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1 Introduction to Industrial Organization

1.1 What is Industrial Organization

- Studies the workings of markets and industries, and, in particular, the way firms compete with each other

- Field of economics concerned with imperfectly competitive markets
  - Perfectly competitive markets: price is given
  - Imperfectly competitive markets: deliberate actions of buyers and sellers to influence price

- Strategic view of how firms interact in these markets
  How firms behave given that there is a connection between market structure and firms’ behavior
  - How should a firm price its product given the existence of rivals
  - How does a firm decide which market to enter
  - Merger decisions
  - Which new product to introduce
  - Methods for attacking or defending markets

- Rely on the tools of Game Theory
  - Interactive decision theory
  - Focuses on strategic decision making and interdependence

- Construct models: abstractions
  - Contrast pricing behavior of: grain farmers at first point of sale
gas station
computer manufacturers
pharmaceuticals (proprietary vs. generics)
  - well established tradition in all science (physics, engineering etc)

1.1.1 Central Questions

- Market power is the ability to set prices above costs and make sustainable profits
- Requires that the mechanism of competition fails to operate

1. Is there market power?
2. How do firms acquire and maintain market power?
• product positioning
• product quality
• advertising
• marketing techniques
• research and development

3. What are the implications of market power?
• greater profits and greater firm value
• money transfer from consumers to firms
• less incentive to be cost efficient
• inefficient allocation of resources

4. Is there a role for public policy regarding market power?
• regulation and antitrust (competition policy) avoid negative consequences of market power
• industrial policy favor the market position of a firm or industry

1.2.1 Topics of Industrial Organization Research
1. Internal Organization of firms Determinants of the scale, scope and organization of firms
2. Market structure and behavior of firms How do market conduct and performance depend on market structure
3. Assessment of market efficiency Public policy
1.2 Historical Development of Industrial Organization

1.2.1 Before the 1930s

- Classical Economics (Smith, Ricardo, Marx)
  - Products have two prices: a market price and a natural price (value)
  - Competition equalizes market and natural price
  - Competition is a process of labor and capital mobility
  - Completely distinguish the price mechanism from the structure of the economy (firms, consumers and market)

- Neoclassical Economics (Marshall)
  - Dispensed with the idea that value is independent of market price
  - Role of the firm and the firm’s management
  - Recognized that a firm can escape into a monopoly position (temporary)
  - Retained the view that competition equalizes price and value without analyzing his concept of competition

- Empirical School
  - Case studies of firms and industries

- Theoretical School (Jevons, Edge worth, Clark, Knight)
  - How competition drives the equalization of prices and costs

1.2.2 From the 1930s to the early 1970s

- Sraffa (1926)
  - Firms face downward sloping demand curves
  - A firm may refrain from further expansion not because costs will rise but because this requires an unacceptable fall in price

- Chamberlin(1933)
  - Theory of Monopolistic Competition
  - Product differentiation
  - Downward sloping demand curves

- 1941 American Economic Association recognized industrial organization as a subdivision of economics

- Harvard Tradition: Mason (1939) Bain (1949)
- Structure - Conduct - Performance Paradigm
- Rested on informal descriptive and no analytic theoretical arguments
- Emphasizes empirical studies of industries
- 1951-1968: Elementary statistical analysis of small cross-section samples of industry level data. Subjective evaluation of many aspects of market structure
- 1967-1977: Econometric analysis of large cross-section samples of industry level data. Objective evaluation of market structure; Production of stylized facts

- Critic on Structure - Conduct - Performance Paradigm
  - Based on loose theories
  - Absence of casual interpretation

- Chicago Tradition: Stigler (1960s)
  - Theoretical movement explaining statistical results
  - Informal stories around regressions
  - Antitrust analysis
  - Case studies
  - Not a rigorous and systematic investigation
  - Distrust on government intervention

1.2.3 After the 1970s

- Dissatisfaction with the limits of empirical analysis that dominated the field
- Development of no cooperative game theory
  - Strategic analysis
  - Asymmetric information

- Theoretical research in IO based on formal game theoretic models
  - Restated S-C-P arguments in formal terms
  - Provided better results as well as techniques over previous approaches
  - Precise assessments of positive and negative aspects of market performance
- But game theoretic framework does not aspire to generality
  - Labyrinth of highly specific models
  - Conclusions which apply only when assumptions are met
  - Generalizations are made rather difficult

- Empirical renaissance in IO
- Motivation of empirical models by formal theoretical models
- Various data sets

- New consideration for policy issues
  - Regulation and antitrust
- Internal organization of firms
1.3 Industry Analysis

- Industries have very different structures
  - Number and size of firms: Ready-to-eat breakfast cereals: high concentration; Restaurants: low concentration
  - Vertical integration: Oil refineries; Automobile market; Milk and milk products

- Industry structures based on the size and number of competitors
  - Fragmented: Dry cleaning, jewelry making
  - Dominant Firm: Microsoft, Beers in diamond market
  - Tight oligopoly: Coca Cola and Pepsi, Airbus and Boeing
  - Loose Oligopoly: Pulp and paper, cigarettes, televisions, stereo electronics

1.3.1 The Structure - Conduct - Performance Model

- S-C-P is useful in several ways
  - Allows to reduce all industry data into meaningful sections
- Conduct and performance are likely to be determined by structure
- Alter structure to improve conduct and performance

• The Feedback Critique to S-C-P

- No one-way causal link
- Conduct can affect market structure
- Market performance can affect conduct as well as market structure

1.3.2 Porter’s Five Forces Model

[Figure 2: Porter’s Five Forces]

• Porter’s five forces are:
  - Bargaining power of suppliers
  - Bargaining power of buyers
  - Threat of new entrants
  - Threat of substitutes
  - Rivalry among competitors

• The strength of the five forces determines the profit potential in an industry by influencing the prices, costs and required investments

1.3.3 The Brandenburger - Nalebuff Model

• Five forces analysis omits an important force
• The force of complementary products
• Brandenburger - Nalebuff forces are:
  - Suppliers
  - Buyers
  - Competitors
  - Complementors

[Figure 3: Brandenburger - Nalebuff Value Net]

• Note: Competitors include sellers of substitutes and potential entrants
• The Six Forces Model
1.4 Market Structure and Market Power

- Market power is the ability to set prices above costs and make sustainable profits
- Requires that the mechanism of competition fails to operate (e.g. barriers to entry, differentiated product that cannot be copied, secret technology etc)
- Basic components of market structure include
  - Number and size distribution of firms
  - Technological and cost conditions
  - Nature of product produced (homogeneous or differentiated)
  - Extent of control over prices by established firms
  - Ease of entry or exit markets
  - Ease with which information flows between buyers and sellers
- Structural characteristics often change slowly and can be regarded as fixed over time

1.4.1 Measure of Concentration

- Concentration refers to the amount of market power held in the hands of a few firms
- Factors Influence Concentration
  - Number of Firms
  - Distribution of output among firms
- Reason for concentration measures
  - Compare concentration among industries
  - Regulation
  - Optimal managerial decisions
- Concentration ratio
  - The sum of market shares of the top $k$ firms in the defined industry. $k$ is normally taken to be 3, 4 or 8.
  \[
  CR_N = \sum_{i=1}^{k} s_i
  \]
  - Linear function of firms’ market shares
Insensitive to unequal market shares

- Herfindahl-Hirshman Index
  - The sum of the squared market shares of all firms in a given industry
    \[ HH = \sum_{i=1}^{N} (s_i)^2 \]
  - Convex function of firms’ market shares
  - Sensitive to unequal market shares

- An Example

<table>
<thead>
<tr>
<th>Industry 1</th>
<th>s_1</th>
<th>s_2</th>
<th>s_3</th>
<th>s_4, s_5</th>
<th>s_6 ... s_8</th>
<th>s_9, s_{10}</th>
<th>CR_4</th>
<th>HH</th>
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<tr>
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<td>5</td>
<td>5</td>
<td>5</td>
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<td>0.385</td>
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<td>Industry 3</td>
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<td>20</td>
<td>20</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>80</td>
<td>0.2</td>
</tr>
<tr>
<td>Industry 4</td>
<td>100/3</td>
<td>100/3</td>
<td>100/3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>100</td>
<td>0.3333</td>
</tr>
<tr>
<td>Industry 4</td>
<td>49</td>
<td>49</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>98.5</td>
<td>0.4802</td>
</tr>
</tbody>
</table>

- Other concentration measures

- **Lorenz curve and the Gini coefficient**
  A Lorenz curve is used to show the share of the industry accounted for by various proportions of firms. The Gini coefficient can be derived from the Lorenz curve, i.e.
  \[ G = 1 - \frac{\sum_{i=1}^{N} \sum_{j=1}^{i} s_j}{0.5N \sum_{i=1}^{N} s_i} \]
  The value of G is determined by the extent to which the Lorenz curve deviates from the line of absolute equality (G = 0 indicates that all firms are of equal size, while G = 1 indicates that a single firm dominates the industry).

- **Hannah and Kay index**
  \[ HK = \sum_{i=1}^{N} (s_i)^{\alpha} \]
  where \( \alpha \) is a parameter that depends on the importance one wishes to attach to the larger firms in the industry (larger \( \alpha \) implies more importance to larger firms).
• Entropy coefficient

\[ E = \sum_{i=1}^{N} s_i \log \frac{1}{s_i} \]

is a measure that quantifies the degree of uncertainty in a given industry (the lower the value of E, the greater is the certainty of the established firms that have a captive market).

• Variance of logarithms of firm sizes

\[ VL = \frac{\sum_{i=1}^{N} (\log s_i - \bar{s})}{N} \]

where \( \bar{s} = \frac{\sum_{i=1}^{N} \log s_i / N} {N} \). VL measures the inequality in firm sizes (many industries have firm size distributions that correspond closely to the log normal distribution).

• Limitations of concentration measures

- Correct definition of the industry: National, regional, or local? University’s refectory, restaurants in islands
- Global Market: Foreign producers excluded Beer producers, oil refineries

1.4.2 Market Definition

• What is a market?
• No clear consensus

- The market for automobiles Should we include light trucks, SUVs?
- The market for soft drinks What are the competitors for Coca Cola and Pepsi?
- With whom do McDonalds and Goodies compete?

• Presumably define a market by closeness in substitutability of the commodities involved

- How close is close?
- How homogeneous do commodities have to be? Does wood compete with plastic? Silk with wool?

• Definition is important
Without consistency the concept of a market is meaningless
- Need indication of competitiveness of a market: affected by definition
- Public policy: decisions on mergers can turn on market definition

- Standard approach has some consistency
  - Based upon industrial data
  - Substitutability in production not consumption (ease of data collection)
    Different qualities of paper

- Government statistical sources
  - National Statistical Service of Greece
  - STACOD, PRODCOM

- Use of production-based statistics has limitations:
  - Can put in different industries products that are in the same market

- The international dimension is important
  - Boeing/McDonnell-Douglas merger
    - Relevant market for automobiles, oil, hairdressing

- Geography is important
  - Barrier to entry if the product is expensive to transport
  - But customers can move
    - What is the relevant market for a beach resort or ski-slope?

- In sum: market definition poses real problems
  - Existing methods represent a reasonable compromise

1.4.3 The Role of Policy

- Government can directly affect market structure
  - By limiting entry Taxi, notaries etc
  - Regulation policy Telecommunications, energy, airlines etc
  - Through the patent system
1.5 Concepts of Competition and Strategies

1.5.1 Competition

- Two concepts of competition
  - “Real” concept of competition is defined in behavioral terms, i.e. as a progress of rivalry
  - Analytical concept of perfect competition refers to a given state or situation

- Stigler (1987) describes competition as: “a rivalry between individuals (or groups or nations), and it arises whenever two or more parties strive for something that all cannot obtain”

- Its breadth encompasses all sorts of:
  - Forms of rivalry (market trading, auctions, races, wars of attrition etc)
  - Instruments of rivalry (prices, advertising, R & D, takeover bids, effort levels etc)
  - Objects of rivalry (profits, market share, corporate control, promotion, prizes, survival etc)
  - Types of rivals

- The identification of competition with rivalry does not in any way presume that “more competition” is necessarily good or an end in itself
  - The existence of scale economies provide a possible case for limiting competition (e.g. telecommunications, energy)

- Meanings of “more competition”
  - Greater freedom of rivals
  - Increase in the number of rivals
  - Move away from collusion towards independent behavior between rivals
  - The reward for obtaining the thing for which all are striving, or the penalty for failing to obtain it, is increased

- Competition was shown to improve efficiency in many circumstances
  - Makes organizations internally more efficient by sharpening incentives to avoid sloth and slack
  - Causes efficient organizations to prosper at the expense of inefficient ones
  - Competition to innovate is the major source of gains in productive efficiency over time
1.5.2 Strategies

- Strategy is the way in which decisions are made
- Business strategy involves long-range planning designed to achieve desired goals
- Business strategy is a vision of a profitable future and a feasible path to get there
- Profits arise because of the uniqueness of the company’s vision

- Some of the strategic variables in firms' portfolios

<table>
<thead>
<tr>
<th>Product features and quality</th>
<th>Vertical integration</th>
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<tbody>
<tr>
<td>Targeting of customers</td>
<td>Cost reduction focus</td>
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<td>Product line</td>
<td>Service provision</td>
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<td>Product standardization</td>
<td>Warranties</td>
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<td>Technological leadership</td>
<td>Input pricing</td>
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<td>Research and development</td>
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<td>Government relations</td>
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<td>Market development and education</td>
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<td>Brand identification</td>
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<td>Geographical markets</td>
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<td>Distribution channels</td>
<td>Inventory levels</td>
</tr>
<tr>
<td>Product pricing</td>
<td>Build to order or inventory</td>
</tr>
</tbody>
</table>

- Price competition
- Non price competition

  - Product Line
  - Product quality
  - Advertising
  - Research and Development - Technology
  - Other marketing variables
1.6 Performance and Profitability

- Performance refers to the social welfare that result in a given industry

\[ \text{Social Welfare} = \text{Consumer Surplus} + \text{Producer Surplus} \]

- Performance includes profitability, efficiency and technical progress
- Market structure is often a guide to market performance
- But this is not a perfect measure
  - Can have near competitive prices even with “few” firms

1.6.1 Industry’s Profitability

[Figure 4: Resources as a Basis for Profitability]

1.6.2 Lerner Index and Markup Factor

- Measure market performance using the Lerner Index

\[ \text{Lerner Index} = \frac{p - MC}{p} \]

A measure of the difference between price and marginal cost a fraction of the product’s price
- The Lerner Index ranges from 0 to 1
  - When Lerner Index = 0, i.e. when \( P = MC \); the firm has no market power
    - Perfect Competition
  - A Lerner Index closer to 1 indicates relatively weak price competition; the firm has market power
    - Monopoly: \( \text{Lerner Index} = \frac{1}{e} \) i.e. inverse of elasticity of demand
- With more than one but not “many” firms, the Lerner Index is more complicated: need to average
  - Suppose the goods are homogeneous so all firms sell at the same price

\[ \text{Lerner Index} = \frac{p - \sum_{i=1}^{N} s_i MC_i}{p} \]
- Markup Factor: From the Lerner Index, the firm can determine the factor by which it should over MC. Rearranging the Lerner Index
The markup factor is \( \frac{1}{1 - L} \).

- When the Lerner Index is zero \( L = 0 \), the markup factor is 1 and \( P = MC \).
- When the Lerner Index is 0.20 \( L = 0.20 \), the markup factor is 1.25 and the firm charges a price that is 1.25 times marginal cost.

