Chapter 4 Quality

- Income ad Quality Purchase
- Quality as Vertical Differentiation
- Market Structure and Quality
- The Market for Lemons
- Quality –Signal Games
- Warrant

Personal Income and Quality Purchase

- Gabszewicz and Thisse (1979,1980), Shaked and Sutton (1982)
- Consider an industry with two firms producing brands with different qualities level k=H and quality level k=L
- There are two consumers, denoted by i, i=1,2. The income of consumer 1 is given by I_1 and the income of consumer 2 by I_2 ($I_1 > I_2 > 0$)
- The utility level of consumer i is given by

$$U_i = \begin{cases} H(I_i - p_H) & \text{if he buys the high-qiality brand} \\ L(I_i - p_L) & \text{if he buys th elow-quality brand} \end{cases}$$

Personal Income and Quality Purchase (cont')

- Proposition
  - (1) If the low-income consumer buys the high-quality brand, then the high-income consumer definitely buys the high-quality brand
  - (2) If the high-income consumer buys the lows brand, then the low-income consumer definitely buys the low-quality brand

Personal Income and Quality Purchase (cont')

- Denote $U_i(k)$ as the utility level of consumers i when he buys the brand with quality k

low-income consumer buys the high-quality brand

$$U_2(H)=H(I_2-p_H)>L(I_2-p_L)=U_2(L)$$

$$\Rightarrow \quad (H-L)I_2>Hp_H-Lp_L$$

$$\Rightarrow \quad (H-L)I_1 > (H-L)I_2>Hp_H-Lp$$

$$\Rightarrow \quad U_1(H)=H(I_1-p_H)>L(I_1-p_L)=U_1(L)$$

High-income consumer buys the high-quality brand

Quality as Vertical Differentiation

- Phips and Tisse (1982)
  - (1) Differentiation is said to be horizontal, if, when the level of the product's characteristic is augmented in the product's space, there exists a consumer whose utility rises and there exists another consumer whose utility falls
  - (2)Differentiation is said to be vertical if all consumers benefit when the level of the product's characteristic is augmented in the product space

Quality as Vertical Differentiation (cont')

- There is continuum of consumers uniformly distributed on the interval [0,1].
- There are two firms, denoted by A and B and located at points a and b from the origin respectively
- The utility of a consumer located at point x, and buying brand i, i=A,B is defined by

$$U_x(i) = \begin{cases} ax - p_A & i = A \\ bx - p_B & i = B \end{cases}$$

Quality as Vertical Differentiation (cont')

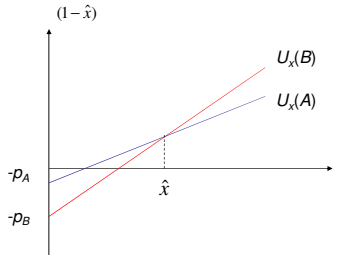
- Let $\hat{x}$ denotes a consumer who is indifferent to whether hw or she buys from firm *A* or from firm *B*. The location of the indifferent consumer is determined by

$$U_{\hat{x}}(A) = a\hat{x} - p_A = b\hat{x} - p_B = U_{\hat{x}}(B)$$

- The number of consumers from *A* is $\hat{x}$, whereas the number of consumers buying from *B* is $(1-\hat{x})$

$$\hat{x} = \frac{p_B - p_A}{b-a} \text{ and } 1\text{-}\hat{x} = 1 - \frac{p_B - p_A}{b-a}$$

Quality as Vertical Differentiation (cont')



Quality as Vertical Differentiation (cont')

- Firm *A* and *B* solve

$$\max_{p_A} \pi_A(a,b,p_A,p_B) = p_A\hat{x} = p_A\left[\frac{p_B - p_A}{b-a}\right]$$

$$\max_{p_B} \pi_B(a,b,p_A,p_B) = p_B(1-\hat{x}) = p_B\left[1 - \frac{p_B - p_A}{b-a}\right]$$

$$\frac{\partial \pi_A}{\partial p_A} = \frac{p_B - 2p_A}{b-a} = 0 \qquad \frac{\partial \pi_B}{\partial p_B} = 1 - \frac{2p_B - p_A}{b-a} = 0$$

$$\Rightarrow \quad p_A(a,b) = \frac{b-a}{3} \text{ and } p_B(a,b) = \frac{2(b-a)}{3}$$

Quality as Vertical Differentiation (cont')

