

Part V. Product quality and information

Chapter 12. Asymmetric information, price and advertising signals



Slides

Industrial Organization: Markets and Strategies

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- Products and services with characteristics that can only be ascertained upon consumption
= **experience goods**
- **Asymmetric information** as consumers have less information than the producers about product quality
 - Firms operate in an environment in which consumers wonder whether products turned out to be of high quality (hidden information) or were chosen to be of high quality (hidden action)

Chapter 12 Learning objectives

- Become familiar with asymmetric information problems in the product market.
- How do firms choose quality in the presence of asymmetric information?
- How are pricing and advertising strategies affected by the presence of asymmetric information?
- Application of signalling games to the study of firm strategy in experience goods markets

Hidden information problem

- Single seller
- Product of two potential levels of quality
 - Quality s can take the value L or H
 - Seller's opportunity cost c_s , $c_H > c_L$
- Buyers of unit mass
 - Valuation of each buyer r_s
 - all consumers prefer high quality, $r_H > r_L$
 - Suppose that $r_s > c_s$
- If there is full information about products quality
 - Seller can profitably sell the product to buyers whatever the actual quality of the product

Hidden information problem (cont'd)

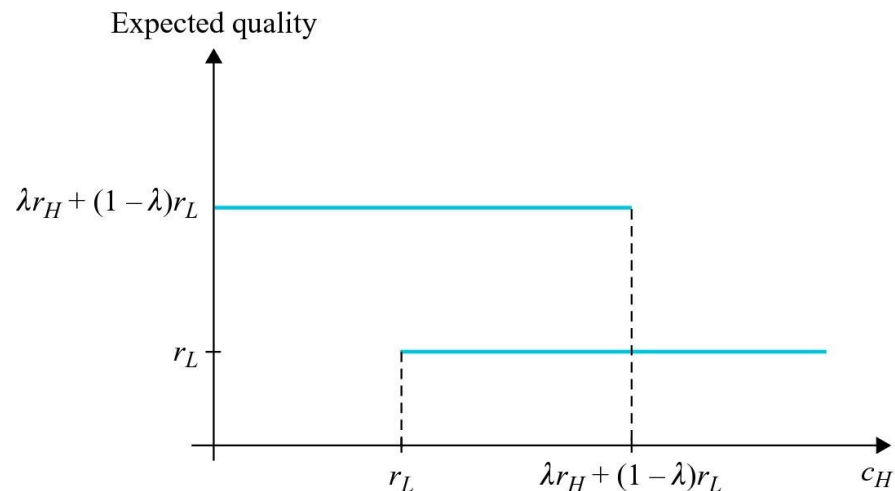
- Only seller observes its product quality
 - Buyers know that with probability λ the product is of high quality
 - Expected utility for buyers is $\lambda r_H + (1 - \lambda)r_L$ provided that both seller types are active
- Three-stage game
 - First stage: nature draws the seller's product quality from some known distribution
 - Its realization is observed by the seller but not by buyers
 - Second stage: seller decides whether and which price to post
 - Third stage: consumers form beliefs about the firm's product quality and make their purchasing decisions

Adverse selection

- Since buyers are homogeneous, seller can extract the full expected surplus from buyers
- If both firm types are active
 - $p = \lambda r_H + (1 - \lambda)r_L$
 - All consumers buy
 - Uncertainty is not resolved: **pooling equilibrium**
 - All potential gains from trade are realized
- $p < c_H$
 - High-quality firm cannot recover its opportunity cost and therefore does not participate
 - Consumers realize that a high-quality seller does not have an incentive to participate
- In equilibrium
 - low-quality seller sets price $p = r_L$
 - The high-quality seller does not post a price
- Only low quality survives: situation of **adverse selection**

Adverse selection (cont'd)

- Expected quality under asymmetric information



- **Lesson:** In markets in which product quality is exogenous but unobservable, high-quality products may not be offered for sale.
- If there is a continuum of quality levels
 - Complete unravelling of the market, so that only the lowest quality survives in the market

Information revelation

- Suppose firms can publicly reveal their quality.
- If it is not costly to release information, all firms will do so in equilibrium.
- Unravelling result: asymmetric information problem is solved.