Lerner Index has limitations:

- Measurement: as with “measuring” a market
- Meaning: measures outcome but not necessarily performance
- Misspecification:
  - If there are sunk entry costs that need to be covered by positive price-cost margin
  - Low price by a high-cost incumbent to protect its market

1.6.3 Dansby-Willig Performance Index

- A measure of how much social welfare would improve if firms in an industry expanded output in a socially efficient manner.
2 Network Economics

2.1 Introduction – Network Utilities

Network Categories:

- One-way Network → Services flow in only one direction
  - Water
  - Electricity
- Two-way Network → Value to each user depends directly on how many other people use the network
  - Telephony
  - E-mail

Network Industries and Network Goods

- Complementary Goods
- Consumption externalities
- Switching costs and lock-in
- Significant economies of scale in production

Complementary Goods

- Complementary goods are the goods that are always consumed together
- Consumers are shopping for systems rather than individual products
- Complementary goods must be compatible, i.e. must operate on the same standard
- Need for coordination of competitors on standards
- Anticompetitive behavior

Consumption Externalities

- Network externalities or adoption externalities
- Interdependency of consumers
- Positive consumption externalities. The utility derived from the consumption of these goods is affected by the number of other people using these or compatible goods
- The larger the network, the stronger the effect
- Multiple equilibria
Switching Costs and Lock-in

- Cost of switching to a different service or adoption a new technology
- Switching costs imply that consumers are locked in
- The degree of lock in depends on the magnitude of switching costs
- Types of switching costs
  - Compatibility
  - Transaction costs
  - Contracts
  - Training and learning
  - Search cost
  - Loyalty cost
  - Psychological cost

- Affect price competition
  - Before lock-in: Intense competition to attract consumers
  - After lock-in: Less competition (consumers will not switch unless the utility difference exceeds the switching cost)
  - Supplier wants to lock-in customer
  - Customer wants to avoid lock-in

Assume c as the cost per month, though in a perfectly competitive market \( p = c \).
Also, \( s \) is the cost of switching and \( d \) the discount for 1st month, that firms can offer:

**Consumer’s choice:**

- **First month:**
  1. Switch: pay \((p - d)\) discounted price of firm2 and also the switching cost(s) from firm1
  2. Don’t switch: pay \((p)\) and stay to the firm1
  3. Utility: \( U_l > U_{l_i} \rightarrow (p - d) + s + p/r > p + p/r \)
     \[ \rightarrow (p - d) + s > p \]
     \[ \rightarrow (p - d) + s = p, \text{ for the indifferent consumer} \]
     \[ \rightarrow d = s, \text{ the desired discount equates to cost of } s \]

- **Second month:**
  Paying \( p \) at both firms. Thus, the critical month is the first.
Producers’ choice:

- Profits: \( \Pi = (p - c) - d + (p - c)/r = 0 \), but \( s = d \)
  \[ \rightarrow (p - c) + (p - c)/r = s \]
  \[ \rightarrow p = c + [r/(1 + r)]s \], Lerner Index or Equilibrium price + switching cost
  \[ \rightarrow p = c \]

Significant Economies of Scale

- Economies of scale
- Very high fixed sunk cost, together with almost negligible marginal cost
- Average cost function declines sharply
- Imperfect competitive market
2.2 Industry Equilibrium and Network Effects

- Network effects: People gain satisfaction when they consuming goods that are also consumed by other people
- That is, the utility of each consumer is affected by the network size

2.2.1 Network Externalities Model

- Network externalities assumption
  - The utility of each consumer increases with the number of other consumers connecting to the same service – The larger the network, the stronger the effect
  - Negative Externalities such as congestion and bottlenecks can also arise as a network grows

The Model

- Continuum group of consumers \( x \in [0,1] \)
  - Low \( x \) implies high willingness to pay
  - High \( x \) implies low willingness to pay

- Total number of consumers who subscribe \( n \), \( 0 \leq n \leq 1 \)
- Subscription price \( p \)
- Utility of consumer \( x \)

\[
U_x = \begin{cases} 
(1 - x)n^e - p & \text{if } x \text{ subscribes} \\
0 & \text{if } x \text{ does not subscribe} 
\end{cases}
\]

- Utility exhibits network externalities (increases with \( n^e \))

Aggregate Demand and Multiple Equilibria

- At a given price \( p \), consumer \( x \) is indifferent between subscribing and not subscribing

\[
\hat{x} = \frac{n^e - p}{n^e}
\]

- Actual number of subscribers is \( n = \hat{x} \)
- Consumers have perfect foresight \( n^e = n = \hat{x} \)

- Inverse demand function

\[
p = \hat{x}(1 - \hat{x})
\]

- Unusual demand curve
  - Low demand levels: Network effect dominates price effect
  - High demand levels: Price effect dominates network effect

- For a given price \( p_0 \) there can be two demand levels
  - Low demand level \( \hat{x}_0^L \)
  - High demand level \( \hat{x}_0^H \)

- Only point \( \hat{x}_0^H \) is a stable demand equilibrium

- Point \( \hat{x}_0^L \) is the critical mass at price \( p_0 \)
  - Minimal number of consumers needed to ensure that at least this number of consumers will benefit from subscribing to the service
  - Indication of marketing effort needed to market a new service

### Monopoly Provider

- No fixed and sunk costs
- Negligible marginal cost
- Monopolist's profit maximization problem

\[
\max_{\hat{x}} \pi(\hat{x}) = p(\hat{x})\hat{x} = \hat{x}(1 - \hat{x})\hat{x}
\]

- \( \pi(\hat{x}) = 0 \) when \( \hat{x} = 0 \)
- \( \pi(\hat{x}) = 0 \) when \( \hat{x} = 1 \) because \( p = 1 \) is then required
- Profit maximizing price is set such that the number of subscribers exceeds half of the population but less than the entire population
- Positive fixed and marginal costs does not change the results
- Entrant can supply to residual demand
  - Sets lower connection fee and earns lower profits
  - Serves consumers with lower willingness to pay
Network Demand Curve

- 1: Stable Equilibrium – Undesired
- 2: Unstable Equilibrium – Critical Mass
- 3: Stable Equilibrium – Desired

2.2.2 Complementary Goods Model

- Network effects without network externalities
- Complementarily assumption
  - Set of goods that are consumed together
  - Systems rather than individuals products
- Supporting Services Approach
  - Consumers gain utility from the basic product of the system and the variety of complementary products
- Components Approach
  - Consumers’ gain utility iff they have all the system of complementary goods

The Model

- Basic products $A$ and $B$ at a price $p_i, i = A, B$
- Total number of supporting products $N_i$
- Consumers’ utility

$$U^\delta = \begin{cases} 
(1 - \delta)\sqrt{N_A} & \text{if basic product is } A \\
\delta \sqrt{N_B} & \text{if basic product is } B 
\end{cases}$$

where parameter $\delta \in [0,1]$ measures relative preference towards product $B$

- Consumers' budget constraint $Y$
- Amount spend on supporting products $E_i = Y - p_i$
• Total number of supporting products depends on the total amount spent on these products $N_i = \delta E_i$

**Equilibrium**

• Indifferent consumer
  \[(1 - \delta)\sqrt{N_A} = \delta \sqrt{N_B}\]

• In equilibrium, $\delta_A = \hat{\delta}$ consumers buy brand A and $\delta_B = (1 - \hat{\delta})$ consumers buy brand B

• $\delta_A \geq \delta_B$ if and only if $N_A \geq N_B$
  - Higher market share is supported by a larger variety of supporting products
  - Large variety of supporting services leads to higher market share

• Equilibrium number of supporting products are $N_A = \hat{\delta}E_A$ and $N_B = \hat{\delta}E_B$ which implies that
  \[\delta = \frac{E_A}{E_A + E_B} = \frac{Y - p_A}{2Y - p_A - p_B}\]

• An increase in $p_A$,
  - decreases $\delta_A$ and increases $\delta_B$
  - decreases $N_A$ and increases $N_B$
  - decreases $U_{A\text{-consumers}}$ and increases $U_{B\text{-consumers}}$

• Network effect: An increase in the number of $B - consumers$ $\uparrow (\delta_B)$ increases the total number of supporting products ($\uparrow N_B$), which in turn increases the welfare of $B - consumers$ ($U_{B\text{-consumers}}$)
2.3 Compatibility and Standardization

2.3.1 Network Externalities Model

- Continuum of consumers
- \( a \) consumers prefer brand \( A \), with \( 0 \leq a \leq 1 \)
- \( b \) consumers prefer brand \( B \), with \( 0 \leq b \leq 1 \)
- Consumers' population is normalized to \( a + b = 1 \)
- Disutility of consuming not preferred brand \( \delta > 0 \) (or extra amount spend for getting ideal brand)
- Utility functions

\[
U^A = \begin{cases} 
    x_A & \text{buys brand } A \\
    x_B - \delta & \text{buys brand } B
\end{cases}
\]

and

\[
U^B = \begin{cases} 
    x_A - \delta & \text{buys brand } A \\
    x_B & \text{buys brand } B
\end{cases}
\]

- Equilibrium: Allocation of buyers between brands \( A \) and \( B \) such that no single buyer would benefit from switching to the competing brand, given that all other consumers do not switch from their adopted brand

**Single Standard Equilibrium**

- Industry is standardized on \( A \) (\( x_A = 1 \))
- For this to be an equilibrium, it must be that

\[
1 - \delta > 0
\]

- Thus, if \( \delta < 1 \), i.e. network effect is preferred, then two single standard equilibria exist \( \rightarrow \) Buy \( A \) than ideal brand \( B \)
- If \( \delta > 1 \), no single standard equilibrium exists

**Two Standard Equilibrium**

- Industry produces \( x_A = a \) and \( x_B = b \)
• For this to be an equilibrium, it must be that
  - Type A consumer: $a > b - \delta$ that is $a > \frac{1-\delta}{2}$
  - Type B consumer: $b > a - \delta$ that is $b > \frac{1-\delta}{2}$

• Thus, if $a, b > \frac{1-\delta}{2}$, i.e. each type of consumers is sufficiently large, then two standard equilibria exist
  - $x_A = a$ and $x_B = b$

• As disutility $\delta$ increases, the parameter range for which incompatibility is an equilibrium increases

**Social Efficiency**

• Social welfare is

$$ W = aU^A + bU^B = \begin{cases} \frac{a + b(1 - \delta)}{a^2 + b^2} & \text{A standard} \\ \frac{a(1 - \delta) + b}{a^2 + b^2} & \text{Both standards} \\ \frac{a(1 - \delta) + b}{a(1 - \delta) + b} & \text{B standard} \end{cases} $$

• If $a > b$, then A standard is socially preferred to B standard

• Market failure: Standardization to less preferred equilibrium
  - Existence of an *installed base* prevent emergence of preferred standard QWERTY keyboard instead of ideal Dvorak keyboard
  - Minor coordination may be sufficient

• Standardization vs. Variety
  - Two standards are preferred over A standard iff
    $$ a^2 + b^2 > a + b(1 - \delta) \iff a < \frac{\delta}{2} $$
  - Two standards are preferred over B standard iff
    $$ a^2 + b^2 > a(1 - \delta) + b \iff b < \frac{\delta}{2} $$

• If $\delta < 1$, i.e. network effect is preferred, then a two standards equilibrium is socially inefficient
• If $\delta > 1$, then a two standards equilibrium is socially optimal if $a, b < \frac{1-\delta}{2}$

• Market failure: Two standards equilibrium need not be socially efficient
• If two standard equilibria is efficient then two standard equilibria exists and none of the one standard equilibria exist

2.3.2 Complementary Goods Model

• Components Approach
  - Consumers' gain utility iff they have all the system of complementary goods

The Model

• System composed by a basic unit $X$ and by a second component $Y$

• Firms $A$ and $B$ producing both components, i.e. $(X_A, Y_A)$ and $(X_B, Y_B)$

• Three consumers
  - $AA$ prefers system $X_A Y_A$
  - $BB$ prefers system $X_B Y_B$
  - $AB$ prefers system $X_A Y_B$

• Utility from consuming system $X_i Y_j$, $i, j \in \{AA, AB, BB\}$
  i.e. consumer enjoys $A$ for buying a component from his ideal system and 0 for a less preferred component

Incompatible Systems

• Systems $X_A Y_B$ and $X_B Y_A$ do not operate

• Available systems $X_A Y_A$ and $X_B Y_B$

• 1st Equilibrium: Consumers $AA$ and $AB$ buy system $X_A Y_A$ and consumer $BB$ buys system $X_B Y_B$
  - prices $p_A^l = p_A^x + p_A^y = \lambda$ and $p_B^l = p_B^x + p_B^y = 2\lambda$
  - quantities $q_A^l = 2$ and $q_B^l = 1$
  - profits $\pi_A^l = \pi_B^l = 2\lambda$

• 2nd Equilibrium: Consumer $AA$ buys system $X_A Y_A$ and consumers $BB$ and $AB$ buy system $X_B Y_B$
  - prices $p_A^l = p_A^x + p_A^y = 2\lambda$ and $p_B^l = p_B^x + p_B^y = \lambda$
  - quantities $q_A^l = 1$ and $q_B^l = 2$
- profits $\pi_A = \pi_B = 2\lambda$

- 3rd Equilibrium: Consumer $AA$ buys system $X_A Y_A$, consumer $BB$ buys system $X_B Y_B$ and $AB$ is not served
  - prices $p_A = p_B = 2\lambda$
  - quantities $q_A = q_B = 1$
  - profits $\pi_A = \pi_B = 2\lambda$

- Consumer surplus
  \[ CS^I = U_{AA}^I + U_{AB}^I + U_{BB}^I = \lambda \]

- Social welfare
  \[ SW = \pi_A^I + \pi_B^I + CS^I = 5\lambda \]

Compatible Systems

- Systems $X_A Y_B$ and $X_B Y_A$ operate
- Available systems $X_A Y_A$, $X_B Y_B$, $X_A Y_B$ and $X_B Y_A$

- Equilibrium: Each consumer buys his ideal system
  - prices $p_A^I = p_B^I = 2\lambda$
  - quantities: Each firm sells 3 components
  - profits $\pi_A^I = \pi_B^I = 3\lambda$

- Consumer surplus
  \[ CS^C = U_{AA}^C + U_{AB}^C + U_{BB}^C = 0 \]

- Social welfare
  \[ SW = \pi_A^C + \pi_B^C + CS^C = 6\lambda \]

Compatibility vs. Incompatibility

- Consumers are never better off with compatible components than with incompatible components
  - Firms extract a surplus that exceeds the aggregate utility gains from compatibility
• Firms make higher profits with compatible components
  - Consumer AB is willing to pay more
  - Compatibility reduces competition for consumer AB
• Social welfare is higher with compatible components
  - Increase in profits exceeds decrease in consumers’ surplus

Effects of Standardization

Consumers

• Satisfaction from compatibility
• Greater network effects
• Less costs (risk) in buying products that eventually disappear
• Lock-in is less possible

But

• No product variety
• No satisfaction for some (demanding) consumers
• Decreases price competition (reduces utility)
• Bad quality standardization

Producers of complementary products

• Satisfaction from standardization
• Adoption of the standard is necessary for survival
• Potential competition from alternative technologies

Dominant Suppliers

• Standardization to new technologies creates a threat in existing dominant suppliers
• Prohibit backward compatibility to potential competitors
• Upgrade with only advance of compatibility with old products of the same firm
• Cooperation with new technology with the hope of gain large market share due to reputation and brand name

Innovators

• Prefer standardization because it leads to greater market size
• Cooperation for standardization
3 Pricing

3.1 Single price

Single pricing is a simple method, where monopolies use a mark-up on their costs:

- Consumer Surplus
- Loss of social welfare
- Same price for all consumers

Challenges:

- More profits without changing neither the costs of the firm, nor the demand curve
- Classification of the consumers
- New pricing methods

3.2 Price discrimination

Most firms charge different prices to different groups of consumers for what is more or less the same good or service. This is price discrimination and it has become widespread in nearly every market. This note looks at variations of price discrimination and evaluates who gains and who loses. Price discrimination occurs when a firm charges a different price to different groups of consumers for an identical good or service, for reasons not associated with costs.

3.2.1 First Degree Price Discrimination (Perfect price discrimination)

Charging whatever the market will be bear. At the optimal pricing, with perfect price discrimination firms separate the whole market into each individual consumer and charges them the price they are willing and able to pay. At this way, firm succeed to extract all the consumer surplus that lies beneath the demand curve.
Requires:

- Permits a firm to extract all surplus from consumers
- Unit demand for the consumers
- Sequential consumer entry
- Producer knows exactly each consumers reservation price
- Quantity level same at the perfect competition
- No arbitrage

Unlikely in practice

- Arbitrage possible
- Incomplete information about individual preference

Examples:

- Car dealers
- Mechanics
- Lawyers
- Doctors

Post prices well above cost and offer discounts depending on their assessment of consumers’ willingness and ability to pay.

