_2 \cdot Q_2(P_2)$.
  - Zero marginal cost.

3. Assumptions

- Consumers derive utility only from using the durable with consumables.
  - Utility from using durable good is the same that from consuming durables:

$$CS(P_2) = \int_{P_2}^{\infty} Q_2(h)dh$$

3.1 Monopolist's commitment problem

- For any price P_2, the monopolist in period 1 would maximize his profits by setting $P_1 = CS(P_2)$.
  - $CS'(P_2) < 0$: the higher P_2, the less a buyer is willing to pay for the durable.
- Profits from selling a durable are $\Pi_1 = P_1 - c_1 = CS(P_2) - c_1$.
  - c_1: marginal production cost for a durable
- Total profits:

$$\Pi = \Pi_1 + \Pi_2 = CS(P_2) - c_1 + P_2 Q_2 = \int_0^{Q_2} P_2(z)dz - c_1$$

$\rightarrow$ Π is strictly decreasing with P_2 (increasing with Q_2).

3.1 Monopolist's commitment problem

- If the monopolist could commit in period 1 to P_2 in period 2, he'd choose P_2 that maximize Π.
  - This yields $P_2^* = 0$: *marginal cost pricing*
- In that case, profits would be

$$\Pi^* = CS(P_2^*) + P_2^* Q_2^* - c_1 = \int_0^{Q_2(0)} P_2(z)dz - c_1.$$

  - Linear demand case ($P_2 = a - Q_2$): $\Pi^* = a^2/2 - c_1$.
- However, this pricing is not time consistent: after the durable good is sold, the monopolist will want to charge a monopoly price for the consumables.

3.1 Monopolist's commitment problem

- If the monopolist cannot commit to the future price (P_2), buyers will anticipate P_2 would be the monopoly price P_2^M.
  - P_2^M is such that $P_2^M Q_2'(P_2^M) + Q_2(P_2^M) = 0$.
- Utility from buying consumable is $CS(P_2^M)$ and $P_1^M = CS(P_2^M)$.
- Total profits are

$$\Pi^M = CS(P_2^M) + P_2^M Q_2 - c_1 = \int_0^{Q_2(P_2^M)} P_2(z)dz - c_1.$$

  Therefore, $\Pi^* > \Pi^M$.
  - Linear demand: $\Pi^M = 3a^2/8 - c_1$.

Proposition 1

A monopolist selling a durable good and the associated consumables faces a time-inconsistency problem.

