7: Behavior based price discrimination
Vertical control

Games, Competition and Markets 2024/25

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Overview

1. Where We Stand
2. Framework
3. Coupons
4. Poaching
5. Double marginalization problem
6. Solving the problem
7. Two-part tariffs
8. Exclusive contracts

Where We Stand

Topics

1. Preliminaries

Introductory lecture. Review of game-theoretic concepts. Some basic models of competition.

2. Consumer Search

What if consumers have to engage in costly search to find out about products and/or prices?

3. Advertising

What if producers have to inform consumers about their products and/or prices?

4. Menu Pricing

What if firms design different products and different prices for different consumers?

5. Durable Goods

What if a monopolist sells a durable good and cannot commit to future quantities?

6. Switching Costs

What if consumers have to pay extra if they switch suppliers?

7. Behavior-Based Price Discrimination

What if firms can base their prices on a consumer's past behavior?

8. Vertical control

What if firms sell products to retailers who then sell it to final consumers?

9. Bundling

What if firms can sell bundles of products?

10. Network externalities and compatibility

What if products exhibit network effects: they becomes more (or sometimes less) useful if more consumers use it. Also: when do firms want to make their products compatible with that of their competitor?

11. Platform competition

What if online platforms bring buyers and sellers together? Or consumers and advertisers?

Behavior based price discrimination

- Price discrimination based on *past* behavior of consumers.
- Here: what and where they bought in the past.
- Alternatively: cookies, browser used, etc. etc.
- i.e. it is *not* based on some objective criterion (third-degree) but also not by offering a menu of options (second-degree).
- Arguably, it's an attempt to achieve first-degree.

Framework

1. Again, we will be looking at past behavior.
2. So again, we will need a two-period model.
3. In fact, the analysis is very close to that of switching costs.

General Approach

1. Solve for equilibrium of period 2, given $\hat{x}_1$ (sales of A in period 1).
2. Move back to stage 1. Figure out the indifferent $\hat{x_1}$ as a function of p_A^1 and p_B^1, taking into account what will happen in period 2.
3. Write down total discounted profits as a function of $\hat{x_1}$, p_A^1 and p_B^1.
4. Maximize and impose symmetry.

Coupons

- Suppose firms give you a *coupon*.
- These entitle you to a discount if you buy again.
- You can also think of this as any other loyalty program that gives you benefits if you buy from the same firm again.
- Again, two firms A and B on the endpoints of a Hotelling line.
- Two periods.
- $\lambda_n = 0$.
- Tastes change after period 1 (otherwise no effect).

Coupons

- In period 1, firm A issues a coupon worth γ_A.
- Firm B issues a coupon worth γ_B.
- These are endogenously determined.
- Consider a consumer in segment A. She will buy again from A in period 2 if

$$v - x - p_A^2 + \gamma_A \geq v - (1 - x) - p_B^2$$

- Hence

$$\hat{x}_A^2 = \frac{1}{2}\left(1 + p_B^2 - p_A^2 + \gamma_A\right).$$

- This has the same effect as switching costs!
- But firm specific.

Coupons

$$\hat{x}_A^2 = \frac{1}{2}\left(1 + p_B^2 - p_A^2 + \gamma_A\right).$$

$$\hat{x}_B^2 = \frac{1}{2}\left(1 + p_B^2 - p_A^2 - \gamma_B\right).$$

$$\begin{aligned}
\pi_A^2\left(p_A^2, p_B^2\right) &= \hat{x}_1 \hat{x}_A^2 \left(p_A - \gamma_A - c\right) + \left(1 - \hat{x}_1\right) \hat{x}_B^2 \left(p_A - c\right) \\
&= \frac{1}{2}\left(1 + p_B^2 - p_A^2 + \gamma_A\right) \hat{x}_1 \left(p_A^2 - \gamma_A - c\right) \\
&\quad + \frac{1}{2}\left(1 + p_B^2 - p_A^2 - \gamma_B\right)\left(1 - \hat{x}_1\right)\left(p_A^2 - c\right)
\end{aligned}$$

