Industrial Organisation

Lecture 7: More on product differentiation
Introduction to the economics of advertising

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Outline

- Endogenous differentiation:
  - Horizontal (different consumers prefer different products)
    - The Salop (1979) circular-city model, and product proliferation.
  - Vertical (all consumers prefer the same products if they have the same price)
    - The Shaked and Sutton (1982) quality-choice model.
- Other topics:
  - Empirical work on product differentiation.
  - Market power without product differentiation.

- Introduction to the economics of advertising.
- Why does advertising work? Three views:
  - Persuasive, Informative, Complementary
- Advertising under monopoly

- Additional reference for the advertising material: Bagwell (2005)

The Salop (1979) circular-city model (OZ 7.3.2)

- Consumers are uniformly distributed around a circle of circumference 1.
- Transport costs are linear like last week (t per unit distance).
- Three stages:
  1. Firms decide whether or not enter. Those that enter must pay a fixed cost F.
  2. The n firms that enter are placed evenly around the circle. (With quadratic transportation costs we could allow firms to choose location.)
     - This means the distance between two firms is $\frac{1}{n}$.
  3. Firms choose prices and produce (with zero MC).

Pricing in the Salop model

- Suppose firm $i \in \{1, \ldots, n\}$ sets price p, but all other firms set a price p^*.
- Firm i has two neighbours, so there is an indifferent consumer both clockwise from it and anti-clockwise from it.
  - Let x^* be the distance to these indifferent consumers (symmetry means they are both the same distance).

    Then $p + tx^* = p^* + t\left(\frac{1}{n} - x^*\right)$, so $x^* = \frac{1}{2n} + \frac{p^* - p}{2t}$.
  - Firm i's profits are then: $2x^* p = p\left(\frac{1}{n} + \frac{p^* - p}{t}\right)$.
  - FOC: $\frac{1}{n} + \frac{p^* - p}{t} - \frac{p}{t} = 0$, so since by symmetry $p = p^*$: $p^* = \frac{t}{n}$.

Entry in the Salop model

- Given $p^* = \frac{t}{n}$, each firm make profits of $p^*\left(\frac{1}{n} + \frac{p^* - p^*}{t}\right) = \frac{t}{n^2}$.
- Free entry then means that $F = \frac{t}{n^2}$, so $n = \sqrt{\frac{t}{F}}$.
  - Meaning $p^* = \sqrt{tF}$.
- Too much or too little?
  - Total surplus is $CS + PS$. Since the price is a transfer, surplus is maximised when transport costs plus entry costs are minimised.
    - Total transport cost is: $2n\int_0^{\frac{1}{2n}} tx\,dx = nt\left(\frac{1}{2n}\right)^2 = \frac{t}{4n}$.
    - So the social planner wants to minimise $\frac{t}{4n} + nF$.
    - FOC: $-\frac{t}{4n^2} + F = 0$, so $4Fn^2 = t$, i.e. $n = \frac{1}{2}\sqrt{\frac{t}{F}}$.
  - Thus there is two times too much entry under free entry.
    - Business stealing effect (like Cournot) dominates non-appropriability of social surplus effect (love of variety).

Product proliferation in the Salop model (1/2)

- Suppose that there were n (even) brands around the circle, but they were owned by only 2 firms (e.g. Kellogg's and General Mills).
  - And suppose that their products alternated around the circle.
  - Then both firms will set a price equal to $\frac{t}{n}$, since as before each product faces competition from a rival on both sides.
  - So both firms will make a profit (not including any entry or brand creation costs) of $\frac{n}{2}\frac{t}{n^2} = \frac{t}{2n}$.
  - If creating each brand costs a firm F, this means net profits are $\frac{t}{2n} - \frac{n}{2}F$. This is positive if $\sqrt{\frac{t}{F}} > n$.