- Firm *A* and *B* solve

$$\pi_A(a,b) = \frac{1}{b-a}\left[\frac{2(b-a)^2}{9} - \frac{(b-a)^2}{9}\right] = \frac{b-a}{9}$$

$$\pi_B(a,b) = \frac{1}{b-a}\left[\frac{4(b-a)^2}{9} - \frac{2(b-a)^2}{9}\right] = \frac{4(b-a)}{9}$$

$$\Rightarrow \quad a^* = 0 \text{ and } b^* = 1$$

Principle of maximum differentiation: In an vertically differentiated quality model each firm chooses maximum differentiation from its rival firm

Market Structure and Quality

- Consider a consumer who lives for two periods who desires light services for two periods
- Assume the consumer is willing to play an amount of *V* per each period of light service
- The unit cost of producing a short-durability light bulb is denoted by c^S, and the unit cost of producing a long-durability is denoted by c^L, where $0<c^S<v$, $0<c^L<2v$ and $c^S<c^L$

Market Structure and Quality (cont')

- Monopoly firm producing light bulbs
  - The profit of a monopoly selling short-durability light bulbs is given by
    $\pi^S = 2(V - c^S)$
  - The profit of a monopoly selling long-durability light bulbs is given by
    $\pi^L = 2V - c^L$

⇨ The monopoly would produce short-durability light bulb is $2c^S < c^L$, and would produce long-durability bulbs if $2c^S > c^L$

Market Structure and Quality (cont')

- Competitive light bulb industry
  - Under perfect competition, the price of each type of light bulb drops to its unit cost

    $p^S=c^S$, $p^L=c^L$
  - The consumer will purchase a short-duration light bulb if

    $2(V-p^S) > 2V-p^L$ or $2c^S<c^L$

Implication

1. The durability of light bulbs is independent of the market structure.
2. The firms would choose the level of durability that minimizes the production cost per unit of time of the product's service

The Innovation-Durability Tradeoff

- We often say to ourselves some variation:
  - My old computer does not want to break down, so I don't know what to do with it once I replace it with a newer model
- Research question
  - Whether and under what conditions firms may produce products with excess durability, from a social point of view
  - Under what conditions do firms find it profitable to produce goods that will last for a very long time so that firms entering with new technologies will not be able to introduce and sell new products owing to the large existing supply of durable old technology

The Innovation-Durability Tradeoff

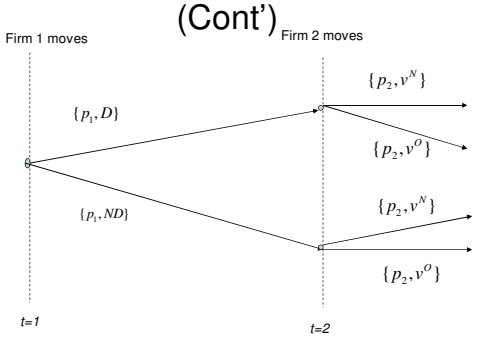
- Firms
  - There are two firms. Firm 1 in endowed with an old technology providing a quality level of v^O to consumers. Firm2 can produce the old-technology product (v^O) ; however, in addition, firm 2 is endowed with the capability of upgrading the technology to a level v^N, $v^N>v^O$ for an innovation cost of $I>0$
  - The product is durable if it lasts for two periods. The unit production cost of a nondurable is denpted by c^{ND}, whereas the unit production cost of a durable is denoted by c^D, where we assume that $c^D > c^{ND}$
  - Assume c^{ND}

The Innovation-Durability Tradeoff (Cont')

- Following Fishman, Gandal, and Shy (1993) – infinite period
- We merely illustrate their argument in two-period model, with a simplifying assumption that in each period there is only one firm
- Consumer
  - In period t=1, there is only one consumer who seeks to purchase computer service for two periods of his or her life, i=1,2
  - In period t=2, one additional consumer enters the markets and seeks to purchase one period of the product's services
  - Let V_t denote the per period gain from the quality of the technology imbedded into the product a consumers purchases in period. Let p_t be the corresponding price

$$U_t \equiv \begin{cases} V_t - p_t & \text{if purchasing the period t technology product} \\ 0 & \text{if not purchasing} \end{cases}$$

The Innovation-Durability Tradeoff (Cont')



The Innovation-Durability Tradeoff (Cont')

Second-period pricing. Given that first-period production is nondurable

$$p_2 = \begin{cases} v^N & \text{if } 2(v^N - v^O) \geq I \\ v^O & \text{if } 2(v^N - v^O) < I \end{cases} \qquad \pi_2 = \begin{cases} 2v^N - I & \text{if } 2(v^N - v^O) \geq I \\ 2v^O & \text{if } 2(v^N - v^O) < I \end{cases}$$

