6: Switching Costs

Games, Competition and Markets 2024/25

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Overview

1. Where We Stand
2. Framework
3. Same taste, naive consumers
4. Same taste, rational consumers
5. Changing tastes, rational consumers

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?

Switching Costs

Switching costs

The costs involved when switching suppliers

- Banks
- Telecom
- Software
- Electricity
- Health insurance
- Etcetera

Framework

1. Hotelling set-up
2. Firm A at 0, firm B at 1.
3. Transportation costs 1.
4. Two periods, covered market.
5. In period 2, a share λ_n of consumers are new. The other λ_0 are old.
6. Switching costs z.

Three models

1. Consumers have same taste in each period, are naive.
2. Consumers have same taste in each period, are forward-looking.
3. Consumers tastes differ in each period.

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.

Model 1: same taste. Step 1

- Suppose that in the first period, a share $\hat{x}_1$ buy from firm A.
- Consumers are naive.
- A consumer that bought from A will still do so in period 2 if $v - x - p_A^2 \geq v - z - (1 - x) - p_B^2$.
- or if $x \leq \frac{1}{2}\left(1 + p_B^2 - p_A^2 + z\right) \equiv \hat{x}_A$.
- A consumer that bought from B will do so again if $x \geq \frac{1}{2}\left(1 + p_B^2 - p_A^2 - z\right) \equiv \hat{x}_B$.
- Note: consumers will not switch if $\hat{x}_B \leq \hat{x}_1 \leq \hat{x}_A$.
- which implies $z \geq \left\|\left(p_A^2 + \hat{x}_1\right) - \left(p_B^2 + 1 - \hat{x}_1\right)\right\|$
- In equilibrium, this will be satisfied.
- New consumers will behave as they always do: buy from A if $x \leq \frac{1}{2}\left(1 + p_B^2 - p_A^2\right)$.

Model 1: same taste, naive consumers. Step 2

- Second period demand of firm 1 thus equals $q_A^2 = \lambda_0 \hat{x}_1 + \lambda_n \left(\frac{1}{2} \left(1 + p_B^2 - p_A^2 \right) \right)$.
- Reaction function: $p_A^2 \left(p_B^2 \right) = \frac{\lambda_0}{\lambda_n} \hat{x}_1 + \frac{1}{2} \left(1 + c + p_B^2 \right)$
- For firm B: $p_B^2 = \frac{\lambda_o}{\lambda_n} \left(1 - \hat{x}_1 \right) + \frac{1}{2} \left(1 + p_A^2 + c \right)$
- Equilibrium:

$$
\begin{aligned}
p_A^2 &= c + \frac{1}{\lambda_n} \left(1 + \frac{1}{3} \left(2\hat{x}_1 - 1 \right) \left(1 - \lambda_n \right) \right) \\
\pi_A^2 &= \frac{1}{2\lambda_n} \left(1 + \frac{1}{3} \left(2\hat{x}_1 - 1 \right) \left(1 - \lambda_n \right) \right)^2
\end{aligned}
$$

$$\begin{aligned} p_A^2 &= c + \frac{1}{\lambda_n}\left(1 + \frac{1}{3}\left(2\hat{x}_1 - 1\right)\left(1 - \lambda_n\right)\right) \\ \pi_A^2 &= \frac{1}{2\lambda_n}\left(1 + \frac{1}{3}\left(2\hat{x}_1 - 1\right)\left(1 - \lambda_n\right)\right)^2 \end{aligned}$$

- With symmetric first-period shares: $p = c + 1/\lambda_n$.
- With $\lambda_n = 1$: standard Hotelling.
- With $\lambda_n = 0$: monopoly prices in period 1

Move back to period 1

- $\pi_A\left(p_A^1, p_B^1\right) = \pi_A^1\left(p_A^1, p_B^1\right) + \delta\pi_2\left(\hat{x}_1\left(p_A^1, p_B^1\right)\right)$, hence the FOC is

$$\frac{\partial \pi_A}{\partial p_A^1} = \frac{\partial \pi_A^1}{\partial p_A^1} + \delta \cdot \frac{\partial \pi_A^2}{\partial \hat{x}_1}\frac{\partial \hat{x}_1}{\partial p_A^1} = 0$$

- With naive consumers, $\hat{x}_1 = \frac{1}{2}\left(1 + p_B^1 - p_A^1\right)$, so $\frac{\partial \hat{x}_1}{\partial p_A^1} = -\frac{1}{2} < 0$.
- Also $\pi_A^1 = \left(p_A^1 - c\right)\hat{x}_1 = \frac{1}{2}\left(1 + p_B^1 - p_A^1\right)\left(p_A^1 - c\right)$, so

$$\frac{\partial \pi_A^1}{\partial p_A^1} = \frac{1}{2}\left(1 + p_B^1 - 2p_A^1 + c\right).$$

