Economics: Notes – Oligopoly & Game Theory


Oligopoly

Oligopoly describes the condition where a company has a great deal of market power because it operates in a market with only a few firms that each produce goods that are clearly different (are not close substitutes).

Typically, the firms in an oligopoly are large companies that require large amounts of capital and years of planning time - a long “short run”. The automobile market is a typical example of oligopoly. While the different types of products in the market are similar, they are not close substitutes.

These factors create a situation where companies can operate closer to a monopoly. Oligopolies exercise large market power to earn higher profits. However, unlike a monopoly, or even a financial trust, the firms in oligopoly are not colluding. They are in competition with each other. However, the level of competition may not be that great.

Competition in Oligopoly

Economist have had a hard time developing theories for how oligopolies compete because the model of oligopoly is so different from other market systems (perfect competition, monopolistic competition and monopoly).

The neoclassical model of markets viewed a company subjected to the forces of a market and that the company would seek to maximize its profits, and its ability to earn an economic profit was based on the amount of competition it faced - market forces of competition would reduce profits.

The only way to avoid market competition and earn profits in the long run was for a firm to become a monopoly or for the firms in a market to collude to fix the market price.

The problem for economist was how to explain long-run profits without collusion – that is, in a state of competition.

Competition & Long-Run Profits

An example of long-run profits in a competitive situation is that of two gas stations on the opposite corners of a busy intersection. They are the only competitors in a market (gas stations in other places are literally distant substitutes). The reality is that they charge similar prices and will make profits in the long-run.

The question is: if they are competitors, why don’t they lower their prices to drive the other out of business and become a monopoly?

The basic answer is that guaranteed lower long-run profits are better than short-run losses that might potentially lead to long-run high profits (each station might loses the price war to become a monopoly).

Oligopoly – A Different Type of Market

The oligopoly situation is fundamentally different from other types of markets in which models consider how a firm operates when confronted by market forces (which represent the behavior of all the other firms grouped together). In perfect competition the competition of market forces are great and in monopoly they are non-existent.
In an oligopoly, the competing firms are not seen as large market forces, but as a handful of other firms. When deciding how to act in the market (such as setting a price), the firm in oligopoly needs to think about the actions of a few specific other companies.

Instead of thinking about simply producing at a profit maximizing quantity, the oligopoly needs to think strategically about how the other firms will act and how they will be affected by the other firm’s markets.

**Goals and Perspective of the Oligopolist**

Typically oligopolies are well established companies that operate in markets that have large barriers to entry and exit (usually because of the large amount of capital required to operate in these markets). Because oligopolies are established companies (think of brands with loyal customers) it is hard for competitors to drive them out of business. This is because:

- Customer loyalty means that customers do not see other firm’s products as perfect substitutes.
- Large capital costs means these companies have a long short-run (and will stay in a market while operating at a loss).

As a result, the companies in oligopolies have established the market share and do not actively seek to compete with other firms beyond increasing, or protecting, their market share.

**Price Theory Model of Oligopoly**

One theory about oligopolies holds that one company – the largest and most powerful – becomes the price leader in a market. It can set the price for its goods and all the other companies set their prices based on the price leader. In this theory, the price leader will set a price that will maximize their profits, and the other companies will follow this price.

However, the problem with this theory is that it does not explain why the other firms do not try to undercut the price leader or attempt to become the price leader. In other words, it holds that while the firms do not collude, they are not really competing, just playing “follow the leader”.

**Game Theory & Oligopoly**

It was not until the development of game theory that there was a convincing explanation for oligopoly.

Game theory studies interactive situations with a focus on how to best strategize in competitive situation. Game theory sets up scenarios (or games) in which two (or more) players have to make independent decisions. The outcome they get is based on their decision and the decision of the other player. For this reason, when deciding about what to do, a player needs to strategically think about the choices made by the other player.

Game theory applies to oligopoly because the few number of firms in a market means that each company needs to account for the other companies’ choices and actions when it is setting its own strategy for operating in the market.

**Market Equilibrium vs. Game Theory**

Game theory approaches economic problems from the perspective of individuals that are out to achieve goals and consider how other individuals will act. This is a different perspective than neoclassical economics, which is based on the idea of market equilibrium.

This difference in perspective means that neoclassical economists think in terms of “equilibrium models” that are based on the idea that markets reach economically efficient equilibrium solutions.
In contrast, game theory builds “agent based models” in which individual agents act with set parameters on their strategies and their collective interaction can lead to a variety of outcomes, and they may not result in an optimal equilibrium solution.

