2 Price competition and switching cost

2.1 Introduction

Oligopoly theory is about strategic interaction

- **Perfect competition**: each individual seller is price taker, his quantity choice does not affect the equilibrium price. Behavior of competitors is irrelevant to his optimal decision.

- **Monopoly**: Seller knows that his quantity choice affects price. But since he is the only seller this price depends only on his own behavior.

- **Oligopoly**: Each seller knows that his quantity decision affects price. But his optimal behavior depends also on what his competitors do. He tries to anticipate their strategic actions (and he should do so rationally).
Strategic Interaction

We use game theory to analyze strategic interaction.

A game is described by players, strategies and payoffs.

What is the solution of a game?

**Nash-equilibrium:** \((s_1^*, s_2^*, ..., s_n^*)\)

A combination of strategies, one for each player, where the strategy of each player is a best response against the strategies of all other players.

\[ \forall i : U_i(s_i^*, s_{-i}^*) \geq U_i(s_i, s_{-i}^*) \ \forall \ s_i \in S_i \quad (2.1) \]

where \(s_{-i} = (s_1, s_2, ..., s_{i-1}, s_{i+1}, ..., s_n)\).

**Justification** of this solution concept

A solution of a game should be a Nash equilibrium since otherwise at least one player would be better off if he chose another strategy.
Potential problems with this solution concept

• Non-existence of a Nash equilibrium.

   In this case we should ask whether or not we have modelled the right game.

• Non-existence of a Nash equilibrium in pure strategies, but existence of a Nash equilibrium in mixed strategies.

   The problem here is how to interpret this equilibrium.

• Existence of several Nash equilibria.

   We can try to reason why some equilibria may be more plausible than others (because of higher payoff, symmetry, risk dominance etc.). How unsatisfying it is to have several equilibria depends on the question we address.
2.2 Price competition: The Bertrand Model

- Players: two firms, \( i = 1, 2 \).
  They produce a homogeneous good, with constant marginal cost, \( c_1 = c_2 = c \), no fixed cost.

- Strategies: \( p_i \geq 0, i = 1, 2 \).
  Prices are chosen simultaneously.

- Market demand: \( p = f(x) \iff x = D(p) \)
  Total demand if \( p_1 \neq p_2 \): \( D(\text{min}(p_1, p_2)) \).
  Demand for firm 1, given \( p_1 \) and \( p_2 \):
  \[
  D_1(p_1, p_2) = \begin{cases} 
  D(p_1) & \text{if } p_1 < p_2 \\
  \frac{1}{2}D(p_1) & \text{if } p_1 = p_2 \\
  0 & \text{if } p_1 > p_2
  \end{cases} 
  \]  
  (2.2)
  and vice versa for firm 2.

  Implicit assumption:
  - Consumers react to marginal price differences.
  - No capacity constraints.

- Payoffs:
  \[
  \pi_1(p_1, p_2) = (p_1 - c)D_1(p_1, p_2) \quad (2.3)
  \]
  \[
  \pi_2(p_1, p_2) = (p_2 - c)D_2(p_1, p_2) \quad (2.4)
  \]
**Bertrand-Solution:** Nash equilibrium \((p_1^*, p_2^*)\) of the game, where
\[
p_i^* \in \arg \max_{p_i} \pi_i(p_i, p_k^*) \quad i = 1, 2 \quad k \neq i .
\] (2.5)

**Proposition 2.1** The unique Nash equilibrium in prices is \(p_1^* = p_2^* = c\).

**Proof:**

(i) Suppose \(p_1 = p_2 > c\)

Then each firm would like to undercut its competitor to serve the whole market.

(ii) Suppose \(p_1 > p_2 > c\)

Then firm 1 would prefer to undercut firm 2's price.

(iii) Suppose \(p_1 > p_2 = c\)

Then firm 2 would prefer to raise its price.

(iv) Suppose \(p_1 = p_2 = c\)

Then no firm has an incentive to deviate from its strategy.