- Moreover, from the solution of the second stage we have

$$\frac{\partial \pi_A^2}{\partial \hat{x}_1} = \frac{1}{\lambda_n}\left(1 + \frac{1}{3}\left(2\hat{x}_1 - 1\right)\left(1 - \lambda_n\right)\right)\left(\frac{2}{3}\left(1 - \lambda_n\right)\right).$$

Move back to period 1

- Plug everything into the FOC and impose symmetry: $\hat{x}_1 = 1/2$.

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

Hence

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

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

Move back to period 1

- Total discounted price that consumers end up paying then equals

$$P = p_1 + \delta p_2 = 1 + c + \frac{1}{3}\delta\left(\frac{1}{\lambda_n} + 2 + 3c\right)$$

- Without switching costs $P = (1 + c)(1 + \delta)$.
- Difference: $\frac{1}{3}\frac{\delta}{\lambda_n}(1 - \lambda_n)$.
- Consumers (at least, those that live for two periods) end up paying a higher price if there are switching costs.
- First period prices lower with switching costs than without.

Model 2: same taste. Rational consumers.

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.

Model 2: same taste. Rational consumers.

- Second period unaffected.
- There will be no switching in equilibrium.
- Second period demand of firm 1 thus equals $q_A^2 = \lambda_0 \hat{x}_1 + \lambda_n \left(\frac{1}{2}\left(1 + p_B^2 - p_A^2\right)\right)$.
- Reaction function: $p_A^2\left(p_B^2\right) = \frac{\lambda_0}{\lambda_n}\hat{x}_1 + \frac{1}{2}\left(1 + c + p_B^2\right)$

$$
\begin{aligned}
p_A^2(\hat{x}_1) &= c + \frac{1}{\lambda_n}\left(1 + \frac{1}{3}\left(2\hat{x}_1 - 1\right)\left(1 - \lambda_n\right)\right) \\
p_B^2(\hat{x}_1) &= c + \frac{1}{\lambda_n}\left(1 + \frac{1}{3}\left(1 - 2\hat{x}_1\right)\left(1 - \lambda_n\right)\right) \\
\pi_A^2(\hat{x}_1) &= \frac{1}{2\lambda_n}\left(1 + \frac{1}{3}\left(2\hat{x}_1 - 1\right)\left(1 - \lambda_n\right)\right)^2
\end{aligned}
$$

Move back to period 1

- $\pi_A\left(p_A^1, p_B^1\right) = \pi_A^1\left(p_A^1, p_B^1\right) + \delta\pi_2\left(\hat{x}_1\left(p_A^1, p_B^1\right)\right)$, hence the FOC is

$$\frac{\partial \pi_A}{\partial p_A^1} = \frac{\partial \pi_A^1}{\partial p_A^1} + \delta \cdot \frac{\partial \pi_A^2}{\partial \hat{x}_1}\frac{\partial \hat{x}_1}{\partial p_A^1} = 0$$

- Again, from the solution of the second stage we have

$$\frac{\partial \pi_A^2}{\partial \hat{x}_1} = \frac{1}{\lambda_n}\left(1 + \frac{1}{3}\left(2\hat{x}_1 - 1\right)\left(1 - \lambda_n\right)\right)\left(\frac{2}{3}\left(1 - \lambda_n\right)\right).$$

- With naive consumers, $\hat{x}_1 = \frac{1}{2}\left(1 + p_B^1 - p_A^1\right)$, so $\frac{\partial \hat{x}_1}{\partial p_A^1} = -\frac{1}{2} < 0$.
- Also again $\pi_A^1 = \left(p_A^1 - c\right)\hat{x}_1 = \frac{1}{2}\left(1 + p_B^1 - p_A^1\right)\left(p_A^1 - c\right)$, so

$$\frac{\partial \pi_A^1}{\partial p_A^1} = \frac{1}{2}\left(1 + p_B^1 - 2p_A^1 + c\right).$$

Behavior of the consumers has now changed.

Total expected surplus when buying from A: $u_A = v - x - p_A^1 + \lambda_o \left(v - x - p_A^2(\hat{x}_1)\right)$,

When buying from B: $u_B = v - (1 - x) - p_B^1 + \lambda_o \left(v - (1 - x) - p_B^2(\hat{x}_1)\right)$.

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

We know $p_B^2(\hat{x}_1) - p_A^2(\hat{x}_1) = \frac{2\lambda_o}{3\lambda_n}\,(1 - 2\hat{x}_1)$.