3.1 Monopolist's commitment problem

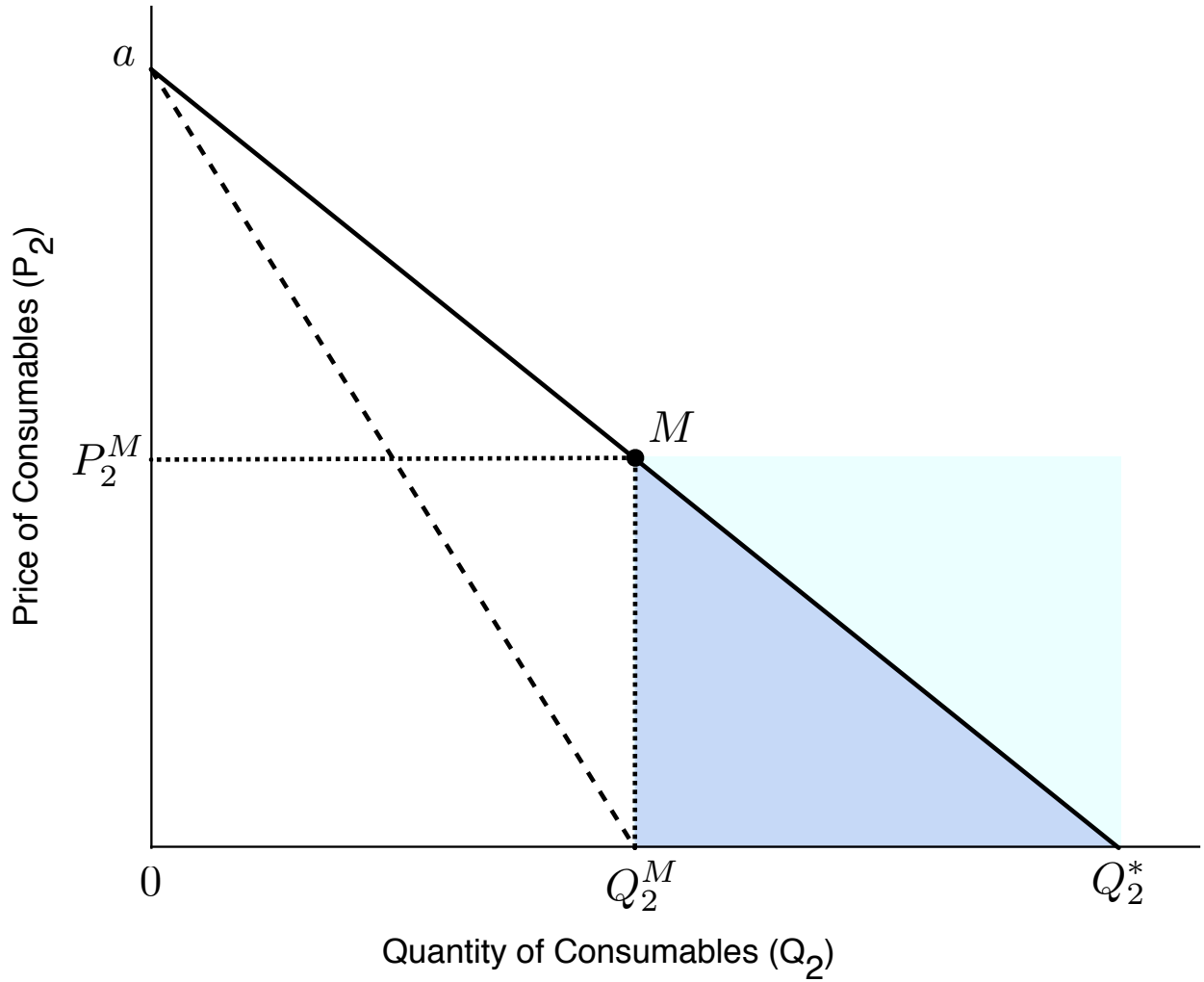


Figure: Monopolist's commitment problem

3.2 Contract with a third party to overcome the problem

- Entering contract with a third party financial firm:
  - *In period 2, the financial firm pays the monopolist s per unit of consumable sold, with the monopolist paying F to the financial firm in period 1.*
  - The contract is signed in period 1 and is known to consumers.
- Period 2: $\Pi_2^E = (P_2 + s)Q_2 - F \Rightarrow P_2^E$ & Q_2^E.
- The monopolist sets $P_1^E = CS(P_2^E)$.

$$\begin{aligned} \Pi^E &= CS(P_2^E) + (P_2 + s)Q_2^E - c_1 - F \\ &= \int_0^{Q_2^E} P_2(z)dz + sQ_2^E - c_1 - F \end{aligned}$$

3.2 Contract with a third party to overcome the problem

- F must be larger than sQ_2^E.
  - Assume the monopolist has bargaining power: $F = sQ_2^E$.
- The monopolist chooses s so as to maximize Π^E.

$$\frac{d\Pi^E}{ds} = \frac{dQ_2^E}{ds} P_2(Q_2^E) = 0 \quad \Rightarrow \quad P_2^E = 0$$

Proposition 2

This contract can serve as a commitment to future low price for consumables.

- The contract may be time-inconsistent?
  - In the beginning of period 2, the monopolist has incentives to reverse the contract because buyers already locked in.
  - Financial firm's reputation; Transaction costs;

4. Accommodating entry into the market for consumables

- Suppose a monopolist could allow one firm to enter the market for consumables.
  - The entry usually reduces the incumbent firm's profit, but it may benefit him if he faces the commitment problem.
- Consider three cases:
  1. The incumbent and the entrant firms engage in simultaneous-move Cournot in the consumable market.
  2. The two firms engage in sequential-move Cournot with the incumbent firm acting as a leader in output choice.
  3. They engage in Bertrand.

4.1 Accommodating entry: Cournot

- Linear demand: $P_2 = a - (Q_{2I} + Q_{2E})$.
- Incumbent (I) & Entrant (E)
- Incumbent charge the entrant a license fee of $f \geq 0$ per unit.
- Profits: $\Pi_{2I} = P_2 Q_{2I} + f Q_{2E}$, $\Pi_{2E} = (P_2 - f) Q_{2E}$.
- Equilibrium:

$$Q_{2I}^C(f) = \frac{a+f}{3},\ Q_{2E}^C(f) = \frac{a-2f}{3},\ P_2^C(f) = \frac{a+f}{3},$$
$$CS^C(f) = \frac{(2a-f)^2}{18},\ \Pi_{2I}^C(f) = \frac{a^2+5af-5f^2}{9},\ \Pi_{2E}^C(f) = \frac{(a-2f)^2}{9}.$$

- P_2^C is increasing in f and CS^C is decreasing in f.