### 3.2.2 Second Degree Price Discrimination (Block Pricing)

This type of price discrimination involves businesses selling off packages of a product deemed to be surplus capacity at lower prices than the previously published/advertised price. There is nearly always some supplementary profit to be made from this strategy. And, it can also be an effective way of securing additional market share within an oligopoly as the main suppliers’ battle for market dominance. Firms may be quite happy to accept a smaller profit margin if it means that they manage to steal an advantage on their rival firms.
Significant factors:

- Different block combinations: \((p_1, q_1), (p_2, q_2), (p_3, q_3), \ldots\)
- Incomplete information about individual preferences
- Introduce blocks due to the market information
- Continuous block improvement
- Consumers are placed in groups by themselves
- The more blocks introduced, the better pricing achieved
- Converts consumer surplus into profit less effectively than first degree
- No arbitrage

Except the quantity block pricing, there are two more pricing methods included at the second degree price discrimination. Early - bird discounts, in which customers booking early, find lower prices. And Off-Peak Pricing, in which there is plenty of spare capacity and marginal costs of production are low at off peak times.

### 3.2.3 Third Degree Price Discrimination

This is the most frequently found form of price discrimination and involves charging different prices for the same product in different segments of the market. The prices charged may bear little or no relation to the cost of production.
Significant factors:

- Different needs of the groups of consumers
- Producer may observe some signal that is related to consumers’ preferences (age, etc.)
- \( P_1 < P_2 \) since group 1 has lower elasticity of demand than group 2
- No information problem (observable characteristics)
- Easy to classify consumers
- Lerner Index \( \frac{(p^m - c)}{p^m} = \frac{1}{\varepsilon} \), two market with \( \varepsilon_1 < \varepsilon_2 < 0 \)
- No arbitrage

Examples of groups:

- Students
- Pensioners
- Unemployed
- Disabled
- Firms

The members of these groups have to show their identity to proof their status.

### 3.2.4 Two part pricing (Non Linear Pricing)

Another pricing policy common to industries with pricing power is to set a two-part tariff for consumers. A fixed fee is charged (often with the justification of it contributed to the fixed costs of supply) and then a supplementary “variable” charge based on the number of units consumed.
Significant factors:

- Set the unit price equal to marginal cost
- \( T = \frac{A}{n} + pq \), where \( A \) = entry fee and \( p \) = Marginal Cost
- Fixed fee for the right to purchase good
- No consumer surplus left

Examples:

- Taxi fares
- Amusement park entrance charges
- Fixed charges set by the utilities (gas, water, electricity, telecommunications)

### 3.3 Choice of Pricing

The flow chart below shows the decisive factors for the followed strategy pricing.
4 Product Differentiation

4.1 Product Differentiation and Competition
How product differentiation affects product market competition?

Claim 1 Product differentiation relaxes intensity of price competition

- Cross elasticity of demand is not infinite at equal prices
- The firms’ mark up increase
- The firms’ profits increase

The strategic decision of the firm to differentiate its products affects the structure of the industry and the equilibrium of the market. Traditional microeconomic theory treats demand and consumption at different dates, at different contingencies and with different characteristics as new commodities. In a loose sense all firms, not excluding monopolists, produce homogeneous and thus the only strategic variable is price.

The main objectives of this section are:

- The types of product differentiation according to consumer’s preference
  - Vertical (quality)
  - Horizontal (location)

- Techniques used by firms in order to resolve differentiation biasness without losing strategic incentive
  - Search goods and advertisement
  - Experience goods and warranties
  - Credence goods and advertising

4.1.1 Monopolistic Competition

- Perfect and symmetric information
- No transportation and search costs
- Free entry and exit
- Large number of firms
- Each firm produces a differentiated product

Monopolistically Competitive Equilibrium

- Suppose $i$ firms that each produce a close, but not, perfect substitute product
- Existence and Quality of all $i$ substitute products are known to consumers
- Demand for substitute product $i$ is $q_i = D_i(p_i)$, which is differentiable and decreasing. Inverse demand $p_i = P_i(q_i)$
- Firm $i$’s cost function is $C(q)$, which is differentiable and increasing
• Single uniform price for each product \( i \) to all consumers
• Firms \( i \)' problem consists of choosing a price-quantity pair that maximizes its profits, i.e.

\[
\max_{p_i \geq 0, q_i \geq 0} p_i q_i - C_i(q_i)
\]

• Similar with monopoly's maximization problem, i.e. the optimal price quantity pair is determined by \( MC = MR \).
• *Lerner index* measures the difference between price and marginal cost

\[
\text{Lerner Index} = \frac{p^m - C'}{p^m}
\]

where \( \varepsilon = \frac{-D'(p^m)p^m}{p^m} \) denotes the demand elasticity.
• Note that the demand used to determine the monopolistically competitive firm's profits is based on the *demand for the individual firm's product*.

**Remarks**

• Since there is free entry and exit, in the long run equilibrium firms earn zero profits
• Hence, the long run monopolistically competitive equilibrium is characterized by \( \pi_i = 0 \) and \( p_i > MC_i \).

**4.1.2 Oligopoly**

• Suppose an oligopoly of 2 firms producing differentiated products
• Demand system (inverse demands)

\[
\begin{align*}
  p_1 &= a - \beta q_1 - \gamma q_2 \\
  p_2 &= a - \beta q_2 - \gamma q_1
\end{align*}
\]

where \( \beta > 0 \) and \( \beta^2 > \gamma^2 \).

• \( \beta^2 > \gamma^2 \) implies that the own price effect dominates the cross price effect, i.e. the effect of increasing \( q_1 \) on \( p_1 \) is larger than the effect of the same increase in \( q_2 \). In other words, \( p_1 \) is more sensitive to \( q_1 \) than to \( q_2 \).
• Measure of differentiation is

\[
\delta \equiv \frac{\gamma^2}{\beta^2}
\]
- if \( \delta \) is close to 0 \((\gamma^2 \to 0)\), then the products are *highly differentiated*, i.e. a change in the price of brand \( j \) will have a small or negligible effect on the demand for product \( i \).
- if \( \delta \) is close to 1 \((\gamma^2 \to \beta^2)\), then the products are *almost homogeneous*, i.e. the cross price effect is close or equal to the own price effect and, thus, a change in the price of brand \( j \) will have strong effects on the demand for product \( i \).

**Cournot Oligopoly**

- **Profit maximization**

  \[
  \max_{q_i} \pi_i(q_1, q_2) = (\alpha - \beta q_i - \gamma q_j)q_i
  \]

  for \( i, j = 1,2 \) and \( i \neq j \).

- **FOC yields the best response functions**

  \[
  q_i = R_i(q_j) = \frac{\alpha - \gamma q_j}{2\beta}
  \]

  for \( i, j = 1,2 \) and \( i \neq j \).

- **Solving the best response functions we get**

  \[
  q_i = \frac{\alpha}{\gamma \rho - \gamma}
  \]

  \[
  p_i = \frac{\alpha \beta}{\gamma \rho + \gamma}
  \]

  \[
  \pi_i = \frac{\alpha^2 \beta}{\gamma \rho^2 + \gamma^2}
  \]

- **As \( \gamma \) increases, i.e. the products become less differentiated, the quantity produced \( q_i \), the price \( p_i \) and the profits \( \pi_i \) decline.**
• In a Cournot game with differentiated products, the profits of firms increase when the products become more differentiated.

Highly Differentiated Products

Almost Homogeneous Products

Completely differentiated product
Bertrand Oligopoly

- The demand system expressed in direct demand functions is

\[
\begin{align*}
q_1 &= a - b p_1 + c p_2 \\
q_2 &= a - b p_2 + c p_1
\end{align*}
\]

where \( a \equiv \frac{\alpha (\beta - \gamma)}{\beta^2 - \gamma^2}, b = \frac{\beta}{\beta^2 - \gamma^2} \) and \( c = \frac{\gamma}{\beta^2 - \gamma^2} \).

- Profit maximization

\[
\max_{p_i} \pi_i (p_1, p_2) = (\alpha - b p_i + c p_j) p_i
\]

for \( i, j = 1, 2 \) and \( i \neq j \).

- FOC yields the best response functions

\[
p_i = R_i(p_j) = \frac{\alpha + c p_j}{2b}
\]

for \( i, j = 1, 2 \) and \( i \neq j \).

- Solving the best response functions we get
\[ p_i = \frac{a}{2b - c} = \frac{\alpha(\beta - \gamma)}{2\beta - \gamma} \]

\[ q_i = \frac{ab}{2b - c} \]

\[ \pi_i = \frac{a^2 b}{(2b - c)^2} = \frac{\alpha^2 \beta(\beta - \gamma)}{(2\beta - \gamma)^2(\beta + \gamma)} \]

- As \( \gamma \) increases, i.e. the products become less differentiated, the price \( p_i \) and the profits \( \pi_i \) decline.
- In a Bertrand game with differentiated products, the profits of firms increase when the products become more differentiated.

Highly Differentiated Products

Almost Homogeneous Products
4.2 Differentiation and Product Selection

- Product differentiation relaxes intensity of price competition
- The supply side takes the form of a two stage process
  - First stage: What product mix to produce
  - Second stage: How to sell the product in the market
- Second stage refers to price competition that arises in the market
- First stage implies that firms compete also on the product space (*Non price competition*)

Price competition and Non price competition
- Price competition → Short run
- Non price competition → Longer run medium

4.2.1 Notion of Product Space

- Defining a product is closely related with defining a market or an industry
- Two goods are almost never perfect substitutes
- Perfect substitution imply that *all* consumers are indifferent between two goods that have the same price
- Goods are almost always differentiated by some characteristic
- A group of products always interacts to some extent with other goods in the economy
- Pricing of goods are outside an industry enters into the demand for the goods in the industry through substitution effects

- How to describe the differentiation between the goods within an industry?
- A good can be described as a bundle of characteristics
  - Quality
  - Location
  - Time
  - Availability
  - Consumers’ information about its existence
  - Consumers’ information about its quality
  - etc
Each consumer has a ranking over the mix of variables

Vertical differentiation

All consumers agree over the most preferred mix of characteristics and, more generally, over the preference ordering, e.g. higher quality is preferable (BMW vs Hyundai, powerful computer vs less powerful computer)

Horizontal differentiation

Each consumer prefers different mix of characteristics and, more generally, has different preference ordering, e.g. location, color etc

4.2.2 Product Choice and Horizontal Differentiation

- Horizontally differentiated product space
- Tastes vary in population, i.e. for some characteristics, the optimal choice depends on the particular consumer
- Alternative interpretations
  - If the characteristic is location, then the problem the firm faces is the choice of their selling points
  - If the characteristic is quality, then the problem the firm faces is the choice of quality of their products
  - If the characteristic is quality and there are more than one firms, then the problem the firm faces is the choice of quality of their products with respect to the qualities offer by its competitors

A simple model of horizontal differentiation

- Linear city of length 1
- Two firms (A and B)
- Differentiation in location
  - Location of firm A is $x = a$
  - Location of firm B is $x = b$
- Consumers are distributed uniformly along the city, i.e. $x \in [0,1]$
- Utility function of a consumer located at $x$
\[ U^x = \begin{cases} 
- p_A - t|x - a| & \text{if he buys from } A \\
- p_B - t|x - (1 - b)| & \text{if he buys from } B 
\end{cases} \]

- Indifferent consumer is located at

\[ \hat{x} = \frac{p_B - p_A}{2t} + \frac{(1 - b + a)}{2} \]

which is the demand function of firm A.

- The demand function of firm B is

\[ 1 - \hat{x} = \frac{p_A - p_B}{2t} + \frac{1 + b - a}{2} \]

- Profit maximization yields

\[ p_A = \frac{t(3 - b + a)}{3} \]

\[ p_A = \frac{t(3 + b - a)}{3} \]

that is equilibrium prices are functions of the firms' location

- If both firms are located at the same point, i.e. meaning that their products are homogenous, then \( p_A = p_A = 0 \) is a unique equilibrium

- Location determines the intensity of price competition

- Linear transportation cost

  - *Principle of minimum differentiation*

  Firms could increase their profits by moving toward the centre of the linear city

  Firms tend to produce similar products

  Their motive is to gain larger market share

- Quadratic transportation cost

  - *Principle of maximum differentiation*

  Firms could increase their profits by moving away from each other

  Firms tend to produce differentiated products

  Their motive is to gain monopoly power in specific niches of the market
• Degree of differentiation depends on consumers’ valuation of the product characteristic
4.3 Quality Choice and Vertical Differentiation

- Vertically differentiated product space
- All consumers agree over the preference ordering
- Alternative interpretations
  - If the characteristic is quality, then the problem the firm faces is the choice of quality of their products
  - If the characteristic is quality and there are more than one firms, then the problem the firm faces is the choice of quality of their products with respect to the qualities offer by its competitors

A simple model of vertical differentiation

- Modified hovelling model
- Linear city of length 1
- Consumers are distributed uniformly along the city, i.e. \( x \in [0,1] \)
- Two firms (A and B)
- Differentiation in location (quality)
  - Location of firm A is \( a \)
  - Location of firm B is \( b \)
  - \( 0 \leq a \leq b \leq 1 \)
  - Ideal brand is located at point 1

- Utility function of a consumer located at \( x \)
  \[
  U^x = \begin{cases} 
  ax - p_A & \text{if he buys from A} \\
  bx - p_B & \text{if he buys from B}
  \end{cases}
  \]

- Indifferent consumer is located at
  \[
  \hat{x} = \frac{p_B - p_A}{b - a}
  \]
  which by assuming that \( a \leq \hat{x} \leq b \), is the demand function of firm A

- The demand function of firm B is
  \[
  1 - \hat{x} = 1 - \frac{p_A - p_B}{b - a}
  \]
• Profit maximization yields

\[ p_A^* = \frac{(b - a)}{3} \]

\[ p_B^* = \frac{2(b - a)}{3} \]

• The firm producing the higher quality brand charges a higher price (even with the same production cost)

• The equilibrium profits are

\[ \pi_A^* = \frac{(b - a)}{9} \]

\[ \pi_B^* = \frac{4(b - a)}{9} \]

• Firms’ profits increase as quality differentiation increases

• With differentiation firms increase their market power in their targeted consumer group
4.4 Quality and Information

Classification of goods

- **Search good**
  - Quality can be ascertained by consumers before a purchase (e.g. clothes, books)
  - Main issue is product selection (quality, product diversity etc)
  - Advertising

- **Experience good**
  - Quality is learned after the good is bought (e.g. wine, canned food, restaurant)
  - Main issue is information. How consumers learn the quality? What incentives do firms have to supply it?
  - Warranties

- **Credence good**
  - Some aspects of quality are rarely learned even after consumption (e.g. fluoride in a toothpaste, prescription drugs)
  - Main issue is information. But a more severe informational problem than experience good
  - Government regulation

- Note however that most goods cannot be classified in this simple manner because they possess attributes that are learned before purchase, after purchase, or never.

4.4.1 Lemon's Market

- Used car market
- Number of sellers > Number of buyers
- High quality and low quality cars
- Proportion $\lambda$ are lemons
- Asymmetric Information
  - Seller know the quality, but buyers don't
- A good (peach) is valued at $H_s$ by the seller and at $H_B$ by buyers
- A lemon is valued at $L_s$ by the seller and $L_B$ by buyers
- Sellers want to sell

$$p \geq H_s \text{ and } p \geq L_s$$

that is, they ask for a price greater than their valuations (note that $H_s > L_s$)
• Buyers’ expected quality is

$$\lambda L_B + (1 - \lambda) H_B$$

• Hence, buyers are willing to buy iff

$$p \leq \lambda L_B + (1 - \lambda) H_B$$

• Lemons are sold when

$$H_S \leq p \leq \lambda L_B + (1 - \lambda) H_B$$

that is a necessary condition for both types of car to be traded is

$$\lambda \geq \frac{H_S - L_B}{H_B - L_B}$$

• Importantly, if

$$H_S \geq \lambda L_B + (1 - \lambda) H_B$$

that is, if

$$\lambda < \frac{H_S - L_B}{H_B - L_B}$$

good cars are not sold.