This yields

$$p_A^2 = \frac{1}{2}\left(1 + c + p_B^2 + 2\gamma_A \hat{x}_1 - \gamma_B (1 - \hat{x}_1)\right),$$

and

$$p_B^2 = \frac{1}{2}\left(1 + c + p_A^2 + 2\gamma_B (1 - \hat{x}_1) - \gamma_A \hat{x}_1\right).$$

Plugging these into each other yields

$$\begin{aligned} p_A^2(\hat{x}_1) &= 1 + c + \gamma_A \hat{x}_1 \\ \pi_A^2(\hat{x}_1) &= \frac{1}{2} - \frac{1}{2}\left(1 - \gamma_A \hat{x}_1 (1 - \hat{x}_1)(\gamma_A + \gamma_B)\right) \end{aligned}$$

Consumers

Expected total surplus buying from A in the first period:

$$u_A = v - x_1 - p_A^1 + \left[\int_0^{\hat{x}_A^2} \left(v - x - \left(p_A^2\left(\hat{x}_1\right) - \gamma_A\right)\right) dx + \int_{\hat{x}_A^2}^1 \left(v - (1-x) - p_B^2\left(\hat{x}_1\right)\right) dx\right]$$

When buying from B :

$$u_B = v - (1 - x_1) - p_B^1 + \left[\int_0^{\hat{x}_B^2} \left(v - x - p_A^2\left(\hat{x}_1\right)\right) dx + \int_{\hat{x}_B^2}^1 \left(v - (1-x) - \left(p_B^2\left(\hat{x}_1\right) - \gamma_B\right)\right) dx\right]$$

$$\Delta u = 1 - 2x_1 + p_B^1 - p_A^1 + \frac{1}{4}\left(\left(\gamma_A + \gamma_B\right)^2 + 2\left(\gamma_A - \gamma_B\right)\right) - \frac{1}{2}\left(\gamma_A + \gamma_B\right)^2 \hat{x}_1.$$

$$\Delta u = 1 - 2x_1 + p_B^1 - p_A^1 + \frac{1}{4}\left(\left(\gamma_A + \gamma_B\right)^2 + 2\left(\gamma_A - \gamma_B\right)\right) - \frac{1}{2}\left(\gamma_A + \gamma_B\right)^2 \hat{x}_1.$$

The indifferent consumer has $\Delta u = 0$, hence

$$\hat{x}_1 = \frac{4\left(1 + p_B^1 - p_A^1\right) + \left(\gamma_A + \gamma_B\right)^2 + 2\left(\gamma_A - \gamma_B\right)}{2\left(4 + \left(\gamma_A + \gamma_B\right)^2\right)}.$$

$$\Pi_A\left(p_A^1, p_A^2, \gamma_A^1, \gamma_A^2\right) = \left(p_1^A - c\right)\hat{x}_1 + \frac{1}{2} - \frac{1}{2}\left(1 - \gamma_A \hat{x}_1\left(1 - \hat{x}_1\right)\left(\gamma_A + \gamma_B\right)\right)$$

FOC, impose symmetry.

Equilibrium

$$\begin{aligned}
\gamma_A &= 2/3 \\
p_A^1 &= c + \frac{13}{9} \\
p_A^2 &= c + \frac{4}{3} \\
\Pi_A &= \frac{10}{9}.
\end{aligned}$$

- Profits increase with coupons.
- Loyal consumers pay a lower price in the second period...
- But total price is higher.

Poaching

- Fudenberg and Tirole (1991)
- Again: two firms on a Hotelling line, two periods.
- No switching costs.
- First-period buying behavior is observable.
- Hence, firms can base second-period prices on first-period buying behavior.
- Similar to coupons, but no commitment.

Solving...

