

Oligopoly

Oligopoly is a market structure in which the number of sellers is small.

Oligopoly requires strategic thinking, unlike perfect competition, monopoly, and monopolistic competition.

- Under perfect competition, monopoly, and monopolistic competition, a seller faces a well defined demand curve for its output, and should choose the quantity where $MR=MC$. The seller does not worry about how other sellers will react, because either the seller is negligibly small, or already a monopoly.
- Under oligopoly, a seller is big enough to affect the market. You must respond to your rivals' choices, but your rivals are responding to your choices.

In oligopoly markets, there is a tension between cooperation and self-interest. If all the firms limit their output, the price is high, but then firms have an incentive to expand output.

The techniques of game theory are used to solve for the equilibrium of an oligopoly market.

“Duopoly” example: Jack and Jill choose how many gallons of water to pump and sell in town. To keep things simple, assume zero costs.

The demand schedule gives us the price the buyers are willing to pay, as a function of the total combined output of Jack and Jill.

If the market structure were perfectly competitive, the market supply curve would be based on marginal costs, so the price would be zero and the quantity would be 120. This is the socially efficient outcome.

If the market structure were a monopoly, the price would be 60 and the quantity would be 60. This outcome maximizes industry profits, and there is a deadweight loss.

If Jack and Jill could form a *cartel*, they would collude with each other to act in unison, like a monopoly. Each seller would produce 30 gallons and share the monopoly profits.

Would they come to this arrangement if they had to choose their quantities separately?

Suppose Jack expects Jill to produce 30 gallons. If he produces 30, both receive profits of \$1800.

But, if he produces 40, the total quantity supplied to the market is 70 gallons, so the market price is \$50. Therefore, Jack's profit would be \$2000, and Jill's profit would be \$1500.

By increasing output and expanding market share, total industry profits fall but Jack is better off. Since Jill is in the same situation, both sellers have an incentive to produce more than their share of the monopoly output.

The cartel solution is not stable. Without the ability to commit to the cartel, self-interest pushes the price below the monopoly level.

What is the duopoly solution?

Suppose Jack and Jill each produce 40 gallons, so that the market price is \$40 and each receives profits of \$1600. Can either seller do better by choosing a different quantity?

If Jack were to produce 30 gallons, the price would be \$50 and his profits would only be \$1500.

If Jack were to produce 50 gallons, the price would be \$30 and his profits would only be \$1500.

Jack and Jill each producing 40 gallons is the *Nash equilibrium* of this oligopoly game. It is stable—neither seller would want to change behavior. Put another way, if each seller expected the other to choose 40, their best response is to choose 40, thereby confirming the expectations.

For general games, a Nash equilibrium is defined to be a combination of strategies (one for each player), for which no player has an alternative strategy that yields a higher payoff, given the strategies chosen by the other players.

This is a notion of joint rationality. Each player is best responding to the other players.

Beyond the example: what can we say, in general, about the Nash equilibrium of “quantity competition” oligopoly games?

With duopoly (like monopoly), there is an output effect and a price effect.

Output effect: Selling one more gallon allows the seller to receive the market price for that gallon.

Price effect: Selling one more gallon causes the market price to fall for all of the gallons the seller produces.

The difference between monopoly and duopoly is that the price effect is cut in half for duopoly, because the reduction in price is multiplied by half the output (in the Nash equilibrium, which is symmetric). Jack does not care that Jill’s output is sold at a lower price.

The price effect is smaller for duopoly than monopoly, and the quantity effect favors more output whenever price is above marginal cost. Therefore, the Nash equilibrium price will be closer to marginal cost than the monopoly price.

The more firms in the oligopoly, the smaller the price effect will be, and the lower the Nash equilibrium price.

When the number of firms approaches infinity, the price effect approaches zero. Therefore, each seller will increase output whenever the price is above marginal cost. In the limit, we have the perfectly competitive price, and the socially efficient quantity.

A Brief Introduction to Game Theory

Game Theory can be used to study oligopoly games other than the “quantity competition” game played by Jack and Jill, as well as arms races, voting games, bargaining games, and so on.

A Game is defined to be:

- A set of *players*
- A set of possible *strategies* for each player,
- A payoff or outcome function that assigns payoffs to each player for each combination of strategies (one strategy for each player).

The Prisoners' Dilemma

Bonnie and Clyde are caught with illegal weapons (1 year sentence), but are suspected of bank robbery. Interrogated in separate rooms.

If both remain silent, one year each.

If one confesses, and testifies against the other, he or she will get immunity and the other gets 20 years.

If both confess, their testimony is not needed, and the plea bargain is 8 years each.

The above description specifies everything needed to define a game: the set of players, the strategy sets, and the payoff function. We can represent the game in matrix form.

		Bonnie's decision	
		confess	remain silent
Clyde's decision	confess	-8 , -8	0 , -20
	remain silent	-20 , 0	-1 , -1

In the matrix above, Clyde's payoff is the first number, and Bonnie's payoff is the second number.

Clyde reasons: "If Bonnie confesses, I can confess and get 8 years, or remain silent and get 20 years. If Bonnie remains silent, I can confess and get 0 years, or remain silent and get 1 year. Either way, confess is a better strategy."

Bonnie reasons the same way, and they each get 8 years.

Confess is a *dominant strategy*. A dominant

strategy is a strategy that gives a higher payoff than any other strategy, no matter what strategies the other players are choosing.

A dominant strategy equilibrium is a special case of a Nash equilibrium. If your strategy is best no matter what, then it is best given what the other players are choosing.