• Then, only lemons are traded in the market and the price of a used (lemon) car is

$$L_B \leq p \leq L_S$$
Complete market failure example

- Quality $Q$ of used cars is uniformly distributed on $[0,1]$, i.e. continuum quality case
- The value of the car is $Q_S = Q$ to a seller
- The value $Q_B = \beta Q$ to a buyer, where $1 < \beta < 2$
- At a price $p$ the cars offered on the market will be those with

\[ Q \leq p \]

- The average quality is

\[ \frac{p}{2} \]

- The expected value to the buyer is

\[ \beta \frac{p}{2} \]

- But then

\[ \beta \frac{p}{2} < p \]

- Hence, the market breaks down completely.

4.4.2 Quality Signaling

- Signaling: Choose a specific strategy that signals to consumers the product's quality
- Examples of signaling strategies
  - A firm can signal the quality it sells by choosing a certain price and by imposing a quantity restriction on the brand it sells
  - A firm can signal the quality it sells by offering warranties on the brand it sells
  - A firm can signal the quality it sells through his choice of advertising
A signaling example

- Warranties as signals of quality in the used car market example
- Suppose that sellers can offer a warranty at a cost. That is, cost of warranties is

\[ c_L \text{ for low quality cars} \]
\[ c_H \text{ for high quality cars} \]

and that

\[ c_L > c_H \]

- Then, the seller of a high quality car, by offering warranty at cost \( c_H \), can set a price \( p = H_B \)
- If

\[ H_B - L_S - c_H \leq L_B - L_S - c_S \]

which implies that

\[ c_H - c_L \geq H_B - L_B \]

the seller of a low quality car has no incentive to imitate the seller of a high quality

- Hence, the seller of a low quality car offers a warranty at cost \( c_L \) and sets a price \( p = H_B \).
- In fact, in this simple example the best the low quality seller can do is to offer no warranty (\( c_L = 0 \)).
5 Advertising

5.1 Introduction

- Advertising provides information
- Sale of a joint product at a single price: Physical product and information
- Advertising is a parameter that shifts the demand curve

Group of Products

- Search goods
  - Consumers identify product characteristics before the actual purchase
  - Consumers do not depend on information obtained from manufacturers
- Experience goods
  - Consumers identify product characteristics after the actual purchase
  - Consumers do depend on information obtained from manufacturers
- Credence goods cannot be assessed

Nature of Advertising

- Informative advertising → Improves welfare
  - Inform consumers about existence, price, location, quality and other product characteristics
  - Enable consumers to make rational choices
  - Reduces consumers’ search costs
  - Reduces product differentiation associated with lack of information
  - Facilitates entry of new firms
  - Fosters competition
  - Encourages production of high quality products

- Persuasive advertising → Reduces welfare
  - Enhance consumers tastes for a certain product
  - Persuade and fool consumers
  - Creates not real differentiation
  - Increases barriers to entry Reduces product competition
  - Reduces product competition
  - Changes consumers’ perceptions
5.2 Optimal Advertising Expenditure Level

5.2.1 Monopoly

- Advertising A at a unit price \( p^A \)
- Demand \( Q(p, A) \) with \( Q_p(p, A) < 0 \) and \( Q_A(p, A) > 0 \)
- Monopoly’s profit maximization problem
  \[
  \max_{p^A} \pi = (p - c)Q(p, A) - F - p^A A
  \]

- FOC for price is
  \[
  \frac{p^* - c}{p^*} = \frac{1}{\eta_p} \quad \text{(Lerner Index)}
  \]

  where \( \eta_p = \frac{\partial Q(p, A)}{\partial p} \frac{p}{Q} \) is the price elasticity of demand.

- FOC for advertising is
  \[
  \frac{p^A A^*}{p^* Q} = \frac{p^* - c}{p^*} \eta_A
  \]

  where \( \eta_A = \frac{\partial Q(p, A)}{\partial A} \frac{A}{Q} \) is the elasticity of demand with respect to advertising.

- **Dorfman Steiner Condition**
  - The advertising - sales revenue ratio should equal the ratio of advertising elasticity to price elasticity of demand.
  \[
  \frac{p^A A^*}{p^* Q} = \frac{\eta_A}{\eta_p}
  \]
  - The advertising - sales revenue ratio should equal the elasticity of price with respect to advertising.
  \[
  \frac{p^A A^*}{p^* Q} = \eta_{pA}
  \]

  where \( \eta_{pA} = \frac{\partial p}{\partial A} \frac{A}{p} \).
- A depends on \( \frac{p^*-c}{p^*} \), i.e. advertising is associated with imperfectly competitive markets.
- \( \uparrow \frac{p^*-c}{p^*} \Rightarrow \uparrow A \), i.e. the greater the profit associated with an extra unit of output, the more the firm is willing to spend on advertising to induce consumers to buy an extra unit of output.
- \( \uparrow \eta_A \Rightarrow \uparrow A \), a firm spends more on advertising per unit of sales revenue, the greater the effect of advertising on sales.

5.2.2 Oligopoly

- Two firms, \( i = 1,2 \)
- Advertising \( A_i \) at a unit price \( p^A \)
- Firm’s \( i \) demand \( q_i(p, A_i, A_j) \)
- Firm’s \( i \) choice of advertising level
  \[
  \max_{A_i} \pi_i = (p - c)q_i(p, A_i, A_j) - F - p^AA_i
  \]
- FOC is
  \[
  \frac{p^A A_i^*}{pq_i} = \frac{p - c}{p} \left[ \eta_{q_iA_i} + \eta_{q_iA_j} \eta_{A_jA_i} \right]
  \]
  - where \( \eta_{q_iA_i} = \frac{\partial q_i(p, A_i, A_j)}{\partial A_i} \frac{A_i}{q_i} \) is the elasticity of firm’s \( i \) demand with respect to firm’s \( i \) advertising
  - \( \eta_{q_iA_j} = \frac{\partial q_i(p, A_i, A_j)}{\partial A_j} \frac{A_j}{q_i} \) is the elasticity of firm’s \( i \) demand with respect to firm’s \( j \) advertising and
  - \( \eta_{A_jA_i} = \frac{dA_j}{dA_i A_j} \) is the elasticity of firm’s \( j \) advertising with respect to firm’s \( i \) advertising

- **Dorfman Steiner Condition**
  \[
  \frac{p^A A_i^*}{pq_i} = \frac{p - c}{p} \left[ \eta_{q_iA_i} + \eta_{q_iA_j} \eta_{A_jA_i} \right]
  \]
- The optimal advertising - sales revenue rate depends on the effect of advertising:
  - i) on consumers’ behavior ($\eta_{q_iA_i}$) and
  - ii) on rival’s behavior ($\eta_{q_iA_j}\eta_{q_jA_t}$)
5.3 Advertising and Quality

- Information about the quality of goods is difficult to acquire than information about prices, location etc.
- Advertising a search good
  - Honest
  - Lies will be detected immediately
  - No purchase of the good
  - Hurts firm's reputation
  - Informative advertising

- Advertising an experience good
  - Honesty is not necessary
  - Firm’s may gain from false advertising
  - Persuade consumers buy their products
  - Hurts firm's reputation
  - Short run profits
  - Persuasive advertising

Milgrom and Roberts (1986)

- Advertising of a new experience good
- Firms
  - Product quality: High (H) or Low (L)
  - Price \( p \)
  - Advertising \( A \) at a price \( p^A \)
  - Choose price-advertising combination \( (p, A) \)

- Consumers
  - Find out the quality of the product after the purchase
  - Observing \( (p, A) \) conclude that product is \( H \) or \( L \)
  - Pay more for a product they believe to be of high quality

- Firm's payoff
  - \( \pi(p, H, H) - p^A A \) is maximized at \( p_{HH} \)
  - \( \pi(p, L, H) - p^A A \) is maximized at \( p_{LH} \)
  - \( \pi(p, H, L) \) is maximized at \( p_{HL} \)

Separating Equilibrium

- An equilibrium where different firms find optimal to separate themselves
- A firm producing high quality products is willing to advertise iff there exist \( (p, A) \) such that
\[ \pi(p, H, H) - p^A A \geq \pi(p_{HL}, H, L) \] (1)

- A firm producing low quality products is not willing to imitate a firm producing high quality products iff there exist \((p, A)\) such that
  \[ \pi(p_{LL}, L, L) \geq \pi(p, L, H) - p^A A \] (2)

- Any combination \((p, A)\) that satisfies (1) and (2) is a candidate for separating equilibrium. In fact,
  \[ \pi(p, H, H) - \pi(p_{HL}, H, L) \geq p^A A \geq \pi(p, L, H) - \pi(p_{LL}, L, L) \]

- Firm producing high quality
  \[ \max_{p, A \geq 0} \pi(p, H, H) - p^A A \]
  such that \(\pi(p_{LL}, L, L) \geq \pi(p, L, H) - p^A A\)

- A solution with \(A = 0\). If \(A > 0\) then the separating equilibrium occurs where the constraint holds with equality
- Firm’s problem specifies to
  \[ \max_{p \geq 0} \pi(p, H, H) - \pi(p, L, H) + \pi(p_{LL}, L, L) \]
  with FOC
  \[ \frac{\partial \pi(p, H, H)}{\partial p} = \frac{\partial \pi(p, L, H)}{\partial p} \]
  i.e. equilibrium occurs where the two isoprofits curves are tangent

- Separating equilibrium: \((p_H, A_H)\) for the firm producing high quality products and \((p_{LH}, 0)\) for the firm producing low quality products
5.4 Advertising and Concentration

5.4.1 Exogenous Sunk Costs

- Homogeneous good industry
- Setup cost of acquiring a single plant of minimum efficient scale
- Sunk cost, i.e. it plays no role in firm's day to day pricing policy
- Setup costs influence prices indirectly by the number of firms enter the industry

Timing
- Stage 1: Entry decisions (sunk cost $\sigma$)
- Stage 2: Price competition

Cournot Case

- $N$ firms
- Demand $X = \frac{S}{p}$, where $S$ is market size
- Assume that if $p > p_0$ then $X = 0$, where $p_0$ is the monopoly price
- Stage 2
- Firm $i$'s profit function in stage 2
  $$\pi = p_i(\sum x_i)x_i - c x_i$$
- Symmetric equilibrium ($x_i = x$ for all $i$)
  $$x = \frac{S N - 1}{c N^2}$$
  $$p = c(1 + \frac{1}{N - 1})$$
- Equilibrium profits
  $$\pi = (p - c)x = \frac{S}{N^2}$$

Stage 1
- Firm $i$ incurs a sunk cost $\sigma$. Entry iff
  $$\frac{S}{N^2} - \sigma \geq 0$$
- Equilibrium number of firms

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Higher \( \frac{S}{\sigma} \), i.e. an increase in the size of the market relative to the level of setup costs, leads to a more fragmented industry

**Bertrand Case**

- If \( N > 1 \) enter the industry, then competition at stage 2 implies \( p = c \) and \( \pi = 0 \)
- For any \( \sigma > 0 \) only one firm enters and sets the monopoly price \( p_0 \)
- Equilibrium number of firms
  \[
  N^* = 1
  \]

**Joint Profit Maximization**

- Firms maximize joint profits in the 2nd stage
- Set monopoly price \( p_0 \) and split the monopoly profits \( \pi_0 \)
- Entry iff
  \[
  \frac{\pi_0}{N} - \sigma \geq 0
  \]
- Equilibrium number of firms
  \[
  N^* = \frac{\pi_0}{\sigma}
  \]

**Main Results**

- Fundamental trade off between tough price competition and equilibrium concentration levels
- The tougher the competition, the more concentrated the industry
- Concentration decreases in market size
where $P(N)$ → Function of price competition

Relation between the market size and the concentration level as measured by $1/N$

### 5.4.2 Endogenous Sunk Costs

- **Advertising**
- Enhance consumers' willingness to pay for a specific firm's product(s)
- $u$ is the perceived quality of product
- $A(u)$ relates endogenous element of sunk cost to $u$
- Consumer utility

$$U = (ux)\delta z^{1-\delta}$$
where $z$ is an outside good

- **Timing**
  - Stage 1: $N$ firms enter, sunk cost $\sigma$
  - Stage 2: Firms choose $u$ at cost $A(u)$
  - Stage 3: Price competition

- Firm $i$ offer $u_i$ and $p_i$
- Consumer chooses product that maximizes the quality-price ratio $\frac{u_i}{p_i}$

**Stage 3: Price competition**

- Equilibrium prices of all firms enjoying positive sales must be proportionate to their perceived qualities, i.e.
  
  \[
  \frac{u_i}{p_i} = \frac{u_j}{p_j}
  \]

- If all firms offer same $\bar{u}$, then
  
  \[
  pQ = S \iff p = \frac{S}{Q}
  \]
  
  where $Q$ is industry output

- Deviant firm offers $\bar{u}$. Then, in equilibrium
  
  \[
  \frac{u}{p} = \frac{\bar{u}}{\bar{p}} \iff p = \frac{u}{\bar{p}}\bar{p}
  \]

  and

  \[
  S = \bar{p}\bar{Q} + pq \iff \bar{p} = \frac{S}{\bar{Q} + (u/\bar{u})q}
  \]

  where $\bar{Q}$ is the combined output of all no deviant firms and $q$ is the output of the deviant firm

- Equilibrium profits
  
  \[
  \pi(u/\bar{u}) = S \left[ 1 - \frac{1}{N - 1 + \frac{u}{\bar{u}}} \right]^2
  \]

  and for $u = \bar{u}$
\[ \pi = \frac{S}{N^2} \]

**Stage 2: Equilibrium Advertising Levels**

- Total sunk cost is \( F(u) = \sigma + A(u) \)
- Firm's payoff is
  \[
  \max_u \left[ \pi(u / \bar{u}) - F(u) \right]
  \]
- No advertising if
  \[
  \frac{d\pi}{du}_{u=\bar{u}=1} \leq \frac{dF}{du}_{u=1}
  \]
  that is, all firms offer a common level of perceived quality \( \bar{u} = 1 \) at equilibrium
- If the above condition fails then firms advertise their products and offer a common level of perceived quality \( \bar{u} > 1 \), where \( \bar{u} \) is determined by
  \[
  \frac{d\pi}{du}_{u=\bar{u}} = \frac{dF}{du}_{u=\bar{u}}
  \]

**Stage 1: Entry**

- Equilibrium \( N^* \) is the largest integer satisfying
  \[
  \frac{S}{N^2} - F^* \geq 0
  \]
- Substituting equilibrium level of advertising obtained in stage 2 we can define a locus in \( (N, F) \) space
- Equilibrium number of firms is described by the intersection of this locus with the zero profit condition \( F = \frac{S}{N^2} \)

**Main Results**

- Small \( S \): no advertising
- High \( S \): increasing \( S \) increases advertising
- Failure of convergence: Increases in market size do not lead to a fall in the level of concentration
5.5 Targeted Advertising

- Informative vs. persuasive advertising
- Heterogeneous consumers with different preferences rankings
- Target advertising to a specific group of consumers
  - Impossible to have products’ attributes that are highly valued by all consumers
  - Reduce cost of advertising
  - Differentiate product

The Model

- Two firms $i = 1, 2$ producing differentiated brands
  - Choose advertising strategy $s^i \in S = \{P, I\}$
    - P persuasive advertising
    - I informative advertising

- Two types of consumers
  - N inexperienced consumers
  - E experienced consumers
    $\theta \in (0, 1)$ brand 1 oriented experienced consumers
    $(1 - \theta)$ brand 2 oriented experienced consumers

Assumption

- Persuasive advertising attracts only inexperienced consumers
  - If $s^1 = P$ and $s^2 \neq P$ then $\pi^i = N$
  - If $s^1 = P$ and $s^2 = P$ then $\pi^i = \frac{N}{2}$

- Informative advertising attracts only experienced consumers who are oriented toward the advertised brand
  - If $s^1 = I$ then $\pi^1 = \theta E$
  - If $s^2 = I$ then $\pi^2 = (1 - \theta) E$

Equilibrium

1. If $N > E$ then $(P, P)$ is a unique equilibrium if $1 - \frac{N}{2E} < \theta < \frac{N}{E}$
2. If \( E > 2N \) then \( \langle I, I \rangle \) is a unique equilibrium if \( \frac{N}{E} < \theta < 1 - \frac{N}{2E} \).

3. If brand 1 is unpopular among experienced users then \( \langle P, I \rangle \) is an equilibrium if \( \theta < \min \left\{ \frac{N}{E}, 1 - \frac{N}{2E} \right\} \).