- Backward induction
- In period 2, firm A can price discriminate. It charges p_{AA} and p_{AB}
- Firm B charges p_{BA} and p_{BB}.
- The indifferent consumers on segments A and B are given by

$$\hat{x}_A^2 = \frac{1}{2}\left(1 + p_{BA}^2 - p_{AA}^2\right); \qquad \hat{x}_B^2 = \frac{1}{2}\left(1 + p_{BB}^2 - p_{AB}^2\right),$$

- Second-period profits for firm A are given by

$$\Pi_A^2 = \Pi_{AA}^2 + \Pi_{AB}^2 \equiv (p_{AA}^2 - c)\hat{x}_A^2 + (p_{AB}^2 - c)(\hat{x}_B^2 - \hat{x}_1),$$

Solving...

Reaction functions:

$$p_{AA}^2 = \frac{1}{2}\left(1 + p_{BA}^2 + c\right); \qquad p_{BA}^2 = \frac{1}{2}\left(2\hat{x}^1 - 1 + p_{AA}^2 + c\right).$$

Solving:

$$p_{AA}^2 = c + \tfrac{1}{3}(1 + 2\hat{x}^1); \qquad p_{BA}^2 = c + \tfrac{1}{3}(4\hat{x}^1 - 1).$$

We then immediately have

$$\hat{x}_A^2 = \frac{1}{6}\left(1 + 2\hat{x}^1\right).$$

$$\Pi_{AA}^2 = \tfrac{1}{18}(1 + 2\hat{x}^1)^2; \qquad \Pi_{BA}^2 = \tfrac{1}{18}(4\hat{x}^1 - 1)^2.$$

On segment B, we can do a similar analysis.

First period

Indifferent consumer:

$$\begin{aligned} v - \hat{x}_1 - p_A^1 \quad &+ \quad \delta(v - (1 - \hat{x}_1) - p_{BA}^2) \\ &= \quad v - (1 - \hat{x}_1) - p_B^1 + \delta(v - \hat{x}_1 - p_{AB}^2), \end{aligned}$$

This yields

$$\hat{x}^1 = \frac{1 + p_B^1 - p_A^1 - \delta(1 + p_{BA}^2 - p_{AB}^2)}{2(1-\delta)}.$$

Plugging in second-period prices

$$\hat{x}^1 = \frac{1}{2} + \frac{3(p_B^1 - p_A^1)}{6 + 2\delta}.$$

First period

A sets p_A^1 as to maximize total discounted profits

$$\begin{aligned}\Pi_A &= (p_A^1 - c)\hat{x}_1 + \delta\Pi_{AA}^2 + \delta\Pi_{AB}^2 \\ &= (p_A^1 - c)\hat{x}_1 + \frac{\delta}{18}(1 + 2\hat{x}^1)^2 + \frac{\delta}{18}(3 - 4\hat{x}^1)^2. \qquad (2)\end{aligned}$$

Taking the derivative with respect to p_A^1 :

$$\frac{\partial \Pi_A}{\partial p_A^1} = (p_A^1 - c)\frac{\partial \hat{x}^1}{\partial p_A^1} + \hat{x}^1 + \frac{2\delta}{9}\left(1 + 2\hat{x}^1\right)\frac{\partial \hat{x}^1}{\partial p_A^1} - \frac{4\delta}{9}\left(3 - 4\hat{x}^1\right)\frac{\partial \hat{x}^1}{\partial p_A^1}.$$

With $\frac{\partial \hat{x}^1}{\partial p_A^1} = \frac{-3}{6+2\delta}$, imposing symmetry

$$\frac{1}{2} - \frac{3}{6 + 2\delta}\left(p_A^1 - c\right) = 0.$$

Equilibrium

$$
\begin{aligned}
p_A^1 &= c + 1 + \frac{\delta}{3}. \\
p_{AA}^2 &= c + \frac{2}{3} \\
p_{AB}^2 &= c + \frac{1}{3} \\
\Pi_A &= \frac{1}{2} + \frac{4}{9}\delta
\end{aligned}
$$

- Loyal consumers are unaffected.
- Consumers that are poached are better off.
- Firms are worse off.
- But welfare decreases.