4.1 Accommodating entry: Cournot

- Period 1: $P_1^C(f) = CS^C(f)$ and $\Pi_{1I}^C(f) = P_1^C(f) - c_1$.
- Total profits:

$$\Pi_I^C(f) = \Pi_{1I}^C(f) + \Pi_{2I}^C(f) = \frac{a^2 + 5af - 5f^2}{9} + \frac{(2a - f)^2}{18} - c_1$$

  is concave in f.
  - $\Pi_I^C(0) = \frac{a^2}{3} - c_1 < \frac{3a^2}{8} - c_1 = \Pi^M$.
  - Accommodating entry without license fee is not beneficial for the incumbent.
- Optimal license fee: $d\Pi_I^C(f)/df = 0 \rightarrow f^C = a/3$.

$$P_2^C(f^C) = 4a/9 < P_2^M, \quad P_1^C(f^C) = 25a^2/162 > P_1^M,$$
$$\Pi_I^C(f^C) = 7a^2/18 - c_1 > \Pi^M, \quad \Pi_{2E}^C(f^C) = a^2/81 > 0.$$

4.1 Accommodating entry: Cournot

Proposition 3

A seller with a monopoly over a durable good and who has a potential monopoly over the consumables can profit by accommodating entry into the consumable market, charging a unit license fee and competing with the entrant in a Cournot fashion.

- Accommodation reduces P_2 and Π_{2I}, but increases P_1 and Π_{1I}, and also generates revenue from the licensing.

4.2 Accommodating entry: Stackelberg

- Consider an incumbent competes with the entrant in quantity as a Stackelberg leader.

$$Q_{2I}^S(f) = \frac{a}{2},\ Q_{2E}^S(f) = \frac{a-2f}{4},\ P_2^S(f) = \frac{a+2f}{4},$$
$$CS^S(f) = \frac{(3a-2f)^2}{32},\ \Pi_{2I}^S(f) = \frac{a^2+4af-4f^2}{8},\ \Pi_{2E}^S(f) = \frac{(a-2f)^2}{16}.$$

- Period 1, the incumbent sets $P_1^S(f) = CS^S(f)$, so total profits are

$$\Pi_I^S(f) = \frac{(3a-2f)^2}{32} + \frac{a^2+4af-4f^2}{8} - c_1$$

- $\Pi_I^S(0) = 13a^2/32 - c_1 > \Pi_I^C(f^C) > \Pi^M$.
- Profit-maximizing licensing fee: $f^S = a/6 < f^C$.

$$P_2^S(f^S) = a/3 < P_2^C(f), \quad P_1^S(f^S) = 2a^2/9 > P_1^C(f^C),$$
$$\Pi_I^S(f^S) = 5a^2/12 - c_1 > \Pi_I^C(f^C), \quad \Pi_{2E}^S(f^S) = a^2/36 > \Pi_{2E}^C(f^C).$$

4.2 Accommodating entry: Stackelberg

Proposition 4

A monopolist which sells a durable good and consumables can profit by allowing entry into the market for consumables and competing with the entrant as a leader in quantity choice. This holds even without licensing fee.

- Interesting results:
  - $\Pi_I^S(0) > \Pi_I^C(f^C)$
  - $\Pi_I^S(f^S) > \Pi_I^C(f^C)$
  - $\Pi_{2E}^S(f^S) > \Pi_{2E}^C(f^C)$

4.3 Accommodating entry: Bertrand

Proposition 5

A firm with a monopoly over a durable good and a potential monopoly over consumables profits from allowing entry into the market for consumables and competing with the entrant in a Bertrand fashion.

- Because the incumbent's profit-maximizing price for the consumables is zero, the incumbent firm cannot increase its profits by charging a per-unit license fee.
- Props 3-5 imply that the incumbent firm should not create entry barriers which raise entry costs. Rather, the incumbent may want to subsidize entry. Such subsidy payments are its costs for the commitment.

