Econ 101: Principles of Microeconomics
Chapter 15 - Oligopoly

Fall 2010

Outline

1. Understanding Oligopolies

2. Game Theory
   - The Prisoner’s Dilemma
   - Overcoming the Prisoner's Dilemma

3. Antitrust Policy
The Oligopoly

- Monopolies are quiet rare, in part due to regulatory efforts to discourage them.
- However, there are many markets that are dominated by a relatively few firms, known as oligopolies.
- The term oligopoly comes from two Greek words: oligoi meaning “few” and poleein meaning “to sell”.
- Examples of oligopolies include:
  1. Airliner Manufacturing: Boeing and Airbus
  2. Food Processing: Kraft Food, PepsiCo and Nestle
  3. US Beer Production: Anheuser-Busch and MillerCoors
  4. US Film Industry: Disney, Paramount, Warners, Columbia, 20th Century Fox and Universal
  7. US Airline Industry: Delta/NWA, United, American

The Problem With Oligopolies

- The problem with oligopolies is much that same as with monopolies—the firms realized they have some market power because relatively few firms provide the good or service.
- Oligopolies still compete— it’s just that the competition is not always as rigorous.
- The situation in which both competition occurs and firms exercise market power is known as imperfect competition
- The market power of the oligopoly will typically result in higher prices and lower production levels in the market than would be efficient
- However, the competition among firms, and particularly their incentives to cheat on each other, will dampen this effect relative to a monopoly.
- Oligopolies are a very difficult type of market structure to study, relative to either perfect competition or a monopoly.
Determining Whether an Oligopoly Exists

- An oligopoly is defined, not by the size of the firms, but by their relative market shares.
- Essentially, if relatively few firms control most of the market sales, then an oligopoly exists.
- One commonly used measure of market concentration is the Herfindahl-Hirschman Index (HHI), which is defined as:

\[
HHI = \sum_{i=1}^{N} S_i^2
\]  

where 
- \( S_i \) denotes the percent of market controlled by the \( i^{th} \) firm
- \( N \) denotes the number of firms in the market.

More on HHI’s

- The HHI ranges from zero to 10000 (i.e., \( 100^2 \) in the case of a monopoly)
- The US Department of Justice uses the following cutoffs:
  - \( HHI < 100 \) indicates a highly competitive market.
  - \( 100 < HHI < 1,000 \) indicates an unconcentrated market.
  - \( 1,000 < HHI < 1,800 \) indicates a moderately concentrated market.
  - \( HHI > 1,800 \) indicates a highly concentrated market.
- HHI examples:
  - PC Operating Systems: HHI=9,182 (Microsoft, Linux)
  - Wide-Body Aircraft: HHI=5,098 (Boeing, Airbus)
  - Diamond Mining: HHI=2,338 (De Beers, Alrosa, Rio Tinto)
  - Movie Distributors: HHI=1,096 (roughly equivalent to 10 first each owning 10% of the market)
  - Retail Grocers: HHI=321
An Alternative View

- A less formal way of looking at market concentration is to examine the market shares held by the top few firms in an industry.

Understanding Oligopolies

- The difficulty in studying oligopolies in general is that there are so many possible ways in which the firms might interact with each other.
  
  1. They might collude; i.e., cooperate with each other so as to maximize their joint profits, dividing up the profit among the firms.
     - Such collusion might take the form of overt collusion (such as forming a cartel)
     - Alternatively it might be indirect, implicit collusion.
  
  2. They might also act non-cooperatively, acting in their own self-interest, but taking into account the actions of other firms.

- In many ways, the actions of the firms become similar to playing games, such as Monopoly or Risk.

- Efforts to model such strategic interactions has led to a whole branch of economics and math known as game theory
The Duopoly

- In order to understand some of the possible behaviors in the case of oligopolies, consider the simplest case - the duopoly (i.e., two firms).
- Think, for example, of the airliner industry, which is dominated by two firms (Boeing and Airbus).
- Suppose that the demand for airliners in any given month is given by

<table>
<thead>
<tr>
<th>Price ($mill.)</th>
<th>Quantity Demanded</th>
<th>Total Revenue (TR = P \times Q)</th>
<th>Marginal Revenue (MR = \Delta TR/\Delta Q)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.00</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>3.50</td>
<td>1</td>
<td>3.50</td>
<td>3.50</td>
</tr>
<tr>
<td>3.00</td>
<td>2</td>
<td>6.00</td>
<td>2.50</td>
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<tr>
<td>2.50</td>
<td>3</td>
<td>7.50</td>
<td>1.50</td>
</tr>
<tr>
<td>2.00</td>
<td>4</td>
<td>8.00</td>
<td>0.50</td>
</tr>
<tr>
<td>1.50</td>
<td>5</td>
<td>7.50</td>
<td>-0.50</td>
</tr>
<tr>
<td>1.00</td>
<td>6</td>
<td>6.00</td>
<td>-1.50</td>
</tr>
<tr>
<td>0.50</td>
<td>7</td>
<td>3.50</td>
<td>-2.50</td>
</tr>
<tr>
<td>0</td>
<td>8</td>
<td>0</td>
<td>-3.50</td>
</tr>
</tbody>
</table>