(Shameless self-promotion, not part of the exam)

Behavior-based Price Discrimination and the Use of Retention Offers

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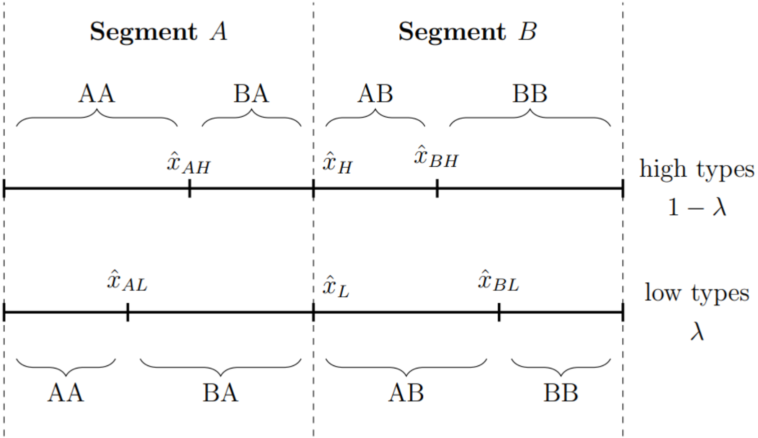
Abstract

We study retention offers, the practice of firms providing better deals to consumers who signal their intent to cancel. In a two-period Hotelling model, firms attempt to poach each other's consumers but can counter this by making retention offers. Low-switching-cost consumers strategically seek out these offers, even if they do not intend to switch. We find that retention offers increase profits but reduce consumer surplus and total welfare. They allow firms to price discriminate against high-switching-cost-consumers while softening competition for low-switching-cost consumers: as they always secure a retention offer, they become more fickle in the second period and hence less worthwhile to attract in the first period.

Keywords: Switching costs, retention offers, behavior-based price discrimination, poaching.

JEL classification: D11, D43, L13.

Figure 1: Market segmentation in both periods, benchmark.



The Double Marginalization Problem

- Consider a monopolist that sells its product to a monopolist retailer that then sells it to final consumers.
- For now we only consider *linear prices*: a price per unit: $T(q) = p_w q$.
- Demand: $D(p) = 1 - p$.
- Marginal cost manufacturer: c. Retailer: none other than p_w.

- **Stage 1**: The monopolist manufacturer sets p_w.
- **Stage 2**: The monopolist retailer sets p.

Solve using backward induction. Given p_w, the retailer sets p to

$$\max_p \left[(p - p_w)(1 - p) \right],$$

so

$$p^* = \frac{1 + p_w}{2}.$$

Final demand then is

$$q = \frac{1 - p_w}{2}.$$

The retailer's profit thus is

$$\Pi_r = \left(\frac{1 - p_w}{2} \right)^2 .$$

The manufacturer's problem is then to

$$\begin{aligned} \max_{p_w} \Pi_m &= (p_w - c)(1 - p) \\ &= (p_w - c)\left(\frac{1 - p_w}{2} \right). \end{aligned}$$

$$\begin{aligned}\max_{p_w} \Pi_m &= (p_w - c)(1-p) \\ &= (p_w - c)\left(\frac{1-p_w}{2}\right).\end{aligned}$$

Hence

$$p_w^* = \frac{1+c}{2}.$$

The final price thus equals

$$p^* = \frac{1+\frac{1+c}{2}}{2} = \frac{3+c}{4}.$$

Total profits of the non-integrated structure are given by

$$\Pi^{ni} = \Pi_m + \Pi_r = \frac{(1-c)^2}{8} + \frac{(1-c)^2}{16} = \frac{3}{16}(1-c)^2.$$

Now consider an integrated industry. Total profits

$$\Pi^i = (p - c)(1 - p),$$

which are maximized by setting

$$p_m^* = \frac{1 + c}{2},$$

so total profits are

$$\Pi^i = \frac{(1 - c)^2}{4} > \Pi^{ni}.$$

This is the **double marginalization problem.**

How to solve it?