Hidden action problem

- Moral hazard
 - Setup as slides before except first stage
 - Firm itself that chooses its quality
 - Firm sets its price at stage 2
 - Buyers form beliefs about product quality and make their purchasing decisions at stage 3
- Benchmark of full information
 - Firm chooses high quality if $r_H - c_H > r_L - c_L$
 - Implements the first-best allocation
- If the quality choice is a hidden action, firm has no means to convince consumers that its product is of high quality
- Hidden action creates a **moral hazard problem**

• **Lesson:** In markets in which firms choose quality, firms tend to provide too low quality from a social point of view.

Risky investments in quality

- Risky investment in quality (where the investment is observable to consumers)
- Allows consumers to obtain information about the expected quality in the market since
 - consumers observe the investment level
 - have a clear understanding of the relationship between investment spending and expected quality
- Probability that the product is of high quality λ
- Investment $I(\lambda)$ as a commitment to meet on average a certain reliability of the product
 - Suppose that $I' > 0$ and $I'' > 0$
 - in particular $I(\lambda) \equiv (k/2) \lambda^2$
 - Assume $r_L > c_L$ and $r_H > c_H$
 - under full information, low and high quality are put on the market
 - Under full information: firm's maximization problem

$$\max_{\lambda} \lambda(r_H - c_H) + (1 - \lambda)(r_L - c_L) - \frac{k}{2} \lambda^2$$

Risky investments in quality (cont'd)

- Probability for high quality

$$\lambda^f \equiv [(r_H - c_H) - (r_L - c_L)]/k$$

- Situation in which consumers observe the firm's investment I but not the realization of quality
 - Expect both qualities to be put on the market
 - Probability that the product is of high quality λ
 - Expected utility $\lambda r_H + (1 - \lambda)r_L$
 - Expected profits

$$\begin{aligned} & \lambda[\lambda r_H + (1 - \lambda)r_L - c_H] + (1 - \lambda)[\lambda r_H + (1 - \lambda)r_L - c_L] - (k/2)\lambda^2 \\ &= \lambda(r_H - c_H) + (1 - \lambda)(r_L - c_L) - (k/2)\lambda^2 \end{aligned}$$

- Objective function of the firm is the same as under full information
 - solution to this problem λ^a is equal to λ^f

Risky investments in quality (cont'd)

- However at stage 2, firm has incentive to exit if $\lambda^a r_H + (1 - \lambda^a)r_L - c_H < 0$
- Then $I(\lambda^a)$ cannot be the profit-maximizing investment decision (if exit is possible)
 - Invest at least $I(\bar{\lambda})$, where $\bar{\lambda} = (c_H - r_L) / (r_H - r_L)$
- Adverse selection effect that makes the full-information investment level unsustainable may lead to *overinvestment* compared to full information

Risky investments in quality (cont'd)

- **Lesson:** If consumers observe investments in the reliability of products but not reliability itself, a firm may actually invest more in reliability (or quality) under asymmetric information than under full information.
- To make the participation of the high-quality firm worthwhile, the firm has to distort its investment upward to convince consumers that a high-quality outcome is more likely

Advertising signals

- Firms spend large amount of resources on advertising and other marketing activities which lack an apparent message or news
 - Big money to convince consumers that quality is high
- Basic intuition
 - Firm can use advertising or distorted prices to signal the quality of its product
 - Signal to consumers that such a firm is of high quality
- 3 channels by which a signalling device can work
 - Repeat purchases
 - Information differences among consumers
 - Cost differences depending on qualities

Repeat purchases

- If the firm can also sell to consumers who have become informed about product quality
 - May have an incentive to spend resources as a signal of product quality
 - Low-quality firm would be discovered at some point and thus loses sales
 - Expected change in profits from cheating for a low-quality firm is possibly less pronounced than the expected change in profits from telling the truth for a high-quality firm
- The model
 - High quality gives a utility of r_H , low quality of r_L
 - Costs of low and high quality are the same, $c_H = c_L = c$
 - All consumers face the same asymmetric information problem
 - Assume that $r_H > c$

Repeat purchases (cont'd)

- A firm sells a product of given quality for two periods
- If a consumer has purchased the product in period 1 she learns the product quality after period 1
- No discounting
- Under **full information**
 - High-quality firm:
 - its product gives utility r_H
 - does not advertise
 - sells its product at $p^1 = p^2 = r_H$
 - Low-quality firm:
 - its product gives utility r_L
 - sells at $p^1 = p^2 = r_L$ if $r_L > c$
 - otherwise, it does not sell and makes zero profits