**Zero Sum Games & Maxmin Strategies**

The concept of game theory was first developed by John von Neumann and Oskar Morgenstern in a book called, “The Theory of Games and Economic Behavior” in 1944.

In the book they introduced the simple two person zero-sum game. A zero sum game is one where one person’s gain is at the expense of the other person – it is a situation of "pure conflict".

The chart to the right shows this game. The letters show each player’s choice and the numbers the benefits they will get. The first player will get the number, the second player will get the negative version of the number.

<table>
<thead>
<tr>
<th>First Player’s Strategy</th>
<th>Second Player’s Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>5</td>
</tr>
<tr>
<td>B</td>
<td>3</td>
</tr>
<tr>
<td>B</td>
<td>7</td>
</tr>
<tr>
<td>A</td>
<td>2</td>
</tr>
</tbody>
</table>

**Maxmin Strategies**

In this game, if the first player chooses “B” and the second player chooses “B” then the first player will get 2 and the second player will get -2.

Facing this payoff matrix, the best strategy for the first player is to chose “A”. The second player will now choose “A” because it will mean the lowest loss. This is the “best-worst” strategy.

The result is the “best-worst” outcome for both players, which is the reason it is called the “maxmin” strategy. The outcome is that neither player gets their preferred result – a little like life.

However, what about “non zero-sum” games where there is an opportunity to gain from cooperation?

**Non-Zero Sum Games & Strategy**

In a non-zero sum game, the players make choices that can benefit both players (but the benefits may not be equal). In game theory, a strategy that produces the best outcome is called an optimal strategy while one that produces any other outcome is a sub-optimal strategy.

The problem with neo classical economic theory for oligopoly is that it would suggest that companies should choose an optimal strategy that would maximize profits by undercutting the price leader.

However, the reality of oligopoly is that companies often choose a sub-optimal strategy of pricing close to the price leader. The fact that the dominant strategy was a sub-optimal strategy confused many economists before the work of John Nash.

John Nash, through his developments in game theory, explained how companies operating in a competitive market would chose sub-optimal strategy because it was the best strategy based on expected strategy of the other companies – this has become known as a Nash Equilibrium.

Basically, companies would choose to keep their prices higher and earn less profits if there was a greater success of achieving those profits. While, there might be greater profits in undercutting the price leader, there is also the risk that this might trigger a price war between companies that will result in little or no profit.

While the choices seem obvious, the problem was explaining how a company decides to act without knowing the decision made by the other companies in the market.
Nash stated the oligopoly situation as a non-zero sum game in which each company followed a strategy based on the expected strategy of the other companies.

**Prisoners’ Dilemma**

The classic example of a Nash Equilibrium is the game known as prisoner’s dilemma.

Imagine two prisoners that have been arrested for committing a serious crime. They worked together in committing this crime and both have evidence that could convict the other. The problem is that the police do not have enough evidence to convict either prisoner for the crime. Without more evidence, both prisoners will go free.

In this situation, the police separate the two prisoners by placing them in different integration rooms – this limits their ability to work together to “beat the rap”.

Now the prisoners need to decide to confess and give evidence or stay quiet – they also need to think about whether their partner in crime will confess and give evidence.

Once they are separated, the police can approach each one with a deal of conviction on a lesser charge if they give evidence against their partner in crime. Of course, the police offer the deal to both prisoners – under the idea that the first to talk gets the deal. Can the police get the evidence or is their honor among thieves? Well, if the police offer enough incentive to talk and the punishment facing the prisoner that does not talk is severe enough, both prisoners will give evidence against the other. Consider the table below showing years in prison for each choice:

For the prisoners, the best choice is for neither prisoner to confess so they both go free – that is the optimal outcome. However, if one prisoner gives evidence and the other does not, the one that gives evidence receives a light sentence, with the other gets a long sentence – a sub-optimal outcome (especially for the one that did not talk).

If they both give evidence, they both get moderate sentences – again this is sub-optimal, but not the worse situation.

The dominant strategy for both prisoners is to choose the sub-optimal strategy of confessing because, while not the best, it is not the worst result.

Clearly, each prisoner has to consider the action of the other, which leads them to the conclusion that best choice is to confess.

In game theory terminology, players can either choose to “cooperate” or “defect”. In the case of prisoners’ dilemma, the best strategy is to defect.

The dominant strategy of defecting in prisoners’ dilemma is because the players cannot communicate with each other or punish each other (retaliate) for choosing a sub-optimal strategy.