Notice that the Prisoners' Dilemma is not a zero-sum game. If somehow Bonnie and Clyde could cooperate, they could remain silent and only get 1 year.

Prisoner's Dilemmas arise in many situations, like the oligopoly game played by Jack and Jill. Restrict attention to two production levels, 30 gallons and 40 gallons.

Low production is the cooperative action, analogous to remain silent, and high production is the action analogous to confess.

In the arms race game, disarm is analogous to

remain silent and arm is analogous to confess.

It is better to be safe than to be at risk, but the cooperative outcome is not stable. If the other side does not arm, then arming keeps you safe and increases your influence in world affairs. If the other side arms, then you are at risk whatever you do, but arming maintains a balance of power.

In the common resources game, Exxon and Chevron own land on top of a pool of oil worth \$12 million. They each must choose whether to drill one well or two wells. Drilling a well costs \$1 million.

If Exxon and Chevron both drill the same number of wells, they each receive \$6 million in revenues. If not, the company that drills 2 wells receives $\frac{2}{3}$ of the revenue (\$8 million) and the company that drills one well receives $\frac{1}{3}$ of the revenue (\$4 million).

Repeated Games

Most oligopoly markets involve sellers who repeatedly compete against each other. Game Theory can still be applied, but the game is more complicated.

Suppose Jack and Jill choose how much water to bring to the market each week. Now a strategy specifies how many gallons to bring during each week, *as a function of what choices were made in the past*. These more complicated strategy sets (sets of functions) allow for rewards and punishments.

Here is a “Trigger strategy” for Jack: Choose 30 gallons in week 1, and continue to choose 30 gallons if Jill has always chosen 30 gallons. If Jill ever chooses a different quantity, choose 40 gallons forever after.

In the infinitely repeated game, it is a Nash equilibrium for Jack and Jill to choose this trigger strategy.

Why is it a Nash equilibrium? Jack is receiving profits of \$1800 per week. If he decides to produce 40 gallons one week, then during that week his profits are \$2000, but every week afterwards his profits are only \$1600.

Without any collusion, Jack and Jill can achieve the cartel outcome. From an economics standpoint, the cartel outcome supported by punishment strategies is the same as collusion. This is a problem for antitrust authorities.

Notice that the cooperative, “good” equilibrium from the standpoint of the sellers is inefficient from society’s standpoint.

In practice, oligopolists have a hard time maintaining cartel profits. Often the strategic choices are not observed by rivals. OPEC countries can secretly pump more oil than what was agreed upon, and demand fluctuations make the cheating hard to spot.

In games with imperfect information, the best Nash equilibrium sometimes involves cycles of cartel discipline followed by a breakdown.

Price Competition

To properly apply Game Theory to a real world market, the game must match the strategic interaction in the market.

For example, making quantity the strategic choice works for the oil market, but not for the airlines market or an auction market, where price is the strategic choice.

Suppose Jack and Jill have huge inventories of water on hand, so the strategic choice is what price to charge. If both charge the same price, they split the market equally. Otherwise, the seller charging the lower price serves the entire market.

Now the Nash equilibrium is for each seller to charge a price of zero! Price competition leads to marginal cost pricing and the socially efficient quantities.

Notice that cartel outcomes are possible as Nash equilibria in games of repeated price competition. In fact, many equilibria are possible in repeated games.

With huge fixed investments and low marginal costs (as in the airlines industry), the number of firms the industry can support depends on the degree of implicit cooperation that can be supported.

There are uncertainties about costs and demand, and different firms might have different ideas about how the cartel should evolve. A price cut that attempts to lead the cartel to a lower price in response to changing market conditions might be misinterpreted as an attempt to cheat. We might expect cycles of profitable periods and price wars.

Sometimes fine details about the strategic environment matter a lot.

- price vs. quantity competition
- uncertainty in demand or costs
- do consumers observe all prices or do they have to search
- producing to order, or for inventory

Complicated issues for antitrust policy

1. Resale Price Maintenance

Manufacturer requires that all retailers sell at a specified price. Are the retailers using the manufacturer to enforce their cartel? Why doesn't the manufacturer want to set a high wholesale price and let retailers compete?

- free rideable services to enhance demand
- provide effective distribution of inventories

2. Predatory Pricing

Should we be concerned with a monopolist reacting to entry by charging too low a price, in order to drive the rival out of business?

Usually not. The monopolist has the bigger market share, and is probably losing more profits than the rival. The major airlines accommodated Southwest (and Southwest was smart enough to enter in secondary airports like Love Field, Midway, National, and Newark).

If the monopolist is more efficient, we should expect a price drop and the rival getting forced out.

On the other hand, the monopolist might have an incentive to send a message to other potential rivals in other cities, in which case it is like a repeated game. Starbucks and Cup O' Joe.

3. Tying Contracts

IBM and punchcards

Is this a way for IBM to use its monopoly over mainframe computers to muscle into the punchcard business?

No. Suppose buyers are willing to pay \$1000 for mainframe service, and punchcards are sold on a perfectly competitive market for \$10. Then IBM can use its monopoly power to charge \$1000 for computers, or it can charge \$1010 for the bundle, but incur the cost of \$10 for punchcards. No advantage from tying.

Tying can be a technique for price discrimination.

Tying can enhance efficiency by providing a seamless interface: Windows and Internet Explorer.

But, ...

Given that browsers are given away for free but can help generate advertising revenue, one could argue that Microsoft is unfairly expanding its reach.