- If \(MC = 1.75\), how much would a monopoly produce? \(Q = 2\)

The Collusion Outcome

- One alternative in the case of a duopoly would be for the two firms to form a cartel
- A cartel is an agreement among several producers to obey output restrictions in order to increase their joint profit.
- Essentially, the cartel acts like a monopolist and simply divides the market among members of the cartel.
- The most famous example of this is the Organization of Petroleum Exporting Countries (OPEC)
- OPEC was formed in 1960’s in response to quotas instituted by President Eisenhower and enforced on Venezuela and Persian Gulf Countries.
- The success of OPEC has varied over time with conditions in the market and geo-political relations among its members and customers.
- Cartels are typically illegal within countries, but in the case of OPEC, the cartel is made up of countries.
The Airline Industry Example

- In our airline duopoly, the cartel outcome would be to produce \( Q = 2 \) with \( P = 3.00 \), dividing the market between the two firms (i.e., \( Q_i = 1 \) for each firm).
- Assume for simplicity that there are no fixed costs and that MC are constant (i.e., MC=ATC) at 1.75.
- The profit for each firm would be:

\[
\text{Profit} = TR - TC = (P - ATC) \times Q_i = (3 - 1.75) \times 1 = 1.25 \text{ mill.}
\]

- The problem for our cartel is that each firm has an incentive to cheat.
- Suppose Boeing stuck to the agreement, making only 1 airplane \( (Q_B = 1) \), but Airbus decided to cheat, making 2 airplanes \( (Q_A = 2) \).
- With total output at \( Q = Q_A + Q_B = 3 \), price drops to 2.50.
- Airbus’s profit rises to

\[
(P - ATC) \times Q_A = (2.50 - 1.75) \times 2 = 1.50 \text{ mill.}
\]
- Boeing’s profit, however, falls to

\[
(P - ATC) \times Q_B = (2.50 - 1.75) \times 1 = 0.75 \text{ mill.}
\]

The Incentive to Cheat

- Where does the incentive to cheat come from?
- When Airbus cheats, two things change:
  1. The positive quantity effect: Airbus is able to sell more units (and Boeing looses out on this gain).
  2. The negative price effect: Both Airbus and Boeing face a lower price for what they do sell.

- Boeing is clearly hurt by the cheating
- Airbus, however, gains, since the quantity effect more than offsets the price effect.
- Of course, Boeing also has the same incentive to cheat.
- If they both cheat and produce 2 units each, then \( Q = 4, P = 2 \), and both firm’s profits drop to

\[
(P - ATC) \times Q_i = (2.00 - 1.75) \times 2 = 0.50 \text{ mill.}
\]
Analyzing the Behavior of Oligopolists

- Oligopoly presents the greatest challenge to economists
- The essence of oligopoly is strategic interdependence
- Each firm anticipates actions of its rivals when making decisions
- In order to understand and predict behavior in oligopoly markets
  - Economists have had to modify the tools used to analyze other market structures and to develop entirely new tools as well
- One approach—game theory—has yielded rich insights into oligopoly behavior
- Game theory deals with any situation in which the reward of any one player (called the payoff) depends on not only his or her own actions but also on those of other players in the game.
- In the case of a two-player game, the interaction is depicted using the payoff matrix.

The Prisoner’s Dilemma

- Perhaps the most famous “game” is the so-called Prison’s Dilemma.
- The underlying story here involves two accomplices in a crime who have been caught.
- The police have enough evidence to convict them of a lesser crime, putting them in prison for 5 years each.
- However, they also suspect that the two are guilty of a more serious crime, but lack the evidence to convict them.
- The goal of the police is to get one or both to confess to the more serious crime and implicate their partner in the process.
- Separating the two so that they can talk, they promise each that
  - If they confess (and their partner does not) they will get a more lenient sentence of 2 years.
  - If they refuse to confess (and their partner does), they will have the book thrown at them with a 20-year sentence.
  - If both confess, both get a 15-year sentence.
- What is the payoff matrix for this game and what should each player do?
The Payoff Matrix

<table>
<thead>
<tr>
<th></th>
<th>Don't Confess</th>
<th>Confess</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Louise</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Don't Confess</td>
<td>Louise gets 5-year sentence</td>
<td>Thelma gets 20-year sentence</td>
</tr>
<tr>
<td>Confess</td>
<td>Louise gets 20-year sentence</td>
<td>Thelma gets 15-year sentence</td>
</tr>
</tbody>
</table>

What Should Louise Do?

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</tbody>
</table>
What Should Thelma Do?

For each individual, their dominant strategy (i.e., their best action regardless of what the other individual chooses to do) is to confess.