Product proliferation in the Salop model (2/2)

- Suppose now that Kellogg's created its brands first.
  - If it creates more than $b^* = \frac{1}{2}\sqrt{\frac{t}{F}}$ brands, then General Mills will never be able to make a profit from creating any brands afterwards.
  - So by filling up the product space, Kellogg's can prevent entry.
    - This will be profitable for them if consumers' valuations for the product is high enough.

- See Schmalensee (1978) for an alternative analysis + an example of this happening in the cereal industry.

Vertical product differentiation (OZ 12.2.2)

- Under vertical differentiation, rather than producing different products, firms produce different *qualities* of the same product.
  - Shaked and Sutton (1982)

- Suppose there are two firms.
  - Firm 1 produces goods of quality s_1 and charges a price p_1 and firm 2 produces goods of quality s_2 and charges a price p_2. Assume $s_1 < s_2$ (so firm 1 is low quality).
  - They both have zero marginal cost.

- There is a unit mass of consumers, indexed by $\theta \in [0,1]$.
  - Consumer θ gets surplus of $v + \theta s - p$ from consuming a good of quality s and paying price p, where v (large) is their underlying valuation of the good.
  - Consumers with low θ are happy to buy "Tesco Value".
  - Consumers with high θ are prepared to pay extra to get "Sainsbury's Taste the Difference".
  - All consumers would buy from Sainsbury's if Sainsbury's was the same price as Tesco however. (This is what makes it vertical differentiation.)

Pricing

- For given qualities, we can solve for the optimal price just as we do in horizontal differentiation models.
  - We find the indifferent consumer, who is located at θ^*. Thus $\theta^* s_1 - p_1 = \theta^* s_2 - p_2$, so $\theta^* = \frac{p_2 - p_1}{s_2 - s_1}$.
  - Thus firm 1's profits are $p_1\theta^* = \frac{p_1 p_2 - p_1^2}{s_2 - s_1}$.
    - FOC: $0 = \frac{p_2 - 2p_1}{s_2 - s_1}$, i.e. $p_1 = \frac{p_2}{2}$.
  - Firm 2's profits are $p_2(1 - \theta^*) = p_2 - \frac{p_2^2 - p_1 p_2}{s_2 - s_1}$.
    - FOC: $0 = 1 - \frac{2p_2 - p_1}{s_2 - s_1}$, i.e. $p_2 = \frac{p_1 + s_2 - s_1}{2}$.
  - Solution: $p_1 = \frac{1}{3}(s_2 - s_1)$, $p_2 = \frac{2}{3}(s_2 - s_1)$.

Profits and quality choice.

- $\theta^* = \frac{p_2 - p_1}{s_2 - s_1} = \frac{\frac{2}{3}(s_2 - s_1) - \frac{1}{3}(s_2 - s_1)}{s_2 - s_1} = \frac{1}{3}$.
- So firm 1 makes profits of $\frac{1}{9}(s_2 - s_1)$ and firm 2 makes profits of $\frac{4}{9}(s_2 - s_1)$.
  - Firm 2's profits are higher both because of higher demand, and because of making greater profit per unit sold.
- Both profits are increasing in the gap in qualities between the two products.
  - So if firms can freely choose quality before the sale period, then one firm will choose quality 0, and the other will choose quality 1.
  - Strategic effect is dominating the demand effect.

Empirical work on product differentiation

- There is a lot of empirical work estimating demand functions in differentiated product markets. See e.g. Carlton and Perloff p.231-233 for a summary.
  - Often take a characteristics approach, running regressions like $\text{valuation} = \alpha\text{characteristics} - \beta\text{price} + \text{other factors}$. Useful in antitrust investigations to work out consequences of e.g. a merger.