4.3 Accommodating entry: Figure

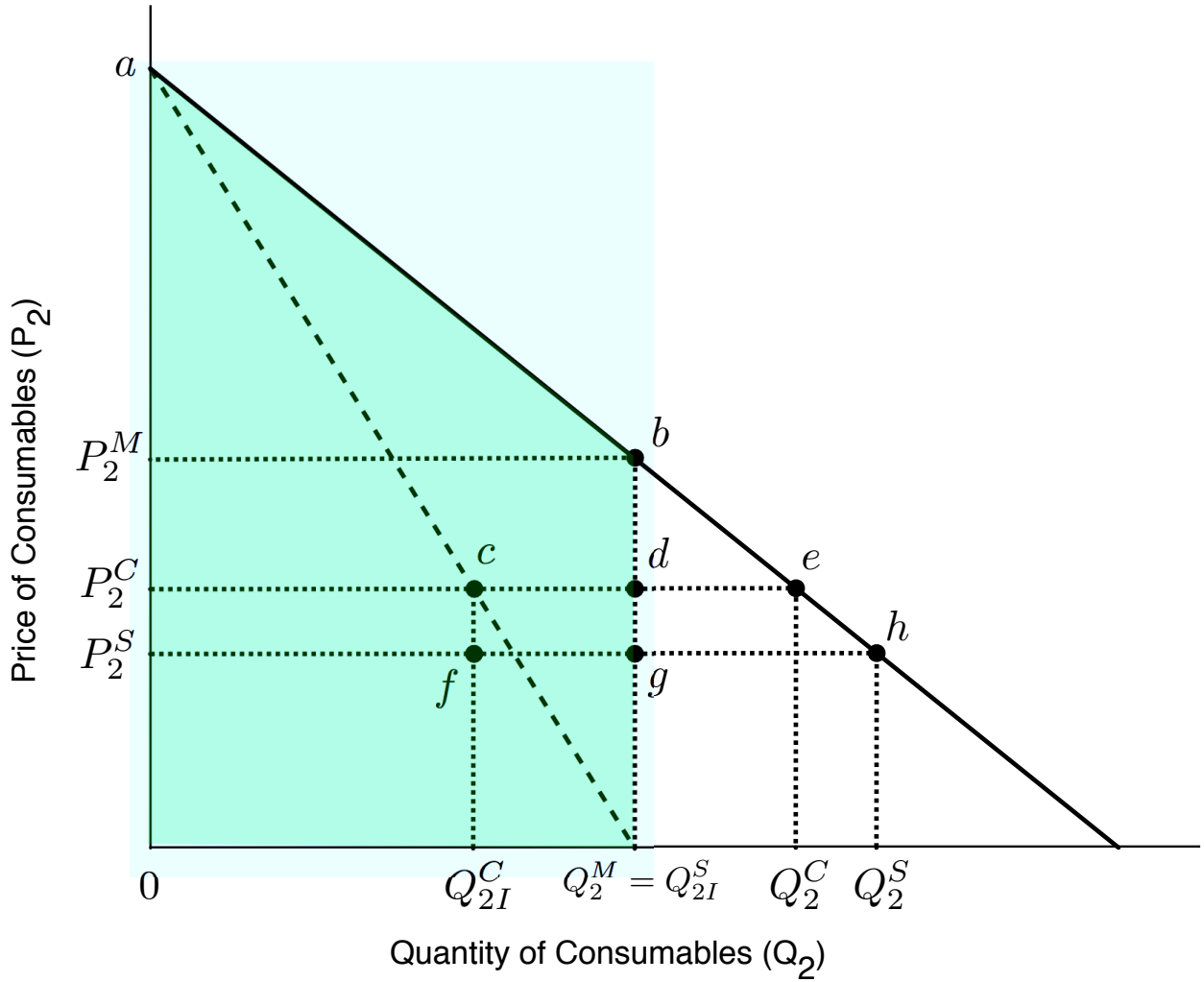


Figure: Not Allowing Entry