4. If brand 1 is sufficiently popular among experienced users then \( \langle I, P \rangle \) is an equilibrium if \( \theta > \max \left\{ \frac{N}{2E}, 1 - \frac{N}{E} \right\} \).
5.6 Comparison Advertising

- Advertising in which the advertised brand and its characteristics are compared with those of the competing brands

- Effects of Comparison Advertising
  - Increases consumers' responsibility to compare
  - Decreases consumers' costs of evaluating products
  - Induces producers to improve product quality
  - Confuses consumers because comparisons lack objectivity

- Comparison advertising is closely monitored and regulated by government agencies

Strategic Use of Comparison Advertising

- Two firms \( i = 1,2 \) producing differentiated brands
  - Choose advertising strategy \( s^i \in S = \{A, C\} \)
    - A non-comparative advertising
    - C comparison advertising

- Two types of consumers
  - \( N \) inexperienced consumers
  - \( E \) experienced consumers
    - \( \theta \in (0,1) \) brand 1 oriented experienced consumers
    - \( (1 - \theta) \) brand 2 oriented experienced consumers

Assumption

- Plain (non-comparative) advertising attracts only inexperienced consumers
- Comparison advertising attracts only experienced consumers who are oriented toward the advertised brand

Equilibrium

1. If \( E > 2N \) then \( \langle C, C \rangle \) is a unique equilibrium
2. If \( E < N \) then \( \langle A, A \rangle \) is a unique equilibrium
3. If brand 1 is sufficiently popular among experienced users then \( \langle C, A \rangle \) is an equilibrium.
6 Entry and Potential Competition

- Potential competition is a mechanism to control the exploitation of market power
- Entry and the threat of entry is the main source of potential competition

6.1 Introduction

Entry Conditions and Behavior of Incumbent Firms

- Free entry: Market conditions make entry easy and possible. Positive profits imply that entry will occur until competition brings down the price so that existing firms will no longer make above normal profits.
- Blockaded entry: Market conditions that are not controlled by the incumbent firms and make entry impossible. The market is not attractive to entrants (no threat of entry) and the incumbent firms behave normally.
- Deterred entry: The incumbent firm modifies its behavior in order to deter entry, i.e. entry deterrence corresponds to strategic actions taken by an incumbent firm when facing a threat of entry.
- Accommodated entry: Entry occurs and the incumbent firms modify their behavior to take into account the new entrant.

6.2 Entry Barriers

A barrier to entry is anything that allows incumbent firms to earn supranormal profits, i.e. to persistently raise prices above competitive level, without threat of entry (Bain, 1956). Competitiveness and performance of an industry are strongly influenced by its entry conditions. Entry barriers significantly reduce potential competition.

Barriers to entry can be divided into two types:

- Natural or exogenous barriers, which reflect the structural conditions of the relevant industry and are normally regarded as beyond the control of the existing firms.
- Artificial or endogenous barriers, are created by the incumbent deliberately to keep potential entrants out or at least retard the rate of entry, i.e. they reflect the strategies that allow firms to erect barriers.

Elements of market structure that affect entry:

- Legal barriers, which are the most effective of all barriers as they are erected by government action and have the backing of the law to enforce potential exclusion.
  - Licensing and certification requirements
  - Patents
  - Monopoly rights granted by legislation
• **Economies of scale**: The market can sustain only a small number of firms that make supranormal profits without inviting entry.
  - Fixed cost

• **Absolute cost advantages**
  - Established firms may own superior production techniques
  - Experience
  - Patented innovations
  - Foreclosed crucial inputs through contracts with suppliers

• **Product differentiation advantage**
  - Patented product
  - Innovations
  - Consumer loyalty
  - Best niches in the product space

• **Capital requirements**: Entrants may have trouble finding financing for their investments because of the risk to the creditors.

• **Geographical barriers**: Restrictions faced by foreign companies attempting to enter a domestic market.

• **Long-term contracts as entry barriers**: The incumbent can preclude entry by signing customers to long-term contracts that can only be broken with penalty.

• **Politicians**

6.3 Contestable Markets

*Baumol, Panzar & Willig (1982)*: One or a limited number of firms in the market does not mean that there is no competition. Potential competition (the threat of entry) may serve to discipline established firms.

**Basic Setup**

- Homogeneous good industry
- Demand \( q = D(p) \)
- \( n \) firms with identical technology \( C(q) \)
- \( m \) incumbents firms and \( n - m > 0 \) potential entrants
- Entry does not require any sunk cost
- Sunk Costs: Costs that cannot be reversed or for which the investment cannot be converted to other causes or resold in order to recapture part of them
- Fixed Costs: Costs that a firm must incur in order to produce, which are independent of the number of units of output
Market imperfections imply that fixed costs are sunk to some extent.
- Fixed costs are sunk only in the short run.

**Perfectly competitive market**

- An industry configuration is the pair \( (\{q_i, \ldots, q_m\}, p) \).
- The industry configuration is *feasible* if the market clears, i.e.
  \[ \exists p, q_1, \ldots, q_m \left( \sum_{i=1}^{m} q_i = D(p) \text{ and } pq_i \geq C(q_i) \right) \]
- The industry configuration is *sustainable* if no entrant can make profit taking the incumbents’ price as given, i.e.
  \[ \forall p^e, q^e \left( p^e \leq p, q^e \leq D(p^e) \text{ and } p^e q^e > C(q^e) \right) \]

- A *perfectly contestable market* is one in which any feasible industry configuration is sustainable. In a perfectly contestable market no new firm can choose lower prices and operate profitably by serving all or part of demand at the new prices.

**Remarks**

- Contestability is not a description of firm behavior but it is rather a statement about the properties of equilibria in a certain kind of market.
- An important condition for a perfectly contestable market is the absence of sunk costs. If sunk costs are modest, the contestability property of market equilibrium depends on the responsiveness of prices on entry. Stiglitz (1987) shows that the existence of even small costs can serve as an entry barrier so that entry will not occur even if the incumbent continues to make monopoly profit.

### 6.4 Strategic Entry Deterrence

Artificial or endogenous barriers are created by the incumbents deliberately to keep potential entrants out of the market. That is, established firms may adopt specific strategies to deter entry in order to reduce potential competition, discourage potential entrants from entering and protect their monopoly rights and profits. These strategies fall into three categories: preemptive strategies, signaling strategies and predatory strategies.

**Preemption**

An incumbent firm has a dominant position either because it arrived first in a natural monopoly or, more generally, because of early investments in research and product design or durable equipment and other cost reduction. The objective of adopting a preemptive strategy is to claim and preserve this monopoly position. The key for the success of the strategy is commitment.

**Signaling**

The objective of this strategy is to reliable convey information that discourages unprofitable entry or survival of competitors. The key for the
success of the signaling strategy is *credible communication*.

- **Predation**
  An incumbent firm profits from battling a current entrant to deter subsequent potential entrants. A predatory strategy (e.g. a price war) advertises that later entrants might also meet aggressive responses. The cost of the predatory strategy (price war) is an investment whose payoff is intimidation of subsequent entrants. The key for the success is *reputation*.

### 6.4.1 Preemption

*Classic Limit pricing model* (Bain, 1956; Sylos-Labini, 1962)

Under some circumstances, incumbent firms may sustain a price so low that it discourages entry

- High quantity and low price
- In the event of the entry, a Leader Follower will be played
- The prospective entrant was assumed to believe that the established firm would maintain the same output after entry that it did before entry (Bain – Sylos Postulate)
- Charging a low price is sufficient for deterring entry

*Spence (1977)* Bell JE

- Distinguishes between capacity and quantity produced
- With no entry, capacity is underutilized
- Threat of entry, the incumbent can expand its output level and use all the capacity, thereby reducing the price to the level that makes entry unprofitable

*Dixit (1980)* EJ

- Bain-Sylos Postulate is inconsistent with strategic behavior
- After entry, the incumbent will not find profitable to utilize its entire capacity
- In the event of entry, Cournot or Bertand will be played
- Given that the entrant knows the post entry market structure, all the entry deterrence strategies are irrelevant to post entry profits
- SPNE implies that the incumbent will not invest in excess capacity for the purpose of entry deterrence
- Over accumulation of capacity will not occur

*Gelraan & Salop (1983)* The entrant invests in limited capacity. The incumbent accommodates entry.
Two stage game
1st stage: Entrant chooses: i) entry or not, ii) capacity $k$, iii) price $p_E$
2nd stage: Incumbent chooses its price $p_I$
Homogeneous good
Demand $p = 100 - Q$
Consumers prefer the less expensive brand
Consumers prefer incumbent's brand at equal prices
Incumbent's demand
$$q^I = \begin{cases} 100 - p^I & \text{if } p^I \leq p_E \\ 100 - k - p^I & \text{if } p^I > p_E \end{cases}$$
Entrant's demand
$$q^E = \begin{cases} k & \text{if } p_E < p^I \\ 0 & \text{if } p_E \geq p^I \end{cases}$$
Given $p^E$, the incumbent chooses: $p^I = p^E$ for entry deterrence or $p^I < p^E$ for entry accommodation
Incumbent's profits
$$\pi_D^I = p^E (100 - p^E) \text{ if entry deterrence}$$
$$\pi_A^I = p^I (100 - k - p^I) \text{ if entry accommodation}$$
Entrant chooses $k$ and $p^E$, such that $\pi_A^I \geq \pi_D^I$
There exist a sufficiently limited capacity level $k$ and a price $p^E$ such that the incumbent will find it profitable to accommodate entry.

6.4.2 Signaling
Milgrom & Roberts (1982)
Limit pricing as a cost signaling device to the potential entrant
- Two periods $t = 1, 2$
- Firm 1 (the incumbent) and firm 2 (the potential entrant)
- Market Demand $p = 10 - Q$
- Firm 2: production cost $c_2 = 1$ & entry cost $F_2 = 9$
- Firm 1’s cost $c_1 \in \{0, 4\}$ is private information $\text{prob } [c_1 = 0] = 0.5$ and $\text{prob } [c_1 = 4] = 0.5$ is common knowledge
- Timing
  - $t = 1$
  - Firm 1 (the incumbent) chooses $q_1^I$
- $t = 2$
  Firm 2 decides whether (or not) to enter. If entry occurs, then both firms play the Cournot game. If entry does not occur, then firm 1 produces the monopoly output $q_1^M$.

- **The equilibrium**
  - $t = 1$
    Firm 1 chooses $q_1^1$ makes profits $\pi_1^1 (c_1, q_1^1)$
  - $t = 2$
    Firm 2 entry decision depends on: i) observed $q_1^1$ and ii) estimated cost structure of firm 1.

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<thead>
<tr>
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<tbody>
<tr>
<td>Low</td>
<td>$\pi_1^C = 13, \pi_2^C = -1.9$</td>
<td>$\pi_1^M = 25, \pi_2 = 0$</td>
</tr>
<tr>
<td>High</td>
<td>$\pi_1^C = 1, \pi_2^C = 7$</td>
<td>$\pi_1^M = 9, \pi_2 = 0$</td>
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- Suppose $c_1 = 0$
  - If Firm 2 knew that $c_1 = 0$, it would not enter $\pi_2^C < 0$.
  - Firm 1 reveals its cost by producing $q_1^1 = 5.83$. Entry will not occur in $t = 2$.
  - Low cost incumbent gains by producing $q_1^1 = 5.83$ and deterring entry
    \[ \pi_1^M + \pi_1^C = 38 < 49.31 = \pi_1^L(5.83) + \pi_1^M \]
  - High cost incumbent would not produce $q_1^1 = 5.83$ since:
    \[ \pi_1^H(5.83) + \pi_1^M = 9.99 < 10 = \pi_1^M + \pi_1^C \]

- Suppose $c_1 = 4$
  - If Firm 2 has no further knowledge it would enter since
    \[ E\pi_2^C = \frac{1}{2} \pi_2^C + \frac{1}{2} \pi_2^H = \frac{1}{2} (-1.9) + \frac{1}{2} 7 > 0 \]
  - Then a firm 1 with $c_1 = 4$ chooses the $q_1^M$

- The limit pricing signaling equilibrium
  - **Firm 1** \[ \begin{cases} 
  \text{if } c_1 = 0 \text{ produce } q_1^1 = 5.83 \text{ and } q_1^2 = q_1^M \\
  \text{if } c_1 = 4 \text{ produce } q_1^1 = q_1^M \text{ and } q_1^2 = q_1^C 
  \end{cases} \]
6.4.3 Predation

Predatory Pricing is a strategy of pricing below marginal cost to drive competitors out of business and then rising price to enjoy the higher profits resulting from lessened competition. The incumbent has to trade-off between current and future profits. For a successful predation, the incumbent must convince the entrant that the market after the new entrance will not be a profitable one. The ultimate goal is to lessen competition by eliminating existing competitors.

One possible mechanism for the incumbent is to install capacity in advance of production:

- Installed capacity is a commitment to a minimum level of output
- The lead firm can manipulate entrants through capacity choice
- The lead firm may be able to deter entry through its capacity choice

However, capacity must be costly to install and should be irreversible.

In the case of predatory pricing, price discrimination as a strategic tool, also permits a firm to “target” price cuts to choose consumers or markets that they will inflict the most damage to the rival.

Potential Problems

- Counter strategies:
  - Stop production
  - Purchase from the predator at the reduced price and stockpile until predator pricing is over.

- Upfront Losses incurred to drive out rivals may exceed the present value of future monopoly profits.

- Predator must have deeper pockets than prey.

6.5 Conclusion

Let’s conclude some characteristics of market’s performance:

- Threat of entry affects market behavior of incumbent firms
- Market contestability leads to efficient pricing and normal (zero) profits, i.e. replicates a perfectly competitive market
- In the absence of actual competition, potential competition is very effective in disciplining the incumbent firms, i.e. potential competition is as effective as actual competition in controlling market performance.
The strategies that may enhance profits, are:

- Limit pricing
- Predatory Pricing
- Raising rivals' costs
- Exercising first or second mover advantage
- Penetration pricing

Each player has to deal with them, because they are not always the best ones. In addition, a lot of care must be taken when using one of the above strategies.
7 Research and Development

7.1 Introduction

- Joseph Schumpeter, Capitalism, Socialism and Democracy (1943)

*Importance of dynamic rather than static competition*

- Stages of competition
  - Short term: Price
  - Medium term: Product variety, capacity, cost
  - Long term: Research and Development, Technology

- Static Competition
  - Price competition
  - Quality competition and sales effort
  - Rigid pattern of conditions (production method, organization form etc.)
  - Margins of profits and outputs

- Dynamic Competition
  - Competition for the new commodity, the new technology, the new source of supply, the new type of organization
  - Foundations of firms
  - Cost or quality advantage

- Why are R&D expenditures higher in some industries than in others?
- Does industry structure have a significant effect on the extent to which firms engage in R&D?
- What is the impact of R&D competition on market structure?
- Is large size a prerequisite for innovation?
- Is market power a prerequisite for innovation?
- Should society disapprove of static market power if it encourages innovation?
- Should society grant a legal monopoly (a patent) to the successful innovator? If so, on what terms?
7.2 R&D and Market Failures

7.2.1 Market Failure

- Imperfect competition
  - Upstream market: knowledge development
  - Public good
  - Downstream market: product development
  - Private good

- Knowledge is a public good
  - Benefit appropriation is difficult
  - Unpriced externalities

- Uncertainty
  - Finance

- No firm enters in the upstream market due to inability of benefit appropriation

7.2.2 The Role of Technological Policy

- Problem correction mechanism (Technological Policy)
- State R&D and free licensing
  - Competitive downstream market
  - Unclear incentives for R&D
- Perfect patenting without licensing
  - Vertical integration of all firms
  - Competitive upstream and downstream market
  - Is perfect patenting possible?
  - Unnecessary costs
- Patenting and licensing
  - Vertical integration of some firms
  - Some competition in upstream and downstream market

- Competition intensity in R&D depends on the problem correction mechanism

7.2.3 Social and Private Incentives for R&D

- Assume a solution to benefit appropriation problem (patent and licensing system)
- Social benefit of innovation

\[ \Delta W = \Delta II + \Delta CS \]

- Increase in industry profits
Spillover \rightarrow \Delta \Pi = \Delta \Pi_i + \Delta \Pi_{-i} + \Delta \Pi^S_{-i}

where \( \Delta \Pi_i > 0, \Delta \Pi_{-i} < 0 \) and \( \Delta \Pi^S_{-i} > 0 \)