- Another line of research tries to quantify the gains from variety.
  - Hausman (1997) is an early example, that finds a very large value of consumer surplus from the introduction of Apple-Cinnamon Cheerios.
    - Gain in value of cereal consumption is around 25% under perfect competition, this falls to around 20% under imperfect competition, since introducing Apple-Cinnamon Cheerios means that the price of other Cheerios brands can be increased.
  - Broda and Weinstein (2010) use scanner data about every good purchased by a sample of 55000 households.
    - Conclude that true inflation is overstated by 0.9% because of the extra value consumers are getting from variety. So "…consumers are willing to pay around seven percent of their income to access the set of goods available in 2003 relative to those available in 1994."

Market power without product differentiation

- Must be careful to distinguish product differentiation from situations in which we get the results of product differentiation (market power etc.) while firms are selling identical goods.
  - Consumer search (OZ 16):
    - Suppose consumers must pay a cost to find out each firm's price. Then there are equilibria in which all firm's charge the monopoly price (so there is no point visiting more than one firm), and equilibria in which firms choose a price at random, above MC. (Burdett and Judd 1983) If some consumers have higher search costs than others then we can get partial sorting by search cost. (Consider e.g. tourist shops.)
  - Switching costs/habits:
    - Many switching costs to changing products (time to change bank accounts, lost airline status points, time to learn how to use new operating system/keyboard). We also become attached to products we are familiar with (=habits). Firms have an incentive to offer low prices early on and increase them later. But even these introductory prices may be higher than MC. (Klemperer 1987)

Conclusions on product differentiation

- When the firms choose location, products will be too different, relative to the social optimum.
  - At least with quadratic costs.
- Price discrimination does not necessarily increase profits when products are differentiated.
- The Salop model is one in which the business stealing effect dominates, leading to excess entry.
- Product proliferation may be used to deter entry.
- Under vertical differentiation firms want to produce as different qualities as possible, and even the low quality firm will make profits.
- Empirical work suggests the returns to variety are large, and that product differentiation is pervasive.
- But $P > MC$ does not always mean products are differentiated.

Further product differentiation exercises

- OZ Ex. 12.9
  - Question 1

Advertising (OZ 11)

- Do you think adverts work?
- How do you think they work?
- Why might economists be interested in advertising?

The persuasive view (OZ 11.1)

- Advertising changes people's preferences.
  - Advertising makes people less willing to substitute between the advertised good and its rivals.
  - Makes demand less elastic, meaning higher prices.
  - Also creates barriers to entry.
    - "I don't want a trainer, I want a Nike trainer."

- Suggests advertising is anti-competitive.
  - But how can we analyse welfare if preferences change?

The informative view (OZ 11.2)

- Advertising provides information about products (e.g. existence, price and quality).
  - Thus mitigates search and experimentation costs.
    - "The advert says Ariel cleans better than its competitor."
  - May also provides indirect information.
    - "If Virgin were not a respectable airline they would not be able to afford to produce adverts such as these, as no one would fly with them more than once."
  - Also helps entry, since entrants may ensure consumers know they have entered.

- Suggests advertising is pro-competitive.

The complementary view Bagwell (2005)

- Advertising provides a complementary good to the product it advertises.
  - Adverts for hybrid cars make a big deal out of the cars green credentials.
    - Thus if you own a hybrid car, and you care about the environment, seeing an advert for the car you bought may make you feel "smug", i.e. increase your utility.
  - Adverts for Porsches feature people who are beautiful and/or rich and/or successful.
    - Thus when you see a Porsche you are inclined to assume the driver has high social status.
    - If the driver values being considered "high status", then seeing a Porsche advert may be a complementary good to owning a Porsche for her. Once s/he's seen the Porsche advert she knows that others who have seen it will see her as high status.
- Clearly related to the persuasive view.
  - But if advertising is a complementary good, then the welfare implications may be drastically different.

Advertising under monopoly (1/4) (OZ 11.1.1)

- Temporarily abstract from questions about how advertising works, and assume that demand is some concave function of advertising, $Q(P, A)$.
- One firm.
- Production has constant MC of c, advertising has constant MC of r.
- Following Dorfman and Steiner (1954).