Second-period pricing. Given that first-period production is durable

$$\begin{cases} \pi_2^L = 2\left(v^N - v^O\right) - I & \text{if } p_2^L = v^N - v^O \\ \pi_2^H = v^N - I & \text{if } p_2^H = v^N \end{cases}$$

⇨ Firm 2 sells its new-technology product if $I \leq \max\left\{2\left(v^N - v^O\right); v^N\right\}$

The Innovation-Durability Tradeoff (Cont')

First -period durability choice

$$\begin{cases} \pi_1^{ND} = v^O - c^{ND} = v^O & \text{if } p_1^{ND} = v^O \text{ (produce nondurable)} \\ \pi_1^D = 2v^O - c^D & \text{if } p_1^D = 2v^O \text{ (produce durable)} \end{cases}$$

Firm 1 produces a durable if $v^O > c^D$. Otherwise, it produces a nondurable.

Durability, innovation, and Welfare

Assumption:

1. The first-period firm find it profitable to produce a durable product
2. The innovation cost for the new technology is at an intermediate range

$$v^O > c^D, \text{and } \max\{2(v^N - v^O); v^N\} < I < 2v^N$$

Implication: firm 1 produces a durable, innovation will not occur, and only the old –technology product will be sold

$$\pi_2^L = 2\left(v^N - v^O\right) - I < 0, \text{and } \pi_2^H = v^N - I < 0$$

Implication: from socially welfare viewpoint, firm 1 produces a non-durable is better than a durable

$$W^D = 3v^O - c^D, \text{ and } W^{ND} = 3v^O$$

The Market for Lemons

- Markets where sellers and buyers do not have the same amount of information about the product over which they transact
  - Markets with asymmetric information, where sellers who own or use the product prior to the sale have a substantial amount of information concerning the particular product they own
  - By contrary, a buyer does not possess the knowledge about the quality of the particular product he wishes to purchase

The Market for Lemons (cont')

- A model of used and new car market (Akerlof 1970)
- Consider an economy with four possible types of cars: brand-new good cars (with value N^G), brand-new lemon (bad) cars (with value N^L) , used good cars (with value U^G), and used lemon cars (with value U^L)
- Half of all cars (new and lemon) are lemons, and half are good cars
- $N^L = U^L = 0$ and $N^G > U^G > 0$

The Market for Lemons (cont')

- The expected value of a new car is given by $EN = 0.5N^G + 0.5N^L = 0.5N^G$
- The expected value of a used car is given by $EU = 0.5U^G + 0.5U^L = 0.5U^G$
- All new cars are sold for the same price p^N
- All used cars are sold for the same price p^U

The Market for Lemons (cont')

The utility of a buyer

$$V^b = \begin{cases} EN - p^N & \text{if he buys a new car} \\ EU - P^U & \text{if he buys a used car} \end{cases}$$

The utility of a seller of a good used car

$$V^{s,G} = \begin{cases} EN - p^N + p^U & \text{if he buys a new car} \\ U^G & \text{if he maintains his (good) use car} \end{cases}$$

The utility of a seller of a lemon used car

$$V^{s,L} = \begin{cases} EN - p^N + p^U & \text{if he buys a new car} \\ U^L & \text{if he maintains his lemon car} \end{cases}$$

The Market for Lemons (cont')

The problem of the buyers

The buyer will buy a used car if

$$p^U \le EU - EN + p^N = \frac{U^G - N^G}{2} + p^N$$

The problem of the good used-car seller

The owner of a good used car sells his car if

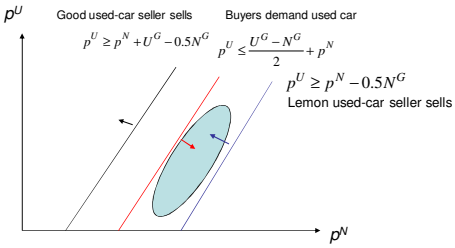
$$p^U \ge p^N + U^G - EN = p^N + U^G - 0.5N^G$$

The problem of the lemon used-car seller

The owner of a lemon used car sells his car if

$$p^U \ge p^N - EN = p^N - 0.5N^G$$

The Market for Lemons (cont')



⇨ Implication : Good used cars are never sold. That is , lemon used cars drive good used cars out the market

Quality–Signal Games

- Consumer are often unable to recognize the quality of a product, even if they are aware that both high-quality and low-quality brands are sold in the market
- A monopoly can signal the quality it sells by choosing a certain price and by quantity restriction on the brand it sells