(v) No equilibrium can involve prices \(< c\) since this would imply making losses.

\[ Q.E.D. \]
Bertrand Paradoxon

Even though there are only two firms, in equilibrium they both charge prices equal to marginal cost.

This result holds no longer if we give up the following assumptions:

- No capacity constraints.
  Suppose e.g. both firms have a capacity equal to half the monopoly output. Then the equilibrium price will be the monopoly price.

- Homogeneous goods.
  In case of product differentiation there is less competitive pressure.

- Constant marginal cost.
Suppose two firms with increasing marginal costs both charge the competitive price $p = c = p^*$ and serve half of the market. Can this be a NE?

No, because there would be an incentive to raise price:

- Opponent would not sell more because he is already selling the marginal unit at marginal cost.
- The firm that increases its price will lose some demand. But this is a second order loss, given that the marginal unit was sold at a price equal marginal cost. Its gains from selling all other units at a higher price outweigh this loss.
Suppose the two firms have different marginal cost, e.g. $c_1 < c_2$ (and $c_2 \leq p^M$)

**Proposition 2.2** If $c_1 < c_2$ (and $c_2 \leq p^M$), then there exists a unique Nash equilibrium where

- *Firm 1 chooses* $p_1 = c_2$.
- *Firm 2 chooses* $p_2 = c_2$.
- *All consumers buy from firm 1.*

**Proof:**

- Consumers are indifferent from which seller to buy.
- Given firm 1’s price, firm 2 cannot gain from undercutting firm 1 or from raising its price.
- Given firm 2’s price and the behavior of the consumers, firm 1 cannot gain from undercutting firm 2 or from raising its price.

**Note**

In equilibrium all consumers have to buy from firm 1. Otherwise firm 1 would prefer to undercut firm 2 marginally. However, if there is no smallest monetary unit then there exists no optimal price $p_1 < p_2 = c_2$. 

2.3 Switching costs

So far, we have assumed that consumers are completely indifferent from which seller to buy if they offer equal prices. This is the reason why they react to marginal price differences. However, if consumers have a history of buying from one seller, they may be less inclined to switch sellers for a marginal price difference if they incur switching costs.

Switching costs result from a consumer’s wish to stay with the same seller, due to some previous investment. This could be (see Klemperer, 1995)

- a physical investment,
  - need for compatibility with existing equipment (different components of computers, cameras and lenses, ball-point pens and cartridges),
  - transaction costs of switching suppliers (bank accounts, telephone services)
- an informational investment
  - costs of finding out how to use the product
  - uncertainty about the quality of untested brands
- an artificially-created investment
- discount coupons and similar devices (frequent-flyer programmes)
- a **psychological** investment
  - non-economic brand-loyalty

Switching costs give firms some market power over their existing customers and thus reduce the intensity of price competition.

To illustrate this point, consider the following example of price competition in the presence of switching costs:

- There are two sellers, 1 and 2, who sell homogeneous products.
- Firm 1’s unit production costs are \( c_1 \), firm 2’s unit production costs are \( c_2 \).
- There are \( N \) consumers with equal reservation price \( v \) for one unit of a good produced by the two firms.
- A fraction \( \alpha \) of all consumers has previously bought from firm 1, while the remaining fraction \( (1 - \alpha) \) were customers of firm 2.
- Each consumer incurs a switching cost \( s \) when changing suppliers, where \( s \geq v - c_1 > 0 \) and \( s \geq v - c_2 > 0 \).
• Firms choose simultaneously their prices $p_1$ and $p_2$.

**Proposition 2.3** There exists a unique Nash equilibrium where both firms charge $p_1 = p_2 = v$ and earn profits

$\pi_1 = \alpha N(v - c_1)$ and $\pi_2 = (1 - \alpha) N(v - c_2)$.

**Proof:**

• Note first that in equilibrium no firm charges a price below marginal cost or above $v$.