Plugging that in yields $\hat{x}_1 = \frac{1}{2} + \frac{p_B - p_A + \lambda_o\left(\frac{2\lambda_o}{3\lambda_n}(1 - 2\hat{x}_1)\right)}{2(1 + \lambda_o)}$.

Solving for $\hat{x}_1$: $\hat{x}_1 = \frac{1}{2}\left(1 + \frac{3\lambda_n(p_B - p_A)}{2 + 2\lambda_n - \lambda_n^2}\right)$.

Solving...

$$\hat{x}_1 = \frac{1}{2}\left(1 + \frac{3\lambda_n\left(p_B^1 - p_A^1\right)}{2 + 2\lambda_n - \lambda_n^2}\right).$$

$$\frac{\partial \hat{x}_1}{\partial p_A^1} = -\frac{1}{2}\left(\frac{3\lambda_n}{2 + 2\lambda_n - \lambda_n^2}\right) < -\frac{1}{2}.$$

Hence first-period demand is now less responsive to price

Pulling everything together

- Plug all the derivatives back into the FOC, impose symmetry...

$$
\begin{aligned}
p^1 &= 1 + c + \frac{1}{3}(1-\lambda_n) \\
p^2 &= c + \frac{1}{\lambda_n}
\end{aligned}
$$

- Note $p^2 - p^1 = \frac{1}{3\lambda_n}(1-\lambda_n)(3-\lambda_n) > 0.$
- Thus, firms sell at a discount in period 1.
- Switching costs make firms better off in each period, consumers worse so.
- Naive consumers are better off...

Model 3: Changing tastes

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.

Model 3: changing tastes

Indifferent consumer in segment A:

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

while the indifferent consumer in segment B again has

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

There will now always be some consumers that switch.
Firm A's second period demand thus equals

$$\begin{aligned} q_A^2\left(p_A^2, p_B^2\right) &= \frac{1}{2}\lambda_n\left(1 + p_B^2 - p_A^2\right) + \lambda_0\left(\hat{x}_1\hat{x}_A^2 + \left(1 - \hat{x}_1\right)\hat{x}_B^2\right) \\ &= \frac{1}{2}\left(1 + p_B^2 - p_A^2 + \left(2\hat{x}_1 - 1\right)\left(1 - \lambda_n\right)z\right), \end{aligned}$$

Model 3: changing tastes

Profits of firm A equal $\pi_A^2 = \left(p_A^2 - c\right) q_A^2$. The FOC becomes

$$\frac{1}{2}\left(1 + p_B^2 - 2p_A^2 + (2\hat{x}_1 - 1)(1 - \lambda_n) z + c\right) = 0,$$

so

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

FOC:

$$\begin{aligned} p_A^2(\hat{x}_1) &= 1 + c + \frac{1}{3}(2\hat{x}_1 - 1)(1 - \lambda_n) z \\ \pi_A^2(\hat{x}_1) &= \frac{1}{2}\left(1 + \frac{1}{3}(2\hat{x}_1 - 1)(1 - \lambda_n) z\right)^2. \end{aligned}$$

Period 1

A consumer at x_1 that buys from A in period 1, will buy from A iff her new $x \leq \hat{x}_A^2$.
Surplus from buying A:

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

When buying from B :

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

Taking the difference between the two yields

$$\Delta u = 1 - 2x_1 + p_B^1 - p_A^1 + \frac{2}{3} \left(1 - 2\hat{x}_1\right) \lambda_o^2 z^2.$$

The indifferent consumer thus has

$$1 - 2\hat{x}_1 + p_B^1 - p_A^1 + \frac{2}{3}\left(1 - 2\hat{x}_1\right)\lambda_o^2 z^2 = 0.$$

$$\hat{x}_1 = \frac{1}{2} + \frac{3}{6 + 4z^2\lambda_o^2}\left(p_B - p_A\right).$$

Consumers are less responsive than without switching costs.

$$\Pi_A = \left(p_A^1 - c\right)\hat{x}_1 + \frac{1}{2}\left(1 + \frac{1}{3}\left(2\hat{x}_1 - 1\right)\left(1 - \lambda_n\right)z\right)^2$$

Take the first order condition, impose symmetry

$$\begin{aligned} p_A^1 &= 1 + c - \frac{2}{3}z\lambda_0\left(1 - z\lambda_o\right) \\ p_A^2 &= 1 + c \end{aligned}$$

First period price is lower than standard Hotelling model, second-period price is equal. Switching costs make consumers better off, and firms worse off.

Thank you for your attention

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