4.3 Accommodating entry: Figure

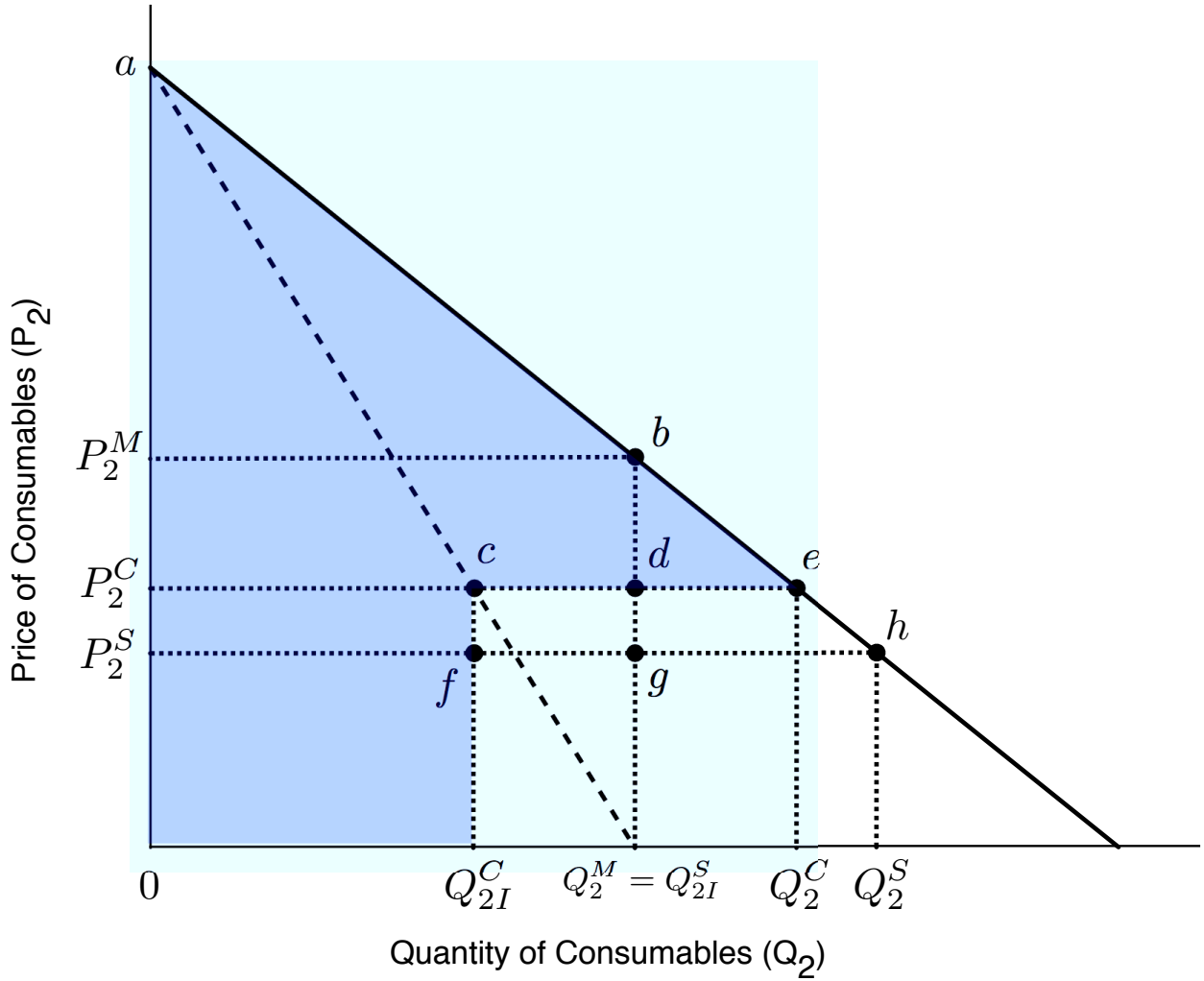


Figure: Allowing Entry with Cournot ($f = 0$)