1. Vertical integration.
2. Resale price maintenance.
3. Quantity fixing.
4. Franchise fee (two-part tariff)

Two-part tariff

Retailer pays a fixed fee A to sell the product, plus per unit price p_f: $T(q) = A + p_f q,$.
Given $T(q)$ the retailer sets p to

$$\max_p \left[(p - p_f)(1 - p) - A\right],$$

which again yields

$$p^* = \frac{1 + p_f}{2}.$$

The retailer's profit thus is

$$\Pi_r = \left(\frac{1 - p_f}{2}\right)^2 - A.$$

$$\Pi_r = \left(\frac{1-p_f}{2}\right)^2 - A.$$

The manufacturer's problem is to

$$\max_{A,p_f} \Pi_m = (p_f - c)\left(\frac{1-p_f}{2}\right) + A \text{ s.t. } \Pi_r \geq 0$$

The manufacturer will set

$$\begin{aligned} A^* &= \left(\frac{1-p_f}{2}\right)^2, \\ p_f^* &= \arg\max_{p_f} \Pi_m = (p_f - c)\left(\frac{1-p_f}{2}\right) + \left(\frac{1-p_f}{2}\right)^2 \end{aligned}$$

which yields

$$p_f^* = c; \qquad A^* = (1-c)^2/2.$$

Exclusive contracts

- Sometimes a manufacturer commits itself to deal with only one retailer.
- Exclusive contracts.
- Surprising. Wouldn't more downstream competition yield higher upstream profits?
- It solves the double marginalization problem!

Set-up

- A single upstream manufacturer (M)
- Two downstream retailers R_A and R_B.
- M has constant unit cost c_M, retailers have constant unit cost c_R.

Without exclusive contracts

Timing

1. M makes simultaneous private offers to each R_j in the form (q_j, t_j), with q quantity and t total payment.
2. Retailers simultaneously announce whether or not they accept the offer.
3. Retail competition occurs. Each retailer offers all units, the market clears.

Generally speaking, prices are $p_j(q_A, q_B)$, so profits are

$$\begin{aligned}
\pi_j(q_A, q_B) &= [p_j(q_A, q_B) - c_R]q_j - t_j \\
\pi_M(q_A, q_B) &= t_A + t_B - c_M(q_A, q_B).
\end{aligned}$$

Without exclusive contracts

- A retailer that receives an offer from the manufacturer must form some conjecture about the offer that the other retailer has received.
- *Passive beliefs*: Each retailer R_j has a fixed conjecture about the offer that is received by the other retailer R_{-j}.
- In equilibrium, these conjectures must be correct.
- Hence, any manufacturer-retailer pair must agree to a contract that *maximizes joint payoff given the contract signed between M and* R_{-j}.
- Given the contract with B, the best the manufacturer can do is offer A a quantity that maximizes As profits, and charge a fixed fee t_A that equals those profits.
- Vice-versa for the contract with B.

Solution without exclusive contracts

(q_A^*, q_B^*) must satisfy

$$\begin{aligned} q_A^* &= \arg\max_{x_A} \left[p_A(q_A, q_B^*) - (c_M + c_R)\right] q_A \\ q_B^* &= \arg\max_{x_B} \left[p_B(q_A^*, q_B) - (c_M + c_R)\right] q_B \end{aligned}$$

But (if this is a homogeneous product and A and B operate on the same market) this is exactly the Cournot equilibrium!

Exclusive contracts

- With exclusive contracts, the manufacturer can earn monopoly profits on a market.
- Hence, if the two retailers are active on two separate markets, having exclusive contracts is definitely not a good idea.
- But if they're on the same market and sell a homogeneous product, it is.

Thank you for your attention

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