Advertising under monopoly (2/4)

- Profits: $(P-c)Q(P,A)-rA$
- FOC P: $0=Q(P,A)+(P-c)\frac{\partial Q(P,A)}{\partial P}$.
  - So: $0=P+(P-c)\frac{P}{Q(P,A)}\frac{\partial Q(P,A)}{\partial P}$
    - from multiplying both sides by $\frac{P}{Q(P,A)}$.
  - $\frac{P}{Q(P,A)}\frac{\partial Q(P,A)}{\partial P}<0$ is the price elasticity of demand, which we will call ϵ_P.
    - Thus $0=P+(P-c)\epsilon_P$, so $\frac{P-c}{P}=-\frac{1}{\epsilon_P}$.

Advertising under monopoly (3/4)

- Profits: $(P-c)Q(P,A)-rA$
- FOC A: $0=(P-c)\frac{\partial Q(P,A)}{\partial A}-r$.
  - So: $0=(P-c)\frac{A}{Q(P,A)}\frac{\partial Q(P,A)}{\partial A}-\frac{A}{Q(P,A)}r$
    - from multiplying both sides by $\frac{A}{Q(P,A)}$.
  - $\frac{A}{Q(P,A)}\frac{\partial Q(P,A)}{\partial A}$ is the advertising elasticity of demand, which we will call ϵ_A.
    - Thus $0=(P-c)\epsilon_A-\frac{A}{Q(P,A)}r$, so $\frac{P-c}{P}=\frac{1}{\epsilon_A}\frac{rA}{PQ}$.

Advertising under monopoly (4/4)

- Equating the two conditions for $\frac{P-c}{P}$ gives: $\frac{1}{\epsilon_A}\frac{rA}{PQ} = -\frac{1}{\epsilon_P}$, i.e. $\frac{rA}{pQ} = \frac{\epsilon_A}{|\epsilon_P|}$ (as long as $\epsilon_P < 0$).
  - Known as the Dorfman-Steiner condition.

- So, advertising expenditure will be high relative to sales revenues when:
  - The advertising elasticity of demand is high.
    - I.e. advertising results in large demand increases.
  - The price elasticity of demand is close to zero.
    - So firms can charge a high mark-up without quantity falling too much.

- Finally, recall $\frac{P-c}{P} = -\frac{1}{\epsilon_P}$. So advertising only affects price through its (ambiguous) effect on the P.E.D..

Effect of advertising on price (1/2)

- Persuasive and complementary advertising may be modelled as shifting the demand curve.

- Suggests $Q(P, A) = F(A) + G(P)$.
  - With this specification, it may be shown (tedious!) that a sufficient condition for $\frac{dP}{dA} > 0$ is $G''(P) \leq 0$.
    - True for linear demand, but not true for isoelastic demand.
    - Possible to construct plausible examples in which advertising decreases price.

Effect of advertising on price (2/2)

- Informative advertising may be modelled as scaling the demand curve.

- Suggest $Q(P,A) = F(A)G(P)$.
  - Then the price elasticity of demand does not depend on A, so advertising will have no effect on the price.
  - Proof: $\frac{\partial Q(P,A)}{\partial P} = F(A)G'(P)$, so $\frac{P}{Q(P,A)}\frac{\partial Q(P,A)}{\partial P} = \frac{P}{F(A)G(P)}F(A)G'(P) = \frac{P}{G(P)}G'(P)$

Advertising summary so far

- Three different views about how advertising works.
- Firms will perform more advertising when they face inelastic demand.
- Effect of advertising on price is ambiguous.
- Read the Bagwell paper (or at least it's introduction and conclusion) to get a wider picture.

Advertising exercises

- OZ Ex. 11.7
  - Question 1,2

- OZ Extra exercises:
  - http://ozshy.50webs.com/io-exercises.pdf
  - Set #16