4.3 Accommodating entry: Figure

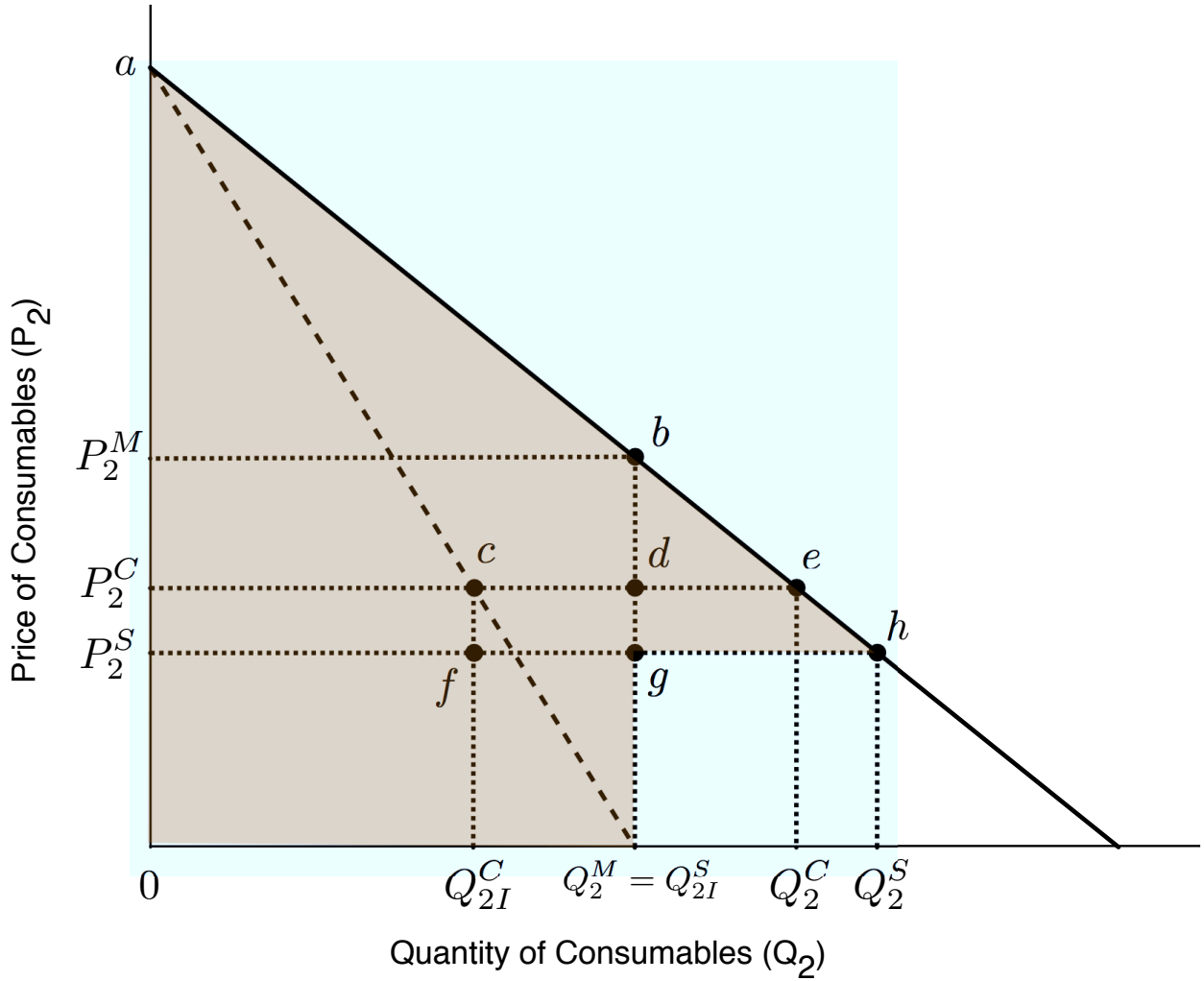


Figure: Allowing Entry with Stackelberg ($f = 0$)

5. Selling to Low Valuers

- To alleviate the commitment problem, a monopolist sells durables to consumers who have a low WTP.
- The strategy increases the price elasticity of demand for the consumable good, which can serve as a commitment to a future low price for the consumables.
  - If the monopolist sells the durable only to high valuers, buyers may fear that they will be charged a high price for consumables, and so be unwilling to buy the durable.
  - But a monopolist who also sold to low valuers will want to set a lower price for the consumables in later periods, and so a high valuer would be willing to pay more for the durable.

5. Selling to Low Valuers

Model

- Two types of consumers: N_H number of High WTP consumer (Type H) & N_L number of Low WTP consumer (Type L)
- Assume $N_H = N_L = 1$ here.
- Individual demand function for consumables:

$$Q_{2H} = a_H - P_2, \quad Q_{2L} = a_L - P_2.$$

  - $Q_2 \equiv Q_{2H} + Q_{2L}$ and $a_H > a_L$.

- Assume here that the monopolist cannot price discriminate for the consumable good.
- Profits from selling consumables: $\Pi_2 = P_2 Q_2$.

5. Selling to Low Valuers

When monopolist does not sell a durable to consumer L

- Demand: $Q_2 = Q_{2H} = a_H - P_2$.
- Equilibrium: $P_2^N = a_H/2$, $Q_2^N = a_H/2$, $\Pi_2^N = a_H^2/4$,
  $CS_H^N = P_{1H}^N = a_H^2/8$, $\Pi_1^N = P_{1H}^N - c_1$, $\Pi^N = 3a_H^2/8 - c_1$.

