OLIGOPOLY AND GAME THEORY

Instructor: Ghislain Nono Gueye

AUBURN UNIVERSITY

Comparing market structures

Perfectly competitive market	Monopolistic competition	Oligopoly	Monopoly
Many sellers	Many sellers	A few sellers	One seller
Similar products	Differentiated products	Typically differentiated products	Unique product without close substitutes
No barrier to entry and exit	Low barriers to entry or exit	Barriers to entry	High barriers to entry

Measuring market power in oligopoly

- Market power is the ability of a firm to control the price of the goods sold.
- There is a negative relationship between the number of firms in an industry and the market power that each firm has.
- In other words: *the fewer, the merrier*
- In general, economists use *concentration ratios* as a gauge of market power that firms have in an oligopoly.
- The most common concentration ratio used is the *four-firm concentration ratio*.

Measuring market power in oligopoly (2)

- The four-firm concentration ratio expresses the sales of the four largest firms in an industry as a percentage of the industry's total sales.
- For example, if the four largest firms in an industry are firms A, B, C and D with respective sales a, b, c and d.
- Given the total sales by all the firms in the industry is x, we can calculate the four-firm concentration ratio as:
- Four-firm concentration ratio = (a + b + c + d) / x

Measuring market power in oligopoly (3)

Industry	Four-firm concentration ratio	Top firms
Search engines	98.5	Google, Yahoo, Microsoft
Wireless Telecommunications	94.7	Verizon, AT&T, Sprint Nextel, T-Mobile
Satellite TV providers	94.5	DIRECTV, DISH Network
Soda production	93.7	Coca-Cola, PepsiCo, Dr Pepper Snapple
Sanitary paper products	92.7	Kimberly-Clark, Procter & Gamble, Georgia Pacific
Lighting and bulb manufacturing	91.9	General Electric, Philips, Siemens
Tire manufacturing	91.3	Goodyear, Michelin, Cooper, Bridgestone
Major household appliances	90.0	Whirlpool, Electrolux, General Electric, LG
Automobile manufacturing	87.0	General Motors, Toyota, Ford, Daimler-Chrysler

Source: Highly Concentrated: Companies That Dominate Their Industries, www.ibisworld.com. Special report, February 2012.

Measuring market power in oligopoly (4)

- In the search engines industry, for instance, the four largest firms hold a very high percentage of the market share (close to 100%).
- At the bottom of the list, in the automobile industry, the four largest firms hold 87% of the market share, which is still very significant.
- This illustrates the fact that oligopolists have big market shares and therefore enjoy significant market power.
- They have much control over their prices.

Collusion and Cartels

- Oligopoly is neither perfect competition nor is it monopoly.
- However, oligopolists often have competitive tendencies as well as monopolistic tendencies.
- They often end up competing against each other even though they have monopolistic advantages.
- In order to understand this better, let's use the case of a *duopoly*.
- A duopoly is an industry with only two firms.

Collusion and Cartels (2)

- Duopolies are hard to come by in general.
- However, we can find duopolies in small communities.
- For example, two telephone service providers could be enough in a small town of a couple of thousands people.
- Following is the demand schedule for cell phones in a small town:

Price in $ (P)	Number of customers (Q)	Total Revenue in $ (TR = P * Q)
180	0	0
165	100	16500
150	200	30000
135	300	40500
120	400	48000
105	500	52500
90	600	54000
75	700	52500
60	800	48000
45	900	40500
30	1000	30000
15	1100	16500
0	1200	0

Collusion and Cartels (4)

- If the two firms want to operate as perfectly competitive firms:
- The following condition must be satisfied: P = MR = MC
- Duopolies usually have excess capacity, which means that the marginal cost is equal to 0.
- For example, each cell phone service provider has a cell phone tower.
- Therefore, the additional cost incurred when a new subscriber is added is 0.
- Consequently, each firm will provide 1200 customers with free phones and will not get any revenues.
- This case scenario is efficient but utterly unrealistic.

Collusion and Cartels (6)

- If the two firms want to operate as monopolies:

- The monopolist chooses the price that maximizes his profit.
- He faces no kind of competition.
- According to the demand schedule, the total revenue is maximized when the price is $90.
- Total revenue is then $54000 with 600 customers.

Collusion and Cartels (7)

- In this case scenario, it is good for the two firms to *collude* so they can earn the highest profit.
- Collusion is an agreement between rival firms that specifies the price that each firm charges and the quantity it produces.
- Therefore, in order for both firms to maximize their profit, each needs to charge $90 and produce 300 phones.
- Each firm will then make a profit of $27000.
- However, collusion is very often illegal and is prohibited by anti-trust laws.
- Firms that have colluded are called a cartel.

Strategic choices

- Even if collusion occurs in a duopoly, there still remains a problem.
- A firm's sole purpose is to maximize profit.
- If both firms agree to charge $90 for their cell phones and produce 300 units each…
- … one of the two firms may be inclined to break the deal and charge a lower price in order to get a higher revenue.

Strategic choices (2)

- Let’s suppose firm A breaks the agreement and charges $75 instead of the agreed $90.
- The total market demand rises to 700.
- Firm A will have 400 customers meanwhile firm B will keep its former 300 customers.
- The new total revenue of firm A will change to $30000, which is an increase in total revenue of $3000 compared to when it was still charging $90.

Strategic choices (3)

- Seeing that firm A is making more profit having cut its price, firm B will react too and match firm A's price.
- Firm B revenue will come from its 300 customers at the new price of $75.
- Firm B's revenue will fall to $22500, which is a loss of $7500.
- But at this point, there is no reason why firm B should sit still and do nothing.
- It will lower its price further down to $60, which will cause an increase in its revenue to increase to $24000.