Note that this is despite the fact that both individuals would be better off by choosing not to confess.

The result, is that both individual’s confess.

The result is what is known in game theory as a Nash Equilibrium; i.e., an equilibrium in which each player takes the action that is best for him or her given the actions taken by the other player.

This is named after the famous mathematician and Nobel prize Laureate John Nash.

Because the individuals do not take into account the impact of their actions on the other players, this is known as a noncooperative equilibrium.
Applying the Prisoner’s Dilemma

- Consider applying this problem to a duopoly of two gas stations located in a small town.
- Suppose the two gas station owners are named Sam and Gus.
- To simplify the analysis, suppose that there are only two price options for the firms: a high price and a low price.
- If both firms charge a low price, their profit per firm is $25,000.
- If both firms charge a high price, they both make more money, with profit per firm increasing to $50,000.
- Their fear, however, with the high price option is that the other firm will cheat and change the low price, in which case the high price station has a negative profit (-$10,000), while the low price station makes $75,000.
- The two owners also know that they cannot explicitly collude
- This is simply a Prisoner’s Dilemma Game

Gus and Sam’s Dilemma

<table>
<thead>
<tr>
<th></th>
<th>High Price</th>
<th>Low Price</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sam</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Price</td>
<td>Sam's Profit = $50,000</td>
<td>Sam's Profit = $75,000</td>
</tr>
<tr>
<td>Low Price</td>
<td>Gus's Profit = $50,000</td>
<td>Gus's Profit = -$10,000</td>
</tr>
<tr>
<td><strong>Gus</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Price</td>
<td>Gus's Profit = $75,000</td>
<td>Gus's Profit = $25,000</td>
</tr>
<tr>
<td>Low Price</td>
<td>Sam's Profit = -$10,000</td>
<td>Sam's Profit = $25,000</td>
</tr>
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Overcoming the Prisoner’s Dilemma

- The Prisoner’s Dilemma is a very simple example of a noncooperative game.
- One key feature of the game is that it assumes that the players interact only the one time.
- This is known in game theory as a **one-shot game**.
- In real-world applications, the players may interact frequently in the marketplace.
- This results in what are known as **repeated games**.
- In repeated games, strategic behavior can emerge, where players take into account that their actions can influence the behavior of other players.
- The game is no longer **noncooperative**, but is now formally known as a **cooperative game**.

**Tit-for-Tat**

- One strategy in a repeated game is to:
  - Begin by behaving cooperatively
  - If the other player cheats, then you engage in cheating the next period.
- This is known as the **tit for tat** strategy.
- Sometimes, simply cheating after the other player has cheated is not enough to enforce cooperation.
- Alternatively, one can engage in a **punishment** stage of the game, where you go beyond simply cheating and engage in extreme behavior.
  - The **punishment phase** can even be harmful to the punisher, but is meant to signal the **cost** of not cooperating.
  - The idea is to signal to the other player that there are significant costs to cheating.
- Examples of punishment phases show up in the real world, such as:
  - Price wars in the airline industry
  - Large output increases by Saudi Arabia to induce cartel cooperation.
Tacit Collusion

- Tit for Tat games are an examples of tacit collusion; i.e., when the firms attempt to control overall output (and hence price) indirectly without a formal agreement.

- Another form of tacit collusion is price leadership
  - One firm—the price leader—sets its price and other sellers copy that price
  - With price leadership, there is no formal agreement
  - Rather the decisions come about because firms realize—without formal discussion—that system benefits all of them
  - Decisions include
    - Choice of leader
    - Criteria it uses to set its price
    - Willingness of other firms to follow

The Limits to Collusion

- Oligopoly power—even with collusion—has its limits
  - Even colluding firms are constrained by market demand curve
  - Collusion—even when it is tacit—may be illegal
  - Collusion is limited by powerful incentives to cheat on any agreement

- No firm wants to completely destroy a collusive agreement by cheating, since this would mean a return to the non-cooperative equilibrium wherein each firm earns lower profit

- However, some firms may be willing to risk destroying agreement if benefits are great enough

- Cheating is most likely to occur—and collusion will be least successful—if
  1. There is difficulty observing other firms prices
  2. Market demand is unstable
  3. There are a large number of sellers
  4. The players have different underlying objectives
Antitrust Policy

- Prior to 1890, cartels were perfectly legal in the U.S.
- In 1881, Standard Oil Company came up with a specific mechanism for collusion: the trust.
- Under this system, firms would place their shares in the hands of a board of trustees, who would control the joint interests of the companies involved.
- In essence, this made the U.S. oil industry a monopoly (controlled by the trust).
- The public backlash led to the Sherman Antitrust Act of 1890, making trusts (and other such forms of collusion) illegal.
- In 1911, Standard Oil was broken up into a series of smaller companies that would compete with each other.
- In the past 20 years or so, the EU has also moved towards similar antitrust efforts.