- Social incentive depends on \( \Delta \Pi_i, \Delta \Pi^S_{-i}, \Delta CS \) and \( \Delta \Pi_{-i} \)
- Private incentive depends on \( \Delta \Pi_i \)
  - \( \Delta CS \) matters only when perfectly discriminatory pricing is possible
  - \( \Delta \Pi^S_{-i} \) matters only when internalization of externalities is possible
- Social and Private incentives are different
- Unclear whether firms overinvest or under invest in R&D (compared with the socially efficient investment level)
7.3 Competition vs. Monopoly
Market structure and R&D

7.3.1 Schumpeterian View (1943)
- Established firms are responsible for technological progress
- But Schumpeter (1934): New firms are most often the vehicle of innovation
- Schumpeterian view: Monopoly situations and R&D are intimately related
  - Monopolies are natural breeding grounds for R&D
  - If one wants to induce firms to undertake R&D one must accept the
    creation of monopolies as a necessary evil

7.3.2 The Arrow Model (1962)
- Suppose an industry that is either a Monopoly or Perfectly Competitive
- Objective: Determine the maximum expenditure in R&D in this two cases
- Maximum expenditure in R&D reflects the firm's incentive for innovation
- Process innovation R&D (cost reduction from $c$ to $c'$, $c' < c$)
- Innovation is protected by a patent of unlimited duration
- Drastic innovation when $p'_m < c$ and non drastic when $p'_m > c$, where $p'_m$ is the monopoly price with the new technology

1. Social Planner
- price equals marginal cost
- Incentive for innovation is the incremental net social surplus attributable to the innovation

2. Monopoly Case
- No entry
- Incentive for innovation is $I_M = \Pi'_m = \Pi_m$

3. Perfect Competition
- Drastic innovation $p'_m \leq c$
  - Innovating firm undercuts its rivals by charging monopoly price $p'_m$
  - Quantity increases to $q'_m$
  - Less efficient firms produce nothing
  - Incentive for innovation is $I_C = \Pi'_m = (p'_m - c')q'_m$
- \( I_m < I_c \)

\[
\begin{align*}
\text{Non drastic innovation } p'_m &> c \\
\text{- Innovating firm undercuts its rivals by charging price } \quad p' &= c - \varepsilon \\
\text{- No change in quantity } \quad q' &= q \\
\text{- Less efficient firms produce nothing} \\
\text{- Incentive for innovation is } \quad I_c &= (c - c')q \\
\text{- } I_m < I_c
\end{align*}
\]

- Monopoly gains less from innovating than does a competitive firm \( I_m < I_c \)
  - Monopoly replaces himself when he innovates (replacement effect)
  - Competitive firm becomes monopoly

- Threat of entry may increase monopoly incentives
  - In both cases incentives are less than the social desirable level
\[ I_m < I_c < I_S \]

### 7.3.3 Gilbert and Newberry (1982)

- 2 firms, a monopoly (Firm 1) and an entrant (firm 2)
- Process innovation R&D (cost reduction from \( c \) to \( c', c' < c \))
- Innovation is protected by a patent of unlimited duration
- Patent race
- Competition for innovation, i.e. zero profit from R&D investments
- Entrant who innovates

\[
\Pi^d e^{-rT(x^d)} = x^d
\]

where \( x^d \) R&D investment, \( T(x^d) \) time of innovation and \( r \) interest rate

- Monopolist's problem
  - Invest \( x^d + \varepsilon \) then \( T(x^d + \varepsilon) < T(x^d) \), i.e. monopoly remains with profits

\[
\Pi^m e^{-rT(x^d+\varepsilon)} - x^d + \varepsilon
\]

  - No investment, i.e. duopoly with profits

\[
\Pi^d e^{-rT(x^d)}
\]

- Monopolist invests iff

\[
\Pi^m e^{-rT(x^d+\varepsilon)} - x^d + \varepsilon > \Pi^d e^{-rT(x^d)}
\]

that is

\[
\Pi^m e^{-rT(x^d+\varepsilon)} > (\Pi^d + \Pi^d)e^{-rT(x^d)} + \varepsilon
\]

- But given that \( \varepsilon \approx 0 \), inequality reduces to

\[
\Pi^m \geq \Pi^d + \Pi^d
\]

Intuitively, the monopolist can always duplicate the situation of the non-colluding duopolists (*efficiency effect*)

- Because competition reduces profits, the monopolist's incentive to remain monopolist is greater than the entrant's incentive to become a duopolist

\[ I_m > I_c \]

- Total incentives of innovation depend on two effects: The efficiency effect and
the replacement effect
- Reinganum (1983) model where replacement effect dominates
- Fundeberg and Tirole (1986) model where efficiency effect dominates

7.3.4 Dasgupta and Stiglitz (1980)

- Oligopoly market \( n \) firms
- Total industry output \( Q = \sum_{i=1}^{n} q_i \)
- Demand \( q(Q) \)
- Unit cost \( c(x_i) \), where \( x \) is investment in R&D
- Perfect patenting, i.e. every firm must invest in R&D for a cost reduction (no imitation)
- Firm’s \( i \) problem

\[
\max_{x_i, q_i} \Pi_i = p(Q)q_i - c(x_i)q_i - x_i
\]

- FOC

\[
p'(Q)q_i + p(Q) = c(x_i)
\]

and

\[-c'(x_i)q_i = 1\]

- Symmetric Nash Equilibrium, i.e. \( x_i = x, q_i = q = \frac{q}{n} \)

\[
p(Q) \left[1 - \frac{1}{\eta(Q)n}\right] = c(x_i)
\]

where \( \eta(Q) \) elasticity of demand and

\[-c'(x) \frac{Q}{n} = 1\]

- Equilibrium with free entry
- Zero profit condition

\[[p(Q) - c(x)]q = x\]

- From the Nash equilibrium condition we get

\[
\frac{nx}{p(Q)Q} = \frac{1}{\eta(Q)n}
\]

- \( nx \) industry’s R&D
- \( p(Q)Q \) industry’s revenue
• Index \( \frac{nx}{p(Q)q} \) industry’s R&D intensity

• Greater concentration (small \( n \)) implies greater R&D intensity

• Equilibrium with barriers to entry

• \( n \) is given exogenously

• \( \frac{dx(n)}{dn} < 0 \)

• Government’s intervention for a reduction of barriers to entry (greater \( n \)) has as a side effect a decrease in industry’s R&D investment
7.4 Cooperation in R&D

- Research Joint Ventures
  - Scope is to conduct R&D efficiently
  - Share expenditures and benefits of a given research project
  - Coordination of research activities
  - Prevent wasteful duplication
  - Internalizes spillovers

- Avoid competition in R&D market
- Prevent competition in the output market (collusion)

Research Joint Ventures may or may not be socially desirable
Research Joint Ventures may increase or decrease R&D activity

7.4.1 d’Aspremont and Jacquemin (1988)

- How firms determine their research efforts given that they compete in the final good's market after the research is completed
- Two stage game
  - $t = 1$ R&D investment
  - $t = 2$ Cournot quantity game
- Inverse demand function $p = a - b(q_1 + q_2)$
- Unit production cost $c_i(x_i, x_j) = c - (x_i + \sigma x_j)$
- Output spillover $\sigma \in [0,1]$ indicates the extent to which a cost reduction by one firm reduces unit cost at the other
- Cost of R&D $y_i = \frac{1}{2} \gamma x_i^2$
- Decreasing returns to scale in R&D

Noncooperative R&D

- $t = 2$
- Given $x_1$ and $x_2$, firms' choose noncooperatively output level

$$\max_{q_i} \pi_i^{nc} = \left[ \alpha - b(q_i + q_j) \right] q_i - \left[ c - (x_i + \sigma x_j) \right] q_i - \frac{1}{2} \gamma x_i^2$$

- The equilibrium outputs are
\[ q_{i}^{nc} = \frac{a - c + (2 - \sigma)x_i + (2\sigma - 1)x_j}{3b} \]

- \( t = 1 \)
- Given \( q_{i}^{nc} \) firms' choose noncooperatively R&D investment

\[ \max_{x_i} \pi_{i}^{nc} |_{q_i=q_i^*} = [\alpha - b(q_i^* + q_j^*)]q_i^* - [c - (x_i + \sigma x_j)]q_i^* - \frac{1}{2} \gamma x_i^2 \Rightarrow \]

\[ \max_{x_i} \pi_{i}^{nc} |_{q_i=q_i^*} = b q_i^2 - \frac{1}{2} \gamma x_i^2 \]

- Symmetric Nash Equilibrium \( x_i = x_j = x^{nc} \)

\[ x^{nc} = \frac{2}{\gamma} \frac{2 - \sigma}{b\gamma - \frac{2}{\alpha}(1 + \sigma)(2 - \sigma)} (\alpha - c) \]

- Taking spillovers into account, the cost reduction realized by each firm is

\[ (1 + \sigma)x^{nc} = \frac{2}{\gamma} \frac{(1 + \sigma)(2 - \sigma)}{b\gamma - \frac{2}{\alpha}(1 + \sigma)(2 - \sigma)} (\alpha - c) \]

- Thus, equilibrium payoffs are

\[ \pi^{nc} = \frac{1}{\gamma} \frac{b\gamma - \frac{2}{\alpha}(2 - \sigma)}{[b\gamma - \frac{2}{\alpha}(1 + \sigma)(2 - \sigma)]^2} (\alpha - c)^2 \]

**Comparative statics: Impact of changes in spillover effect**

- If spillover level is small \((\sigma < \frac{1}{2})\) then an increase in spillover
  - Improves technological performance \((\frac{\partial(1+\sigma)x^{nc}}{\partial \sigma} > 0)\)
  - Increases output per firm \((\frac{\partial q^{nc}}{\partial \sigma} > 0)\)
  - Increases consumers' surplus \((\frac{\partial CS}{\partial \sigma} > 0)\)
  - Increases firms' profits \((\frac{\partial q^{nc}}{\partial \sigma} > 0)\)
  - Thus, net social surplus increases

- If spillover level is large \((\sigma > \frac{1}{2})\) then an increase in spillover
- Worsen technological performance \( \left( \frac{\partial (1+\sigma)x^{nc}}{\partial \sigma} < 0 \right) \)
- Decreases output per firm \( \left( \frac{\partial q_{nc}}{\partial \sigma} < 0 \right) \)
- Decreases consumers’ surplus \( \left( \frac{\partial CS}{\partial \sigma} < 0 \right) \)
- Increases firms’ profits \( \left( \frac{\partial q_{nc}^{i}}{\partial \sigma} > 0 \right) \) for some range above \( \sigma = \frac{1}{2} \)
- Ambiguous effect on net social surplus

- Market system results in an insufficient level of innovation

**Cooperative R&D**

- Research Joint Venture
- The two firms set up a single R&D lab and divide the costs equally
- Unit production cost \( c_i(x) = c - x \)
- \( t = 2 \)
- Given \( x \) firms’ choose non cooperatively output level

\[
\max q_i^n \pi_i^n = \left[ \alpha - b(q_i + q_j) \right] q_i - [c - x]q_i - \frac{1}{2}(\frac{1}{2} \gamma x_i^2)
\]

- The equilibrium outputs are

\[
q_i^n = \frac{a - c + x}{3b}
\]

- \( t = 1 \)
- Given \( q_i^n \) firms’ choose cooperatively R&D investment R&D level, i.e. choose \( x \) that maximizes the sum of second stage profits

\[
\max_x \left( \pi_1^c | q_1 = q_1^* + \pi_2^c | q_2 = q_2^* \right) = 2b \left[ \frac{a - (c - x)}{3b} \right] - \frac{1}{2} \gamma x^2
\]

- Equilibrium R&D level \( x^c \)

\[
x^c = \frac{4}{\gamma} \frac{a - c}{b \gamma - 4}
\]

**Comparative statics: Cooperative vs. non cooperative R&D**

- R&D level
- If spillover level is small \((\sigma < \frac{1}{2})\) then \(x^c < x^{nc}\)
- If spillover level is large \((\sigma > \frac{1}{2})\) then \(x^c > x^{nc}\)

- R&D effects on unit production cost
  \[(1 + \sigma)x^{nc} > x^c\]

R&D cooperation worsens technological performance

- Unit costs are higher with a Research Joint Venture
  \[c_i(x) > c_i(x_i, x_j)\]

- Output is smaller \((q^c < q^{nc})\) and consumers are worse off \((CS^c < CS^{nc})\)

- Firms' profits
  - If spillover level is small \((\sigma < 0.42 < \frac{1}{2})\) then \(\pi^c < \pi^{nc}\)
  - If spillover level is large \((\sigma > 0.42)\) then \(\pi^c > \pi^{nc}\)

- If \(\sigma > 0.42\) then forming a Research Joint Venture may be socially beneficial
  - not because it improves technological performance
  - but increase in firms' profits outweighs consumers' loss

### 7.4.2 Kamien, Muller and Zang (1992)

- Two stage game
  - \(t = 1\) R&D investment
  - \(t = 2\) Cournot quantity game
- Inverse demand function \(p = a - b(q_1 + q_2)\)
- Unit production cost \(c_i(x_i) = c - x_i\)
- Cost of R&D \(x_i = \sqrt{\frac{2}{y}(y_i + sy_j)}\)
- Input spillover \(s \in [0,1]\) indicates the extent to which spending on cost reducing R&D by one firm reduces unit cost at the other
- In the absence of spillovers the two models are equivalent

**Results**

- Non cooperative R&D
- Market system results in an insufficient level of innovation
- Increases in input spillovers worsen technological performance for all spillover levels
  \[
  \frac{\partial}{\partial s} \sqrt[2]{(1+s)y^{nc}} < 0 \text{ for all } s \in [0,1]
  \]

- Cooperative R&D
  - Cooperation improves technological performance if there are input spillovers
    \[
    x^c > \sqrt{\frac{2}{\gamma} (1 + s) y^{nc}}
    \]
  - Cooperation increases output \((q^c > q^{nc})\) and consumers' surplus \((CS^c > CS^{nc})\)
  - Effect on firms' profits is ambiguous
    If spillover level is small \((s < \frac{1}{2})\) then \(\pi^c < \pi^{nc}\)
    If spillover level is large \((s > \frac{1}{2})\) then \(\pi^c > \pi^{nc}\)
- If \(s > \frac{1}{2}\) then forming a Research Joint Venture is socially beneficial
- If \(s < \frac{1}{2}\) then forming a Research Joint Venture may not be socially beneficial
  - decrease in firms' profit is greater than consumers' benefit
  - incentives may be needed to induce firms to invest in R&D
7.5 Licensing

Why a firm that invested a substantial amount in R&D finds it profitable to license its technology to a competing firm?