**Multiple Iteration Games and a Cooperative World**

The choice of defecting as the dominant strategy is not so clear if the prisoners play the game multiple times in a row. In that case, a player could take the risk of playing the optimal strategy (cooperating) with the threat of playing the non-optimal strategy (defecting) in the following turn if other player chooses to defect (instead of cooperating).
If a player adopts this strategy, then they could “signal” to the other player that they are willing to cooperate, but will retaliate if the other player does not cooperate.

This way the optimal strategy can become the dominant strategy.

While it seems to defy the logic of profit maximization, often companies in competitive and risky situations often operate under much the same logic. It is better to choose a strategy that will give less profit rather than a riskier strategy that might be more profitable but could also be more costly.

In essence the strategy is not to maximize profit, but to minimize loses – Cooperate and receive a small risk free profit instead of defecting which could result in either winning or losing a large profit. (As a point of connection, think of how this connects to the Behavioral Economics concept of Prospect Theory).

However, if the risks are calculated and factored in, these companies are still trying to maximize their profits – only that they have calculated the expected probability of receiving a profit.

**Prisoners’ Dilemma and Neoclassical Economic Theory**

The reality of Nash Equilibrium challenged the ideals of neoclassical economics – namely that self-interested economic actors will make choices that will create the greatest individual and social benefits.

Clearly, if self-interested individuals were choosing to defect to a “sub-optimal” equilibrium, this ideal was not being met.

While the ideas of game theory do challenge neoclassical equilibrium theory, this does not mean that neoclassical equilibrium theory is wrong. It is just not the best tool for analyzing oligopoly markets.

**Business Example of Game Theory - Pricing Strategy**

The diagram to the right shows the game theory matrix for an oligopoly market made up of two companies: Alpha and Beta. The diagram shows profits in millions of dollars that each company will receive based on its pricing policy. Beta’s profits are shown in the northeast corner and Alpha’s profits in the southwest corner of each cell.

What is the result if both firms follow a high-price policy?
If Beta commits to a high-price policy, what strategy should Alpha follow?

If Alpha makes a strategic pricing decision without knowing Beta’s choice, but is able to project an expected decision for Beta, what would be the best strategic decision for Alpha to make?

What is the most likely outcome of the strategic decisions made by Alpha and Beta?

**Stag Hunt – A Game of Social Cooperation**

The game of Stag Hunt describes a conflict between safety and social cooperation. Two individual go out on a hunt. Each can choose to hunt a stag or hunt a rabbit. Each player must choose an action without knowing the choice of the other. If a player hunts a stag, he must have the cooperation of his partner to succeed. An individual player can get a rabbit by themselves. A stag is worth more than a rabbit. This game is used as an analogy for social cooperation.
Game of Chicken

This is a game in which two players engage in an activity that will result in serious harm unless one of them backs down.

The game describes a situation in which the players are driving cars at each other in a head-on collision. The first to turn away is humiliated as the “chicken”.

The phrase game of chicken may also be used as a metaphor for a situation where two parties engage in a showdown where they have nothing to gain, and only pride stops them from backing down. An example of this is the case of nuclear brinkmanship during the Cold War.

<table>
<thead>
<tr>
<th>Player 1</th>
<th>Turn away</th>
<th>Drive straight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turn away</td>
<td>0, 0</td>
<td>-1, +1</td>
</tr>
<tr>
<td>Drive straight</td>
<td>+1, -1</td>
<td>-20, -20</td>
</tr>
</tbody>
</table>

Game Theory and Market Design Theory

Game Theory has become the central idea to the process of “matching” in Market Design Theory. Economists use Market Design Theory to replicate the market process for situations where markets do not work for private goods. The market system does not work for some types of private goods because markets fail to provide a good environment for people be matched up to conduct exchanges. In most markets, buyers and sellers are able to meet, carefully compare options and openly negotiate on a price. In order for this to happen, a market has to do the following three things:

- The market needs to bring together enough buyers and sellers to allow for both sides to get a good outcome - economists use the term "thickness" to describe this characteristic of markets.
- The market needs to be safe for market participants to reveal or act on confidential information - typically, markets provide an incentive for participants to reveal what they know.
- The market needs to give participants enough time to make choices between different options and also allow participants to conduct transactions quickly - economists use the term "congestion" to describe this characteristic of markets.

If a market does not do these things, then there is a “matching” problem in which buyers cannot coordinate their transactions with sellers in a way that is both individually satisfying and socially sufficient. Economists have used Game Theory to design programs that allow participants to be matched so that they can engage in transitions. Typically, these are computer based programs that allow large numbers of participants to safely reveal confidential information and that use complex algorithms to quickly match participants. Examples of this are kidney exchange, specialized labor markets (such as doctors), choosing schools in urban school districts and selling the radio spectrum for communication.