Quality –Signal Games (cont')

- Suppose there is a continuum of identical consumers
- For a given price denoted by *p*, the utility function of each consumer is give by

$$U = \begin{cases} H - p & if \text{ the brand is of high quality} \\ L - p & if \text{ the brand is of low quality} \\ 0 & 0 \end{cases}$$

- Denote by c_H the unit production if it is a high- quality producer, and c_L If it is a low-quality producer
- The monopolist is a high-quality producer and $L > c_H$

Quality–Signal Games (cont')

- If the monopolist set $p^m = H;\ and\ q^m = \frac{L - c_L}{H - c_L}$
  - (a) consumers can infer that the brand is of high quality
  - (b) q^m consumers will purchase the product and (1-q^m) consumers will not purchase the brand due to the lack of supply

Proof

If the monopolist were a low-quality producer, then he could clearly sell to all consumers for the price $p=L$ and make a profit of $\pi^L(L,1)=L-c^L$

$$\pi^L(p^m, q^m) = (p^m - c^L)q^m = (H - c_L)\frac{L - c_L}{H - c_L} = L - c_L = \pi(L,1)$$

Quality–Signal Games (cont')

- Cost of revealing information

⇨ $[H - c_H] - [(H - c_H)\frac{L - c_L}{H - c_L}]$

Profit under perfect information — Profit under information asymmetry

- Will it be profitable to signal its quality level to the consumers ?

⇨ YES $[(H - c_H)\frac{L - c_L}{H - c_L}] > (L - c_H)\cdot 1$

The consumers believes it is high quality — The consumers believes it is low quality

Warranties

- The product can either fully operative or fully defective. A defective product has no value to buyer and cannot be resold for scrap
- At the time of purchase neither sellers nor buyers know whether the specific product is defective
- The manufacturer/seller has two options regarding the sale of the product
  - (a) He or she can sell the product without a warranty
  - (b) He or she can sell the product with full replacement warranty, which guarantees full replacement of a defective product with no loss of value to the buyer

Warranties under symmetric information

- Consider a product whose value to the consumer is V if the product is operative, and 0 if the product is defective
- Suppose there is a known probability for the products if the type to be functional, we denote this probability by ρ
- Let p denote the monopoly price and $c>0$ denote the unit production cost of the product
- The utility of the consumer

$$U=\begin{cases} V-p & \text{if he buys the product with full warranty} \\ \rho V-p & \text{if he buys the product without any warranty} \\ 0 & 0 \end{cases}$$

Warranties under symmetric information (cont')

The problem of the monopoly

- No warranty

$$p^{NW}=\rho V \quad \text{and} \quad \pi^{NW}=\rho V-c$$

- Warranty

$$p^{W}=V \text{ and } \pi^{W}=V-[c+(1-\rho)c+(1-\rho)^2c+\cdots]=V-\frac{c}{\rho}$$

⇨ If $V>\frac{c}{\rho}$ the monopoly will make profit under any warranty policy

The Role of Warranties under Asymmetric Information

- Consider an economy with two producers. A high-quality producer selling a product with probability ρ_H of being operative, and a low-quality producer producing a product with probability ρ_L of being reliable ,$0<\rho_L<\rho_H<1$
- However, the consumer does not have any way of knowing which one of the firm produces the more reliable product
- We can show that by producing a warranty with the product and choosing a certain price, the high-quality firm can signal to the consumer that it is selling the more reliable product

The Role of Warranties under Asymmetric Information (cont')

- No warranties
  - Since the consumer cannot distinguish the producers before purchase, both products are sold for the same price
  - A result of Bertrand price competition, $p^{NW}=c$ and $\pi_i^{NW}=0$

The Role of Warranties under Asymmetric Information (cont')

- Warranty as signal
  - The high-quality producer can push the low quality producer out of the market by setting $p^W=c/\rho_L$

$$p^{W}=\frac{c}{\rho_L} \text{ and } \pi^{W}=\frac{c}{\rho_L}-\frac{c}{\rho_H}>0$$

  - If the low-quality producer sells products with warrant y, then his profit equals 0 $\pi_L^W(p^W)=p^W-\frac{c}{\rho_L}=0$
  - If the low-quality producer sells product without warranty, then all the consumers will purchase the product with warranty (e.g. product from high-quality producer

$$U_H^W=V-p^W=V-\frac{c}{\rho_L}>U_L^{NW}=\rho_L V-c$$