Inventors and Licensing

1. Independent inventor unable to exploit a patent
   - Clear incentive to license
   - Licensing to one firm or several firms?
2. Inventor that has production capabilities
   - Unclear incentive of licensing to rivals

Motivation to License

1. Product market incentives
   - Competition improves managerial incentives
     Improve firms' performance
     Further investments
2. Soft product market competition
   - Efficiency effect: competition destroys industry's profits
     Bertrand competition
   - Product differentiation, capacity constraints etc.
     Soft competition
     Industry's cost savings associated with licensing may dominate loss in industry's profits
   - No overlapping geographical markets, Unrelated products
3. Strategic licensing
   - Lower rival's incentive to invent around the initial innovation
   - Save on wasteful R&D expenditures (industry's point of view)

Types of licensing agreements

1. Fixed fee independent of the output of licensee
2. Per unit fee for every unit sold/produced by the licensee
3. Two part tariff, i.e. combination of fixed fee and per unit fee
7.5.1 A Simple Model of Licensing

- Homogeneous good industry
- Cournot duopoly (firms 1 and 2)
- Unit production cost $c$
- Firm 1 invents a cost reduction technology (from $c$ to $c'$, $c' < c$)
- Drastic innovation when $p_m' \leq c$ and non drastic when $p_m' > c$, where $p_m'$ is the monopoly price with the new technology

**Drastic Innovation**

**No licensing**
- Firm 1 does not license its technology
- Firm 1 becomes monopoly (firm 2 produces nothing)
- $\pi_1^{nl}(c', c) = \pi_1^m(c')$ and $q_1^{nl}(c', c) = q_2^m(c')$

**Licensing**
- Firm 1 licenses technology to firm 2
- Duopoly remains
- Efficiency effect suggests that $\pi_1^m(c') \geq \pi_1^d(c', c') + \pi_2^d(c', c)$
- A drastic innovation is exploited by a single firm

**Nondrastic Innovation**

**No licensing**
- Firm 1 does not license its technology
- Asymmetric Cournot competition (firm 1 produces at $c'$ and firm 2 produces at $c$)
- $\pi_1^{nl}(c', c) > \pi_2^{nl}(c', c)$ and $q_1^{nl}(c', c) > q_2^{nl}(c', c)$
- Firm with lower unit cost produces higher amount and earns higher profits

**Licensing**
- Firm 1 licenses technology to firm 2
- *Per unit fee* licensing agreement
  Firm 2 produces at $c' < c$ and pays to firm 1 $R = r q_2(c', c')$
Firms' profit functions

\[ \pi_1(c', c') = pq_1 - c'q_1 + r_2 \]

and

\[ \pi_2(c', c') = pq_2 - c'q_2 - r_2 \]

Firm 1 is the leader
Offers a take-it-or-leave-it contract to firm 2
Sets \( r = c - c' \)

Firm 2 accepts licensing contract
 Produces \( q_2^l(c', c') = q_2^{nl}(c', c') \)
 Earns \( \pi_2^l(c', c') = \pi_2^{nl}(c', c') \)

Firm 1
 Produces \( q_1^l(c', c') = q_1^{nl}(c', c') \)
 But earns \( \pi_1^l(c', c') = \pi_1^{nl}(c', c') + r_2^{nl}(c', c') > \pi_1^{nl}(c', c') \)

Firm 1 gains all the extra generated surplus by the cost reduction of firm 2
(leader assumption)
Licensing can increase profits of all firms
Licensing increases social welfare

7.5.2 Strategic Licensing

Lower rival's incentive to invent around the initial innovation
Save on wasteful R&D expenditures

A Simple Example

Firm 1 is a monopoly and produces at \( c' \)
Firm 2 can invent around firm's 1 patent
Invest \( k \) on R&D
Acquire a different technology for production at \( c' \)
No licensing

- Firm 1 does not license its technology
- Duopoly with $\pi_1^d$ for firm 1 and $\pi_2^d - k$ for firm 2
- Firm 2 invests iff $\pi^d \geq k$

Licensing

- Firm 1 licenses technology to firm 2
- Firm 2 pays $R$ to firm 1
- Duopoly with $\pi_1^d + R$ for firm 1 and $\pi_2^d - R$ for firm 2
- Firm 1 licenses iff $\pi_1^d + R \geq \pi_1^d \iff R \geq 0$
- Firm 2 accepts licensing agreement $\pi_2^d - R \geq 0 \iff \pi_2^d \geq R$
- Firm 2 prefers licensing iff $\pi_2^d - R \geq \pi_2^d - k \iff k \geq R$
- There exists a $R \in [0, k]$ such that the above three conditions are satisfied $\pi_2^d \geq k \geq R \geq 0$
- The two firms have an incentive to enter a licensing agreement to save the R&D cost
7.6 Patent

- Patent system encourages technological innovation
  - Provide private incentives for innovation
  - Make information available to the public as fast as possible

- Monopoly rights as an incentive for technological innovation

- Creates a market distortion since patent protected goods are priced differently

- Patent is characterized by
  - Patent length: Duration of monopoly rights
  - Patent breadth: Extent of monopoly rights

7.6.1 Patent Design

- Inverse demand function $p = a - Q$

- R&D Investment $x$ at a cost $y = \frac{1}{2} \gamma x^2$

- Process innovation R&D (cost reduction from $c$ to $c' = c - x$)

- Nondrastic innovation, i.e. $p'_{m} > c$

- Patent for $T \geq 0$ periods

- $\rho$ discount factor

- Effects of innovation (patent period)
  - No change in price and output after innovation
  - Innovator earns positive profits
    - $SW = CS + \Pi^I$

- Effects of innovation (after patent expires)
  - Price decreases and quantity increases
  - Innovator earns zero profit
    - $SW = CS + \Pi^I + DL$
A Two Stage Game (Nordhaus, 1969)

- **1st stage**: Government sets duration of patent
- **2nd stage**: Firm chooses R&D level

**2nd Stage**

- Innovator takes duration of patent as given and chooses investment $x$
- Innovator's objective
  \[
  \max_x \pi(x; T) = \sum_{t=1}^{T} \rho^{t-1} [pq - (c - x)] - \frac{1}{2} \gamma x^2
  \]
- Innovator's optimal R&D level
  \[
  x^I = \frac{1 - \rho^T}{1 - \rho} (a - c)
  \]
- *R&D increases with the duration of the patent*
- R&D increases with an increase in demand
- R&D decreases with an increase in the unit cost
- R&D increases with an increase in the discount factor (decrease in the interest rate)

**1st Stage**

- Government sets duration of patent to maximize social welfare, taking into account the effect on innovator's R&D level
- Social welfare
  - Patent period $SW = CS + \Pi^I$
  - After patent expires $SW = CS + \Pi^I + DL$
- Government's objective
  \[
  \max_T SW(T) = \sum_{t=1}^{\infty} \rho^{t-1} [CS + \Pi^I] \sum_{t=1}^{\infty} \rho^{t-1} DL - \frac{1}{2} \gamma x^2
  \]
  \[s.t. \quad x^I = \frac{1 - \rho^T}{1 - \rho} (a - c)\]
- The optimal patent life is finite
- *The monopoly distortion associated with an infinitely lived monopoly is larger than the innovation distortion associated with an insufficient reward to the innovator*
8 Vertical and Horizontal Relations

8.1 Introduction

Economic theory starts by examining

Many producers

↓

Many consumers

Variations are the monopoly structure

Producer

↓

Many consumers

and the oligopoly structure

Producer    Producer

↓    ↓

Many consumers

Why intermediation?

Scope of intermediation

Intermediation as a strategic response to market failures. Intermediaries gain some or all of the extra surplus they generate when they correct the market failures

Many producers

↓

Many distributors

↓

Many consumers

In effect real markets are characterized by this structure

Producer    Producer
Vertical restraints from the producers to the distributors arise as a way to gain some of the extra surplus the intermediaries generate. That is vertical restraints are strategic response to intermediation.

Later, intermediaries gain bargaining power and started to impose vertical restraints to producers to regain some of the extra surplus intermediation generates. That is, vertical restraints from distributors as a strategic response to vertical restraints of the producers. Issue of bargaining in vertical restraints.

### 8.2 Vertical Contractual Relations

In most markets, producers do not sell their goods directly to final consumers. Instead, they often use intermediaries, wholesalers and retailers, as distributors of their production. Further, the final good is often produced in several stages, from raw material, to intermediate good, to final product, which implies significant firms’ interactions before the good reaches the consumers.

Vertical relationships among firms are much richer and more complex than those between a firm and its consumers. Very often, these interactions involve formal and legally enforceable contracts. These vertical contractual arrangements are referred to as vertical restraints. Such formal contractual interactions employ strategic considerations just as much as did the pricing and production decisions of each firm. However, the manifestation of those tactical issues is more subtle largely because, by its very nature, a vertical relationship involves some element of cooperation as well as the usual ingredient of self interest.

To gain some initial insight on the topic, consider the classical example of the vertical relationship between a producer and a distributor.

```
Producer
  ↓
Distributor
  ↓
Consumers
```

In general, both the producer and the distributor decide on different actions that affect each others profits. However, what is an optimal action for one is not necessarily optimal for the other. To put it another way, each party’s actions create an externality on the other. As a result, a party can try to use vertical contracts and clauses so as to
restrain the choice of the other and induce an outcome which is more favorable to itself. That is, each party wants to exert vertical control to the other.

Indeed, most relationships between producers and distributors consist of sophisticated contracts using more than the simple linear pricing rule. These vertical contracts not only set more general terms for payments (non-linear prices, two-part tariffs, quantity discounts, royalties, slotting allowances), but also include terms limiting one party’s decisions (resale price maintenance, quantity, fixing, tie-ins) or softening competition (exclusive dealing, franchising, exclusive territories). Note also that many vertical restraints have been imposed on distributors by producers while others have been imposed on producers by distributors.

The economics literature on vertical relationships is extensive. In this literature there are various explanations for the motivations of vertical restraints. In particular, they can be split into three broad categories:

1. Efficiency motive: Vertical restraints can be used to solve vertical coordination problems and to restore the efficiency of the vertical interaction.

2. Anti-competitive motive: Vertical restraints can eliminate or reduce the competition between rival vertical structures.

3. Rent-shifting motive: Vertical restraints can serve as a basis for monetary transfers between producers and distributors.

In this respect, their impact on consumer surplus and economic welfare are unclear and have been actively debated. Some believe that vertical agreements are very different from agreements between competing firms and appear only when they help improving the efficiency of the vertical structure. Since vertical restraints can be efficiency enhancing, competition agencies should let firms design these arrangements as they wish. On the other hand, there is the belief that any contractual term that restrict one party’s freedom of trade -and this would be the case for most if not all vertical restraints- can only be harmful and should thus be banned.

Which of these effects dominates and which vertical restraints will be adopted in a particular situation depend critically on the informational environment and on the vertical and horizontal market structures.

**8.3 Vertical and Horizontal Externalities**

The vertical structure, considered as a whole, faces a number of decision variables: some affect the joint profit (retail prices, quantity sold to consumers, selling efforts etc.) while others affect the way this joint profit is shared between the different parties (wholesale price, franchise fee etc.). The decentralization of the decision variables that affect the joint profit to the distributors can cause inefficiencies since they create externalities that have to be correctly accounted for. In general, the externalities arise from the fact that each firm, when setting its mark-up does not take into account the impact of this decision on the other firm’s profit. Vertical restraints can then be used as means to coordinate and restore the efficiency of the vertical structure.

**8.3.1 Linear Prices and Vertical Externalities**
In the context of a vertical structure, a monopoly producer who uses a linear pricing policy charges a wholesale price above its marginal cost of production. The distributors then face a marginal cost for their production (distribution) at least equal to the wholesale price and, on this basis, they make their pricing, promotional and technological decisions. The vertical externality is that any decision made by a distributor that increases the demand for the final good, generates an incremental profit not only for him but also for the initial producer. However, the distributor who maximizes his own profit, does not take the producer’s incremental profit into account and, therefore, tends to make decisions that lead to too low a consumption of the good.

The distributor’s choice of price and promotional effort are the main examples used in the literature that illustrate how the linear pricing policy of the producer and the optimal decisions of the distributor result in significant inefficiencies for the vertical structure as a whole.

**Double Marginalization**

Double marginalization has been the first vertical externality problem formally analyzed and refers to situations where both the producer and the distributor enjoy some market power.

\[
\text{Producer} \\
\downarrow \\
\text{Distributor} \\
\downarrow \\
\text{Consumers}
\]

**Basic Setup**

- Monopoly producer sells to monopoly distributor
- Marginal cost \( c \) for the producer
- Marginal cost \( \gamma \) for the distributor
- Demand \( q = D(p) \)

**Vertically integrated structure**

- Suppose the producer and the distributor are integrated in a unique company
- Joint profit maximization yields a price
  \[
  p^m(c) = \arg \max_p [(p - c - \gamma)D(p)]
  \]

**Decentralized structure**
• Suppose the producer and the distributor are separated
• Producer sells at a wholesale price \( w \)
• Producer’s profit maximization yields
  \[ w > c \]
• Distributor’s profit maximization yields a price
  \[ p^m(w) = \arg \max_p [(p - w - \gamma)D(p)] \]

Comparison and Results
• Prices are lower under a vertically integrated structure than under the separated one, i.e. \( p^m(c) < p^m(w) \) (recall that \( w > c \) and that the monopoly price is an increasing function of marginal cost).
• Since price is lower under vertical integration, consumer surplus increases when a separated structure integrates.
• The profit created by the vertical integrated structure is also higher from the profit of the decentralized structure.
• Since both consumer surplus and producer surplus increase, total welfare unambiguously rises from integration.

The retail price is higher in the decentralized structure than in the integrated structure because of the two successive mark-ups. That is, the producer and the distributor add a mark-up to their costs thereby leading to excessive prices. When making their pricing decisions the two independent firms ignore the effect of their individual mark-ups on each other’s profits, while the integrated monopolist internalizes such externality. That is, the double marginalization can be solved by a vertically integrated structure.

Remark If one of the two firms is competitive in the sense that it sells at marginal cost, then vertical integration does not increase the profit of the monopoly firm. The intuition behind this result is that the competitive sector does not introduce a price distortion. Thus, the monopoly sector does not exercise an externality on the competitive sector, whose price-cost margin is zero.

Downstream Moral Hazard
Distributors usually provide a range of services that make the producer’s good more attractive to consumers: services such as free delivery, credit, pre-sale advice to potential buyers, use of salespersons, show rooms, after-sales services or parking facilities and so on. To the extent that these promotional effort affects the demand for the good, the producer wants to encourage the distributor to supply it.
Basic Setup

- Monopoly producer sells to monopoly distributor
- Marginal cost $c$ for the producer
- Distributor’s promotional effort $e$
- Marginal cost $\gamma(e)$ for the distributor with $\gamma'(e) > 0$
- Demand $q = D(p, e)$ with $\partial D / \partial e > 0$
- Inverse demand $p = P(q, e)$ with $\partial P / \partial q < 0$ and $\partial P / \partial e > 0$
- Note that now the decision variables are $q$ and $e$.

Vertically integrated structure

- Suppose the producer and the distributor are integrated in a unique company
- Joint profit maximization yields

$$
(q^m(c), e^m(c)) = \arg \max_{(q,e)} [(P(q, e) - c - \gamma(e))q]
$$

Decentralized structure

- Suppose the producer and the distributor are separated
- Producer uses a simple linear policy and sells at a uniform wholesale price $w$
- Distributor perceives a marginal cost equal to

$$
w + \gamma(e)
$$

- Distributor’s profit maximization yields

$$
(q^m(w), e^m(w)) = \arg \max_{(q,e)} [(P(q, e) - w - \gamma(e))q]
$$

- Producer will choose the wholesale price $w$ so as to maximize its own profit given the distributors’ reaction to this wholesale price, i.e.

$$
w^* = \arg \max_w [(w - c)q^m(w)]
$$

- Producer’s profit maximization yields
Comparison and Results

- Quantities are higher under a vertically integrated structure than under the separated one, i.e. \( q^m(c) > q^m(w) \) (note again that \( w^* > c \)) and, thus, prices are lower under a vertical integration, i.e. \( p^m(c) < p^m(w) \).

- Promotional services are also higher under the vertically integrated structure than under the separated one, i.e. \( e^m(c) > e^m(w) \).

- Consumer surplus increases when a separated structure integrates.

- The joint profit is not maximized under the decentralized structure.

- Total welfare unambiguously rises from vertical integration.

The distortion in promotional services resembles the distortion in retail price. The distributor does not take into account the extra profit for the producer associated with an increase in services, which is \( (w^* - c) \frac{\partial P}{\partial e} \). Again, this is because the producer’s mark-up makes the distributor’s profit margin smaller than that of the vertical structure. Thus, for any retail price, the distributor provides too few services and so causes the demand to be too small. The main reason of these results is that the producer who uses a simple linear policy has only one instrument (the wholesale price \( w \)) to control the two decisions that affect the joint profit (\( p \) or \( q \) and \( e \)) as well as the allocation of this profits.

Remark In addition to the distributor’s investments in promotional services, sometimes the producer also provides services such as product quality and brand advertising that may be difficult to measure precisely. This gives rise to a double moral hazard problem. In this situation, the producer and the distributor tend to free ride on each other’s services.

8.3.2 Retail Competition and Horizontal Externalities

Besides the vertical externalities between a producer and the distributors that carry its products there are often exist horizontal externalities among retailers that determine an inefficient outcome from the point of view of the vertical structure as a whole. More specific, competition in the downstream sector creates an horizontal externality or sometimes a free rider problem among distributors. The problem arises because when a distributor chooses a retail price and a promotional service level it only considers its own profit and not the profits of other distributors.

Intra-brand Competition
The first example is the horizontal externality exerted by distributors on the producer through their competition. That is, competition among distributors may result that the level of promotional services is not the one the producer prefers.