• Suppose firm 2 charges $p_2$, where $v \geq p_2 \geq c_2$. Then the optimal price for firm 1 to set is $v$. Since $s \geq v - c_2$, no one of its previous customers will switch to firm 2. To attract any of firm 2’s customers firm 1 would have to offer a price smaller than $p_2 - s \leq p_2 - v + c_1 \leq c_1$. This cannot be optimal.

• Similarly, the optimal price for firm 2 to set is $v$.

• Thus, the unique equilibrium is one where both firms charge $v$.

\[ Q.E.D. \]
Discussion:

• If switching costs are lower, the sellers may not be able to act exactly as monopolists. However, price competition is less intense if switching costs are present than if they are not.

• Switching costs imply that market shares are valuable. However, this in turn should give an incentive to compete very aggressively for customers in the beginning, in order to build up a large customer base.

To illustrate this point consider the following two-period set-up which is an extension of our example above:

• Firm 1 and 2 produce homogeneous goods, at constant marginal cost $c$.

• There are $N$ consumers with equal reservation price $v$ for one unit of a good produced by the two firms.

• In Period 1 consumers are completely indifferent from which seller to buy. A fraction $\alpha \geq 0$ of all consumers buys from firm 1, while the remaining fraction $(1 - \alpha) \geq 0$ buy from firm 2.

• Each consumer incurs a switching cost $s$ when changing suppliers, where $s \geq v - c > 0$. 
• Firms choose simultaneously their prices in Period 1 and in Period 2.

• There is no discounting.

**Proposition 2.4** In equilibrium, both firms charge a price \( p_1^1 = p_2^1 = c - (v - c) \) in Period 1 and a price \( p_1^2 = p_2^2 = v \) in Period 2. Demand is shared equally in both periods and both firms make zero profits in equilibrium.

**Proof:**

• From the previous Proposition we know that profits of Period 2 are \( \pi_1 = \alpha N(v - c) \) and \( \pi_2 = (1 - \alpha) N(v - c) \).

• Suppose firm 2 sets a price \( p_2^1 > 2c - v \). Then firm 1 has an incentive to undercut firm 2, serve all consumers at a price above \( 2c - v \) in Period 1 and at a price \( v \) in Period 2.

• Suppose firm 2 sets a price \( p_2^1 = 2c - v \). Then it is optimal for firm 1 to offer the same price and serve half of the market in both periods. This yields zero profits.

• The same argument holds vice versa for firm 2.

\( Q.E.D. \)
Discussion

Note that in a two-period setting with switching cost, prices in the first period are lower, prices in the second period higher than in a one-period model without switching cost.

Examples for this kind of aggressive competition for market share in the early stages of a market include:

- Free bank services for students and high charges after students graduate.
- Cheap computer equipment for educational institutions, hoping for future sales from current students.
- Private TV stations show fewer advertisements at the beginning of a film.

Competition for customers can explain price wars when new markets open, new groups of customers enter the market or new firms enter the market.
Second-period switching cost might increase first-period prices

In our example, second period prices were independent of market share in first period.

More generally, if there are some consumers who are not completely locked in in the second period, we expect

• Larger market share in period 1 induces higher prices in period 2.
• Lower market share in period 1 induces lower prices in period 2.

A firm with fewer customers is more interested in attracting new customers than a firm with many customers.

• Firms may want to compete less for market share because competitors are more aggressive if they have lower market share.
• Firms may want to compete less aggressively if consumers anticipate that low prices today induce high prices tomorrow and hence have less elastic demand.
Are switching costs bad for competition?

Set up with many periods and consumers entering the market over time

- Incentive to raise price to exploit old customers
- Incentive to lower price to attract new customers
- Discounting reinforces incentive to raise prices.
- Raising price today gives larger market share to competitor tomorrow and makes him compete less aggressively tomorrow.
- Consumers do not react easily to price reductions because they anticipate higher prices later on.

There is a strong presumption that switching costs raise prices and profits.