Repeat purchases (cont'd)

- Under **asymmetric information**

Period 1

- Firm learns its type but consumers do not
- Then, the firm sets its first-period price and it possibly takes some action that can be publicly observed
 - Spends some amount of resources on advertising A (which becomes public information)
- Consumers decide whether to buy
 - If a consumer buys, she observes the product quality

Repeat purchases (cont'd)

- Under **asymmetric information**

Period 2

- The firm sets its second-period price and afterwards consumers buy.
- Since advertising expenditures cannot be rational in the second period, only need to consider advertising in the first period

Analyse separating *perfect Bayesian Nash equilibria*

- Restrict attention to belief systems in which only the advertising level but not the price can affect beliefs
- Equilibrium actions A, p^1, p^2 depending on type and beliefs $\mu(A)$

Repeat purchases (cont'd)

- Case 1: the low quality is profitable
 - Two justifications as to why advertising can be a signal of product quality
 - Consumers may boycott a firm that they trusted in period 1 and that has failed them (not formalized here)
 - Repeat purchase effect
- Case 2: the low quality is not profitable
 - Low quality will not be active in separating equilibrium
 - Equilibrium profits $\pi_H = 2r_H - 2c - A$ and $\pi_L = 0$
 - For $A \geq r_H - c$, the low-quality firm's incentive constraint is satisfied
 - Second-period profits of the *high-quality firm* depend on its first-period action

Repeat purchases (cont'd)

- **Lesson:** Advertising and other strategies in which a firm publicly 'burns money' can be a credible means for a firm to communicate to consumers that it is of high quality. In particular, such a strategy can be successful if a repeat purchase effect is present.
- Consumers may base their beliefs on price
- Case that firms cannot advertise but in which the price may contain information about product quality
 - Any price below c would lead to losses for a low-quality firm
 - Beliefs that any price below c must come from a high-quality firm
 - Price (weakly) below marginal costs: signal of high quality

Repeat purchases (cont'd)

- **Lesson:** A price below marginal costs can be a credible strategy for a firm to communicate to consumers that it is of high quality because it allows the firm to benefit from repeat purchases.

Price signals – differential information

- Single period, $r_L > c$
- Positive share of fully informed consumers
- Sufficiently large share:
 - Firm can separate with full information prices
- Smaller share:
 - Firm has to lower its price below the full information level
 - Informed consumers generate an information spillover
 - Uninformed consumers obtain information through the firm's price because they know that some other consumers have better information and act according to this information

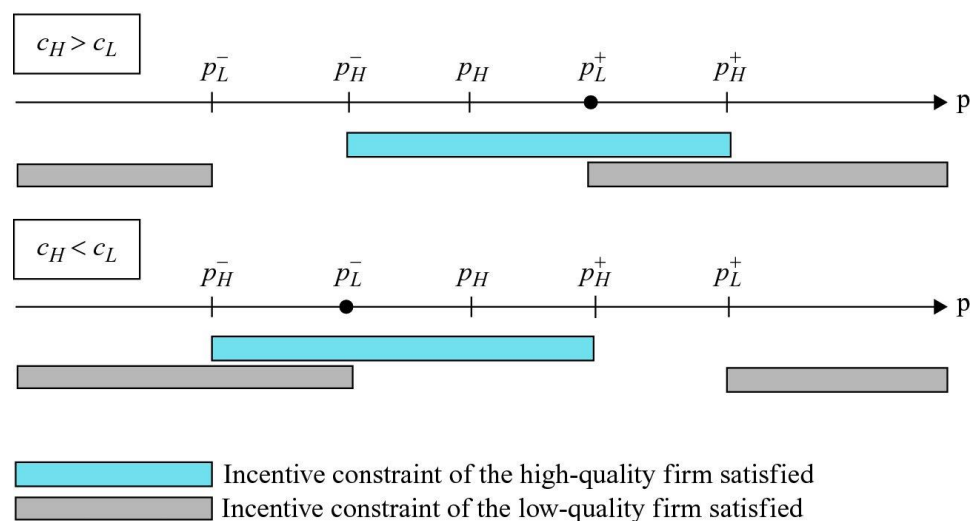
Price signals – differential information (cont'd)

- **Lesson:** If some consumers know the product quality, the high-quality firm can use its price to signal quality to the remaining share of uninformed consumers. As the share of informed consumers increases, the price of the high-quality firm reaches the corresponding full-information price. Above a critical size of informed consumers, signalling is feasible with full-information prices.