![Diagram: Producer, Distributor, Consumers]

**Basic Setup**
- Monopoly producer sells to a competitive downstream market
- Marginal cost $c$ for the producer
- Distributors’ promotional effort $e$
- Marginal cost $\gamma(e)$ for all distributors with $\gamma'(e) > 0$
- Demand $q = D(p, e)$ with $\partial D / \partial e > 0$
- All consumers are identical and their net surplus is $S(p, e)$ with $\partial S / \partial p = -D(p, e)$
- Note that now the decision variables are $p$ and $e$.

**Vertically integrated structure**
- Suppose the producer and the distributors are integrated
- Joint profit maximization yields
  \[
  (p^m(c), e^m(c)) = \arg \max_{(p,e)} [(p - c - \gamma(e))D(p, e)]
  \]
- The first order condition for services is
  \[
  [p^m(c) - c - \gamma(e^m(c))] \frac{\partial D}{\partial e} = \gamma'(e^m(c))D
  \]
  which suggests that the equilibrium level of promotional services is determined by the effect these promotional services have on the marginal consumer (equalizes cost with marginal revenue accruing from the increase in demand).
Decentralized structure

- Suppose the producer and the distributors are separated
- Producer uses a simple linear policy and sells at a uniform wholesale price $w$
- Each distributor perceives a marginal cost equal to $w + \gamma(e)$
- Consumers buy from the distributor that offers the best pair of $p$ and $e$
- Competitive equilibrium requires $p = w + \gamma(e)$. It follows that 
  $$(p^c(w), e^c(w)) = \arg\max_{(p,e)} S(p - c - \gamma(e), e)$$
- The first order condition for services is 
  $$\frac{\partial S}{\partial e} = \gamma'(e^c(w))D$$
  which suggests that the equilibrium level of promotional services is determined by the effect these promotional services have on the average consumer (equalizes cost with marginal consumer surplus which embodies the increase in demand for all inframarginal consumers).

Comparison and Results

- Competitive distributors may provide too few or too many services, from the vertical structure’s point of view, depending on whether services are more valued by marginal or average consumers.

Intra-brand competition is not necessarily enough to ensure that joint profits are maximized. While the producer chooses a wholesale above its marginal cost in order to maximize its own profit, intra-brand competition pushes the distribution to choose the effort level and therefore retail prices that maximize the consumer’s surplus. In other words, competition between identical distributors eliminates the retail mark-up and induces distributors to choose the consumers’ preferred balance between retail price and level of services. As a result, the joint profit is not maximized.

**Free Riding Among Distributors**

The main example of an horizontal externality concerns the level of promotional services provided by distributors. Competition among distributors may prevent the provision of such services. A distributor who incurs the cost of providing the promotional service must charge a higher price than the distributor who does not provide the service. Consumers then have an incentive to visit the first distributor to obtain all the necessary information about the good and then buy them from the second distributor.
In other words, if the promotional services cannot be perfectly appropriated by one distributor, i.e. if there are spillovers which benefit other distributors carrying the same brand, then these services become a public good on which the distributors will free ride and, thus, there will be an under provision of these services which reduces the producer’s profit (Telser, 1960).
9 Durable Goods Theory

9.1 Introduction

- Anonymous Case
  - Secondhand market exists
  - Buyer anonymity
  - Uniform price for both generation
  - Outdated technology is still around
  - Books

- Semi anonymous Case
  - No secondhand market
  - Buyer semi anonymity
  - Market segmentation is possible
  - Former customers pay less for upgrade
  - New customers pay more for new generation product
  - Software, PCs

- Identified Customers
  - No secondhand market
  - Fully identifiable customers
  - Arbitrage condition not binding
  - Market segmentation
  - Former customers pay more
  - New customers pay less
  - Supercomputers, Specialized software
9.2 Pricing by a Durable Good Monopoly

- Goods offered by the monopolist at two different dates are substitutes
- Durable good monopoly creates his own competition (selling today reduces demand tomorrow)
- Monopoly price discriminates over time
- First charges a high price and sells only to consumers who are most eager to buy the good. Then cuts the price to reach a slightly less eager clientele, and so on.
- Involuntary discrimination
- Monopoly would be better off if it could commit ex ante not to lower the price

Leasing versus Selling

- Durable good that lasts for two periods
- Monopoly has the option to lease or to sell the good
- Cost is constant and normalized to zero
- Discount factor \( \delta = \frac{1}{1+r} \) where \( r \) is the interest rate
- Demand \( q = D(p) = 1 - p \)

Selling

2\textsuperscript{nd} Period

- Suppose that at period 1 the monopoly sold \( q_1 \)
- Residual demand at period 2 is \( p_2 = 1 - q_1 - q_2 \)
- Monopoly chooses \( (p_2, q_2) \) to maximize profits

\[
\max_{p_2, q_2 \geq 0} \pi_2 = p_2 q_2 = (1 - q_1 - q_2) q_2
\]

- Monopoly's pricing rule implies that

\[
q_2 = \frac{1 - q_1}{2} \quad \text{and} \quad p_2 = \frac{1 - q_1}{2}
\]

and, thus, the optimal profits are \( \pi_2 = \frac{(1 - q_1)^2}{4} \)

1\textsuperscript{st} Period

- The price that the buyers are willing to pay depends on their expectation of the price \( p_2^E \) during period 2
\[ p_1 = (1 - q_1) + \delta p_2^E \]

- Suppose that consumers anticipate correctly the price, i.e. \( p_2^E = p_2 = \frac{1 - q_1}{2} \)
  therefore
  \[
  p_1 = (1 - q_1) + \delta \frac{1 - q_1}{2} = (1 - q_1)(1 + \frac{\delta}{2})
  \]

- Monopoly chooses \((p_t, q_t)\) to maximize profits
  \[
  \max_{q_i \geq 0} \Pi_{setting} = \pi_1 + \delta \pi_2 = p_1 q_1 + \delta p_2 q_2
  \]
  \[
  = (1 - q_1) \left( 1 + \frac{\delta}{2} \right) q_1 + \frac{\delta(1 - q_1)}{4}
  \]

- Monopoly's pricing rule implies that
  \[
  p_1 = \frac{(2 + \delta)^2}{2(4 + \delta)}
  \]

- Note that \( p_1 > p_2 \)

**Leasing**

- Monopoly chooses \((p_t, q_t)\) each period to maximize per period profits
  \[
  \max_{p_t > 0} p_t q_t = p_t D(p_t)
  \]

- Monopoly's pricing rule implies that
  \[
  p_1 = p_2 = \frac{1}{2} \text{ and } q_1 = \frac{1}{2}
  \]

- Residual demand for period 2 is \( p_2 = 1 - q_1 - q_2 \). Therefore,
  \[
  q_2 = 1 - q_1 - p_2 = 1 - \frac{1}{2} - \frac{1}{2} = 0
  \]

- Monopoly's total profits are
  \[
  \Pi_{Leasing} = \pi_1 + \delta \pi_2 = p_1 q_1 + \delta(p_1 q_1 + p_2 q_2)
  \]
  \[
  = \frac{1}{4} + \frac{1}{4} \delta = \frac{1}{4} (1 + \delta)
  \]
Discussion

- If consumer buys the product at period 1 pays
  \[ p_1 = \frac{(2 + \delta)^2}{2(4 + \delta)} \]
- If consumer leases for 2 periods pays
  \[ p_1 + \delta p_2 = \frac{1 + \delta}{2} \]
- Note that
  \[ \frac{(2 + \delta)^2}{2(4 + \delta)} < \frac{1 + \delta}{2} \]
- Importantly
  \[ \Pi_{leasing} > \Pi_{setting} \]
- Intuition
  Consumers anticipate that a selling monopoly will lower future prices and, thus, their willingness to pay in the 1st period decreases. The monopoly is induced to lower its 1st period price, which results in lower profits.
9.3 Quality and Durability

- Monopoly power and quality (or durability) of the product
  - Monopoly have incentives to produce goods of lower durability
  - No implied relationship between monopoly power and durability
    (Swan’s independence result)

- 2 periods

- Firm produces 2 qualities
  - short durability at a cost \( c^S \)
  - long durability at a cost \( c^L \)
    - \( c^S < c^L \)

- Consumer is willing to pay \( V \) per period
  - \( 0 < c^S < V \)
  - \( 0 < c^L < 2V \)

Monopoly

- Short durability
  - price \( p^S = V \)
  - quantity \( q = 2 \)
  - profits \( \pi^S = 2(V - c^S) \)

- Long durability
  - price \( p^L = 2V \)
  - quantity \( q = 1 \)
  - profits \( \pi^L = 2V - c^L \)

- Monopoly produces short durability goods iff
  \[ \pi^S > \pi^L \iff c^L > 2c^S \]

- Monopoly produces long durability goods iff
  \[ \pi^S < \pi^L \iff c^L < 2c^S \]

- Monopoly’s decision depends only on cost minimization
Competition

- Under perfect competition, price equals marginal cost
  - for short durability good $p^S = c^S$
  - for short durability good $p^L = c^L$

- Consumer purchases short durability goods iff

$$2(V - p^S) > 2V - p^L \iff p^L > 2p^S \iff c^L > 2c^S$$

- Consumer purchases long durability goods iff

$$2(V - p^S) < 2V - p^L \iff p^L < 2p^S \iff c^L < 2c^S$$

- Consumer’s and firms’ decisions depend only on cost minimization

Swan’s Independent Result

- Durability is independent of market structure

- Firms choose level of durability that minimizes the production cost per unit of time of the product
9.4 Innovation Durability Trade-off

- Whether and under what conditions firms produce products of excess durability
- With excess durability, new technologies will not be able to be introduced and sold

Consumers

- 2 consumers
- \( t = 1 \)
  1st consumer leaves for 2 periods
- \( t = 2 \)
  2nd consumer
- \( u_t = \begin{cases} \ V_t - p_t & \text{purchasing} \\ 0 & \text{no purchasing} \end{cases} \)

Firms

- Firm 1
  operates at \( t = 1 \)
  produces quality \( u^0 \)

- Firm 2
  operates at \( t = 2 \)
  can produce quality \( u^0 \) and
  can also upgrade quality product \( u^N (u^N > u^0) \) at a cost \( l \)

- Durable good lasts for 2 periods \( \rightarrow \) cost \( c^D \)
- Non durable good lasts for 1 period \( c^{ND} = 0 \)

2nd Period given a Durable Good

- old consumer has \( u^0 \) technology
- new consumer buys
- Firm 2: low pricing to get both consumers
  - Old consumer \( u^N - p^L_2 \) or \( u^0 \)
    \[ u^N - p^L_2 \geq u^0 \iff u^N - u^0 \geq p^L_2 \iff u^N - u^0 = p^L_2 \]
  - New consumer \( u^N - p^L_2 \)
  - Firm gets \( \pi^f = 2p^L_2 - l = 2(u^N - u^0) - l \)
• Firm 2: high price to get new consumers
  - New consumer $u^N - p_2^H \text{ or } 0$, which implies $p_2^H = u^N$
  - Firm gets $\pi_2^H = u^N - I$

• Firm 2: sells old technology to new consumers
  - New consumer $u^0 - p_2 \text{ or } 0$, which implies $p_2 = u^0$
  - Firm gets $\pi_2 = u^0$

• New technology iff
  
  $$2(u^N - u^0) - I \geq u^0$$
  $$u^N - I \geq u^0$$

• New technology at low price iff
  
  $$2(u^N - u^0) - I > u^N - I \iff$$
  $$u^N > 2u^0$$

  that is firm 2 sells new technology to both consumers

• Iff
  
  $$u^N < 2u^0$$

  firm 2 sells new technology to new consumers

1st Period Durability Choice

• if non durable good
  - max price $p_1^{ND} = u^0$
  - profits $\pi_1^{ND} = u^0 - c^{ND} = u^0$

• if durable good
  - max price $p_1^D = 2u^0$
  - profits $\pi_1^D = 2u^0 - c^D$

• Firm 1 produces durable good iff
  
  $$\pi_1^D \geq \pi_1^{ND} \iff$$
  $$2u^0 - c^D \geq u^0 \iff$$
  $$u^0 \geq c^D$$

• Firm 1 produces non durable good iff
  
  $$\pi_1^D < \pi_1^{ND} \iff$$
  $$u^0 < c^D$$
Social Welfare

- $W = U_1^1 + U_2^1 + U_2 + \pi_1 + \pi_2$
- Assume that $u^0 > c^D$, i.e. durable good is profitable
- Assume that $\max\{2(u^N - u^0); u^N\} < I < 2u^N$, i.e. the innovation cost is at an intermediate range
- Then $W^D < W^{ND}$, that is social welfare is reduced if durable good is produced
- Durability as a strategic action to capture future market share
- Durability does not serve consumers
- Durability destroys incentives for innovation
- Durability is costly from a social point of view
9.5 Planned Obsolescence

- Planned obsolescence is the marketing strategy of deliberately introducing usefulness. This means that the product is no longer perceived as having value, that is the product is no longer wanted even though it is still in good working order.
- Deterioration is a process of disintegration or degeneration.
- The difference is that obsolescence is a perception about the usefulness of an object whereas deterioration is a physical process.

Killing off markets for used textbooks

- \( t = 1,2 \)
- \( n \) consumers with valuation \( V \)
- \( U_t = \begin{cases} V - p_t & \text{if buy} \\ 0 & \text{if not buy} \end{cases} \)
- \( c \) production cost
- \( F \) investment at period \( t = 2 \) for upgrade
- Timing
  - \( t = 1 \) monopoly chooses price \( p_1 \)
  - \( t = 2 \) monopoly chooses price \( p_2 \) and upgrade

Second period

- Suppose \( n \) consumers buy at \( t = 1 \)
- Suppose that \( n \) consumers sell product in the secondhand market
- Monopoly has to decide about \( F \) (invest or not)
- New edition
  - If new edition is introduced \( \rightarrow \) the value of old edition is zero
  - None of \( n \) period 1 consumers are able to sell their used products
  - All \( n \) consumers of period 2 buy new edition \( p_2^N = V \) and
    \[
    \pi_2^{N|p_2^N = V} = n(V - c) - F
    \]
- Old edition
  - Firm and \( n \) period 1 consumers compete
  - \( n \) period 1 consumers’ production cost is zero
  - Monopoly’s production cost is \( c \)
  - Hence competition implies
    \[
    p_2^o = c
    \]
    and
    \[
    \pi_2^o = 0
    \]
First period

- New edition is introduced iff
  \[ \pi_2^N \geq \pi_2^O \iff n(V - c) - F \geq 0 \]
  \[ n(V - c) \geq F \]

- If new edition then
  \[ p_1 = V \]

- If old edition then
  \[ p_1 = V + c \]

Note that, given no new edition is introduced, the old edition has an extra value (resale price). The monopoly can take this extra value from the consumers.

- Total monopoly profits
  \[ \pi = n(p_1 - c) + \pi_2 = \begin{cases} n(V - c) + n(V - c) - F & \text{if new edition} \\ n(V + c - c) + 0 & \text{if no new edition} \end{cases} \]

Social Welfare

- \( W = U_1 + U_2 + \pi \)
- New edition
  \[ W^N = n(V - c) + n(V - c) - F \]
  since \( U_1 = V - V = 0 \) and \( U_2 = V - V = 0 \)

- Old edition
  \[ W^O = n(V - c) + nV \]
  since \( U_1 = V + c - V - c = 0, U_2 = V - c \) and \( \pi = n(V + c - c) \)

- It follows that
  \[ W^O > W^N \]
  that is the new edition is social undesirable

Remarks
- Possibility of reselling the product (secondhand market exists)
  → competition for the monopoly
  → upgrading for disconnecting from the used good market
- New edition has no other goal (same valuation with old edition)
10 Reading List

- Baye, M. (2005), Managerial Economics and Business Strategy, McGraw Hill. [Ch. 7]
- Shy O. (1995), *Industrial Organization*, MIT Press. [Ch. 9, Ch. 11]
- Tirole J. (1988), *The Theory of Industrial Organization*, MIT Press. [Introduction], [Ch. 10] and [Sections 2.4 & 7.3]
• Martin S. (2002), Advanced Industrial Organization, Blackwell. [Ch. 9], [Ch. 14]
• Schumpeter J. (1943), Capitalism, Socialism and Democracy, Allen & Un-win.