When monopolist sells a durable to consumer L

- Demand: $Q_2 = \begin{cases} a_H - P_2 & \text{for } P_2 > a_L, \\ (a_H + a_L) - 2P_2 & \text{for } P_2 \leq a_L. \end{cases}$
- Assume $\sqrt{2} - 1 < a_L/a_H \leq 1$.

  $\rightarrow$ The demand for consumables by a low valuer is sufficiently high so that the monopolist wants to sell to them.

- Equilibrium in period 2:
  $P_2^Y = (a_H + a_L)/4$, $Q_{2H}^Y = (3a_H - a_L)/4$, $Q_{2L}^Y = (3a_L - a_H)/4$,
  $Q_2^Y = (a_H + a_L)/2$, $\Pi_2^Y = (a_H + a_L)^2/8$,
  $CS_L^Y = (3a_L - a_H)^2/32$, $CS_H^Y = (3a_H - a_L)^2/32$.

5. Selling to Low Valuers

When monopolist sells a durable to consumer L (cont'd)

- In period 1, the monopolist *can perfectly price discriminate* between high and low valuers.
  - $P_{1H}^Y = CS_H^Y$ and $P_{1L}^Y = CS_L^Y$.
- Profits from selling durables: $\Pi_1^Y = CS_H^Y + CS_L^Y - 2c_1$.
- Total profits: $\Pi^Y = \Pi_1^Y + \Pi_2^Y$.
- We have: $\Pi^Y > \Pi^N$ when $0 \leq c_1 < \bar{c}_1 \equiv \frac{(a_H - a_L)^2 + 6a_L^2}{16}$
- $P_{1L}^Y - \bar{c}_1 < 0$: monopolist profits from selling the durable good to low valuers **even at a price below the marginal production cost**.
- Define $\Pi_L^Y \equiv P_{1L}^Y - c_1 + P_2^Y Q_{2L}^Y$. Then,

$$\Pi_L^Y \big|_{c_1 = \bar{c}_1} = -(a_H - a_L)(3a_H + a_L)/32 < 0.$$

The monopolist profits from selling a durable and consumables to low-valuers even when the total profits from doing so are negative.

5. Selling to Low Valuers

Proposition 6

A monopolist selling durables and consumables can profit from selling durables to low valuers even at a price less than marginal cost. The strategy increases the price elasticity of demand for consumables, which can serve as a commitment to a future low price of consumables.

- The firm profits from selling to low valuers not because it profits from selling them consumables, but because the firm thereby assures high valuers that it will set a low price for consumables, and so increases demand for the durable good by high valuers.