Strategic choices (4)

- Firm A will try to react to firm B's action by lowering its prices too.
- It would not be wise for firm A to try to increase its market share by lowering the price below $60.
- For example, if firm A charges $45, its revenue will go down to $22500, which is $1500 less than if it had just matched firm B's price.
- Both firms will end up charging $60 for their phones and individually make a profit of $24000.
- In an oligopoly, a firm's market share is determined by the products it offers, the price it charges and the actions of its competitors.

The Nash equilibrium

- The first kind of equilibrium we discussed earlier was the market equilibrium.
- The market equilibrium sets the price at a level that makes quantity demanded and quantity supplied equal.
- In the case of an oligopoly, price is not set the same way as we just saw.
- A Nash equilibrium is a state in which no economic agent can be better off by changing its current strategy.

The Nash equilibrium (2)

- In the cell phone oligopoly example, the Nash equilibrium occurs when each firm produces 400 phones at a price of $60 each.
- No firm can individually change this current strategy and increase its profit.

Game Theory

- So far, we have analyzed strategic decisions in a duopoly.
- Those decisions are said to be “strategic” because they depend on what others do.
- In our duopoly example, firm A broke the deal, then firm B reacted, then firm A reacted again… and they finally reached an equilibrium.
- This is an example of game theory – a branch of mathematics used in economics to analyze the strategic behavior of decision-makers.
- In general, game theory allows us to determine the level of cooperation which is most likely to occur.

A game

- A game consists of:
- A set of players: firm A and firm B
- A set of strategies available: cut price, increase price
- A specification of the payoffs for each combination of strategies: more profit, less profit, same profit
- A game is usually represented by a payoff matrix.
- A payoff matrix shows the players, the available strategies and the corresponding payoffs.

A very popular game: the prisoner's dilemma

- Two prisoners are being interrogated separately about a crime they both participated in.
- Each is offered a plea bargain to cooperate by testifying against the other.
- If both suspects refuse to cooperate, neither can be convicted of a more serious crime though they will have to spend some time in jail.
- But the police have offered full immunity if one cooperates and the other does not.
- If both confess, they will spend more time in jail than if they had both stayed quiet.

A very popular game: the prisoner's dilemma: payoff matrix

Prisoner A \ Prisoner B	Testify	Keep quiet
Testify	(10,10)	(0,25)
Keep quiet	(25,0)	(1,1)

- Two players are in this game: prisoner A and prisoner B
- Each player has two strategies: to testify or to keep quiet
- The numbers in blue are the payoffs of prisoner A.
- The numbers in red are the payoffs of prisoner B.
- If both testify, they will both spend 10 years in jail.
- If both keep quiet, they will both spend only 1 year in jail.
- If one confesses and the other stays quiet, the one who confesses will be immediately released but the prisoner who stayed quiet will spend 25 years in jail.

A very popular game: the prisoner's dilemma: payoff matrix (2)

Prisoner A \ Prisoner B	Testify	Keep quiet
Testify	1 (10,10)	2 (0,25)
Keep quiet	3 (25,0)	4 (1,1)

- If both prisoners testify (quadrant 1):
  - Prisoner A gets 10 years
  - Prisoner B gets 10 years
- If both prisoners keep quiet (quadrant 4):
  - Prisoner A gets 1 year
  - Prisoner B gets 1 year
- If prisoner A testifies and prisoner B keeps quiet (quadrant 2):
  - Prisoner A goes free
  - Prisoner B gets 25 years
- If prisoner A keeps quiet and prisoner B testifies: (quadrant 3)
  - Prisoner A gets 25 years
  - Prisoner B goes free.

Analyzing the prisoner's dilemma

- Each suspect is interrogated separately and simultaneously.
- The decisions of each prisoner is therefore made non-cooperatively, which is why they both face a dilemma.
- Dilemma faced by prisoner A if he testifies:

- He gets 10 years if prisoner B also testifies.
- He goes free if prisoner B keeps quiet

- Dilemma faced by prisoner A if he keeps quiet:

- He gets 25 years if prisoner B testifies.
- He gets 1 year if prisoner B also keeps quiet.

Analyzing the prisoner's dilemma (2)

- No matter what choice prisoner B makes, prisoner A is always better off choosing to testify.
- In the same way, no matter what choice prisoner A makes, prisoner B is always better off choosing to testify.
- *They will end up testifying both and getting a 10-year sentence even though keeping quiet has a better outcome.*
- In this game, to testify is called a dominant strategy.
- A dominant strategy is a strategy whose outcome is the best irrespective of the choices of other players.

Finding the dominant strategy in a few games: Game 1

		Player B: Left	Player B: Right
Player A	Up	1 (7,2)	2 (5,3)
	Down	3 (3,4)	4 (4,6)

Game 1: Player A

- The two players in this game are player A and player B.
- Player A's strategies are Up and Down.
- Player B's strategies are Left and Right.
- If player A chooses Up:
- His payoff is 7 if player B chooses left.
- His payoff is 5 if player B chooses right.
- If player A chooses Down:
- His payoff is 3 if player B chooses left.
- His payoff is 4 if player B chooses right.
- Player A's dominant strategy is Up because his payoff is the highest irrespective of player B's choice.

Game 1: Player B

- Player B’s strategies are Left and Right.
- If player B chooses Left:
- His payoff is 2 if player A chooses Up.
- His payoff is 4 if player A chooses Down.
- If player B chooses Right:
- His payoff is 3 if player A chooses Up.
- His payoff is 6 if player A chooses Down.
- Player B’s dominant strategy is Right because his payoff is the highest irrespective of player A’s choice.