Price signals – cost differences

- Single period
- Cost differences between high and low quality
- Consumers have variable demand
- Produce low quality at marginal cost c_L and high quality at c_H
- Demand is independent of true quality since consumers purchase only once and no consumer has any private information on the product's quality
- Result: Price can be used as signal of product quality

Price signals (cont'd)



- $c_H > c_L$: Firm can signal its type by setting a sufficiently *high* price
- $c_H < c_L$: Firm can signal its type by setting a sufficiently *low* price

- **Lesson:** In an environment with asymmetric information about a firm's product quality, if marginal production costs depend on quality, a firm can signal its product quality with price. Signalling is possibly costly, i.e., the firm sets a price that is different from its full-information price.

Joint price and advertising signals

- Two-period model
 - Investigate whether a monopolist wants to use a two-dimensional signal in the form of price and advertising as a signal of product quality
 - First period: firm sets its price p^1 and an advertising expenditure A
 - Second period: price p^2
 - Demand is now sensitive to price changes
 - Destroys the equivalence of price and advertising signals
 - Repeated purchases are more likely in the case of positive former experience (stemming from high quality)
 - Stimulating initial purchase is valuable especially for products with high quality
 - *Repeat-business effect*: for any given beliefs fewer consumers buy in the second period if the first-period price rises
 - Lost consumers are more painful for producers of high quality

Joint price and advertising signals (cont'd)

- $c_H > c_L$
 - Monopolist able to signal high quality through $A > 0$ and upward distorted price
- $c_H \leq c_L$
 - Advertising not part of the signalling strategy, signal with low price

• **Lesson:** With repeat purchases and variable demand, the monopolist may use advertising as part of his signalling strategy only if $c_H > c_L$.

- An upward distortion of the first-period price above $p^m(s_H)$ reduces quantity sold and revenues
- If $c_H > c_L$
 - distortion is less painful for a producer of high quality than for a producer of low quality
- A price increase also decreases second-period revenue since there is a smaller number of consumers who were served in period 1
 - More painful for a producer of high quality

Price signalling under imperfect competition

- Two firms compete in prices
 - want to use price as a signal of product quality
- Firms have private information about their quality
- Consumers can update their beliefs about quality because they observe prices
- Competitor does not have this option available
- Symmetric separating perfect Bayesian equilibria

$$p_L^* \equiv p_{1L}^* = p_{2L}^* \neq p_{1H}^* = p_{2H}^* \equiv p_H^*$$

Price signalling under imperfect competition (cont'd)

- Low-quality firm chooses its full-information best response
- In monopoly model
 - Presence of asymmetric information does not change the outside option for consumers
 - Low-quality firm sets the same price under asymmetric information as under full information
- Not the case under competition
 - Firm best responds to the competitor's expected equilibrium price
 - Different from the full-information equilibrium price

Price signalling under imperfect competition (cont'd)

- If high quality is more costly than low quality
 - A high price can signal high quality also under imperfect competition
 - Separating prices are above full-information prices
 - Both for low-quality and high-quality firms
- Suppose at an earlier stage (however, after they know their type), firms can decide whether to reveal information about product quality
 - There are parameter values for which both types of firm prefer not to reveal this information

Price signalling under imperfect competition (cont'd)

- **Lesson:** A high price can signal product quality also under competition. If high quality is costly, a high-quality firm distorts its price upward. Equilibrium prices are greater than prices under full information. Equilibrium profits may be greater than in the same market under full information for low-quality and high-quality firms. The asymmetric information problem may therefore persist even if firms can reveal their private information to consumers without costs.

Review questions

- If a firm faces asymmetric information and it has to invest in R&D to increase the probability of high quality, does this information lead to more or less investment? Discuss the effects that play a role.
- What is the role of advertising spending in experience good markets? Are spending caps welfare increasing?
- If a firm can choose price and advertising to convince consumers of high quality, do there exist circumstances under which the firm prefers not to use one of those two instruments? Discuss.
- Consider a market in which product quality does not affect marginal costs. Do repeat purchases facilitate or hinder advertising signals?