5. Selling to Low Valuers

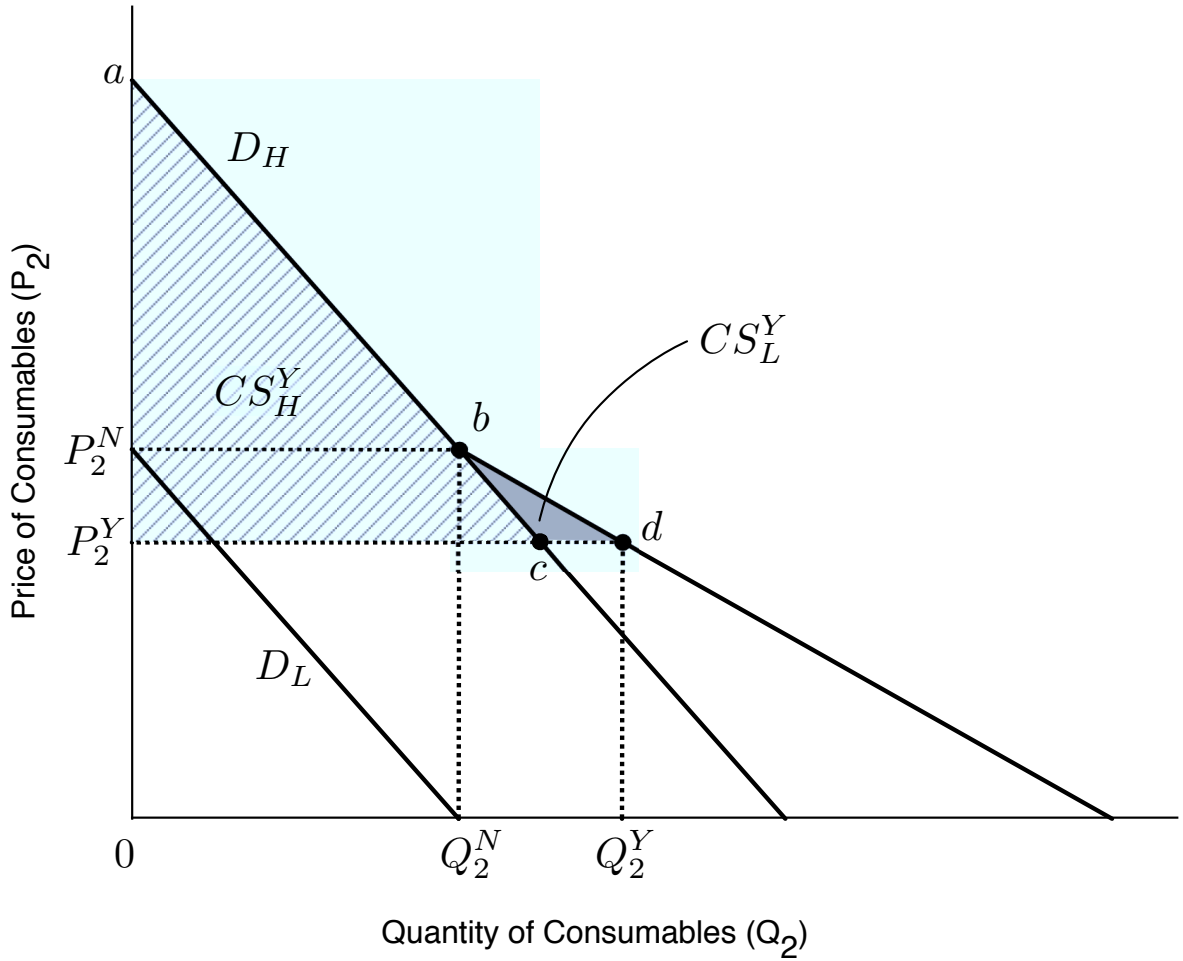


Figure: Selling to Low Valuers

5. Selling to Low Valuers

- How to price discriminate between high and low valuers:
  - Offering high-end and low-end models, using common consumables (e.g., printer, copier, and iPod).
  - Selling the durable at a low price only at locations frequented by low valuers, say Walmart.
- Our mechanism is the opposite of *status goods* or *snob goods*.
  - Status: valuation of the good by high valuers (rich) declines with the number of low valuers (poor) who buy the good.
  - Our mechanism: Increased purchases of the durable by low valuers reduces P_2, so the demand by high valuers increases with purchases by low valuers.
- Our approach offers a different view of advertising.
  - Firm can profit by making it known that the durables are sold to low valuers.
  - Signaling (Nelson 1974): signaling the quality of the good.
  - Ours: signaling who the buyers are.

5.1 Imperfect price discrimination

- Consider imperfect price discrimination for durables and consumables.
- $|P_{iH} - P_{iL}| \leq K$ for $i = \{1, 2\}$.
  - The price difference is constrained to be at most K_1 for durables and at most K_2 for consumables.
  - K_i reflects arbitrage costs or search costs to find a low price.
  - $K_i = 0$: the monopolist cannot price discriminate.
  - $K_i = \infty$: the monopolist can perfectly price discriminate.

  (So far, we assumed $K_1 = \infty$ and $K_2 = 0$.)
- Question: How does the ability to price discriminate affect the monopolist?

5.1 Imperfect price discrimination

Proposition 7

Monopolist's profits increase with its ability to price discrm for the durable goods. If it can perfectly price discrm on durables, then profits decline with its ability to price discrm on consumables. In contrast, if it cannot perfectly price discrm on durable, profits increase with its ability to price discrm on consumables.

- When $K_1 = \infty$, the greater the ability to price discrm. for durables, the higher Π_2, but the lower its total profits. Price discrm. for consumables leads to a higher P_{2H}, which leads to lower P_{1H}.
  - The monopolist wants to commit to no future price discrm on consumables, but such a commitment is also time-inconsistent.
- When K_1 is small, the greater the ability to price discrm on consumables, the higher its profits. Price discrm on consumables leads to higher P_{2H} and lower P_{2L}, which leads to higher P_{1L}.

6. Conclusion

Our solutions

1. **Entering a financial contract with a third financial firm:**
   - Contract: a seller obtains a subsidy for each unit of consumable it sells, in exchange for a lump-sum payment to the fin. firm.
   - It increases the seller's MR from selling consumables and so induces the seller to lower the price of consumables.
2. **Allowing entry into the market for consumables:**
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