THEME 2: FIRMS' STRATEGIES AND MARKET FAILURE
SYLLABUS CONTENT (H3)

Theme 2: Firms' Strategies and Market Failure	
Theme 2 examines strategies and decisions made by firms to achieve their objectives. These strategies include game theory strategies and other strategies to develop competitive advantage, counter risk, uncertainty and asymmetric information. With reference to quasi-public goods and asymmetric information, candidates will be able to examine market failure and evaluate strategies and policies.	
Economics Content	
2.1 Firms' Strategies	**Additional Information**
2.1.1 How firms make decisions and develop strategies to achieve their objectives a. Strategies to develop competitive advantage in consideration of the nature and competitive intensity of the market through analysis of competitive rivalry within an industry, bargaining power of suppliers, bargaining power of customers, threat of new entrants and threat of substitute products b. Strategies with respect to other firms' decisions (including strategies arising from game theory and the economics of cooperation: prisoner's dilemma, Nash equilibrium)	Only analysis of equilibrium in pure strategies for Game Theory is required. Detailed technical analyses of Game Theory are not required.
2.2 Market Failure	
2.2.1 Quasi-public goods a. Issue of common resources (the tragedy of the commons) and significance of clearly-defined property rights – Coase Theorem and tradeable permits b. Club goods 2.2.2 Uncertainty and asymmetric information a. Uncertainty and attitudes to risk (risk-averse, risk neutral and risk-inclined) b. Asymmetric information in relation to problems of adverse selection, moral hazard and principal-agent problem in product, insurance and labour markets c. Effects of uncertainty and asymmetric information on the decisions made by economic agents d. Strategies and policy measures to address problems of risk and uncertainty, and asymmetric information including insurance, monitoring, co-payment, signalling, screening and efficiency wages	Detailed technical analyses of risk, uncertainty, and asymmetric information are not required.

Anderson Serangoon Junior College
JC2 H3 Economics 2025

THEME 2: FIRMS' STRATEGIES AND MARKET FAILURE

CHAPTER 1: FIRMS' STRATEGIES

1. STRATEGIES TO DEVELOP COMPETITIVE ADVANTAGE

- **EFFICIENCY AND EQUITY**
  - **X-INEFFICIENCY**
  - **EQUITY**
  - **SOCIAL EFFICIENCY: 'PARETO OPTIMALITY'**
- **FIVE FORCES STRATEGIC MODEL**
  - **DETERMINING COMPETITIVE ADVANTAGE**
  - **ACHIEVING COMPETITIVE ADVANTAGE**

2. STRATEGIES WITH RESPECT TO OTHER FIRMS' DECISIONS

- **COMPETITION AND COLLUSION**
  - **TACIT COLLUSION: PRICE LEADERSHIP**
  - **FACTORS FAVOURING COLLUSION**
  - **NON-COLLUSIVE OLIGOPOLY**
    - **THE BERTRABD MODEL**
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- **GAME THEORY**
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  - **COOPERATIVE AND NON-COOPERATIVE GAMES**
  - **THE THREE ELEMENTS OF GAMES**
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  - **PRICE COMPETITION**
  - **ADVERTISING**

Firms' Strategies and Market Failure

Overview

In Theme 2, the decision-making approach will be explored further as we look into firms and their strategies, markets and market failure.

In Theme 2.1.1, we look at firms' strategies to achieve their primary goal of maximising profits. First, we will examine the economic aspects of Michael Porter's Five Forces model and how it can be applied to help firms develop a competitive advantage. To a certain extent, firms have control over these decisions, but they cannot be made in isolation because they exist in dynamic market environments. We will thus look at how firms react strategically to each other's decisions as we examine game theory and the economics of cooperation. Some important questions that will be explored are:

- How does a firm develop competitive advantage in consideration of the nature and competitive intensity of the market?
- What strategies should firms prioritise in their decision-making?
- How do firms thrive in a dynamic market environment?
- How should firms take into account the decisions of other economic agents in their own decision-making?

1. Strategies to develop competitive advantage

Introduction

In the theory of the firm, it is commonly assumed that the objective of the firm and its owner(s) is to maximise profits. As firms make decisions, these decisions will invariably affect firms' profitability and efficiency as well as societal welfare.

The different dimensions of efficiency include:

- Productive efficiency
- Allocative efficiency
- Dynamic efficiency
- X-inefficiency

Economic efficiency says nothing about fairness or equity. A set of values and beliefs thus governs the choice of how equity should be defined.

Examples of the views of equity include:

- Utilitarian Approach
- Contractarian Approach (Rawlsian Approach)

Societal welfare is typically defined as the summation of consumer and producer surplus in H2 Economics. The existence of market failures will create deadweight loss to society thereby prompting the possibility of government intervention.

Firms develop competitive advantage in consideration of the nature and competitive intensity of the market through analysis of competitive rivalry within an industry, bargaining power of suppliers, bargaining power of customers, threat of new entrants and threat of substitute products.

Firms often use competitive strategic analysis in marketing and strategic management to assess strengths and weaknesses of competitors within the market. With this analysis, firms implement strategies that will provide them with a distinct advantage over their competitors and enact barriers to prevent competitors from entering the market.

Strategies of Firms includes:

- Advertising
- Research and Development
- Innovation
- Outsourcing
- Patents
- Other Entry Limiting Behaviour

Efficiency and Equity

Microeconomics is concerned with the allocation of scarce resources: with the answering of the what, how and for whom questions. But how satisfactorily will these questions be answered? Clearly this depends on society's objectives.

There are two major objectives that we can identify: efficiency and equity.

Efficiency. If altering what was produced or how it was produced could make us all better off (or at least make some of us better off without anyone losing), then it would be efficient to do so. For a society to achieve full economic efficiency, three conditions must be met:

Efficiency in production (productive efficiency)

- This is where production of each item is at minimum cost. Producing any other way would cost more. It is the least-cost combination of factors for a given output or the maximum output for a given cost of production.

Efficiency in consumption.

- This is where consumers allocate their expenditures so as to get maximum satisfaction from their income. Any other pattern of consumption would make people feel worse off.

Efficiency in specialisation and exchange.

- This is where firms specialise in producing goods for sale to consumers, and where individuals specialise in doing jobs in order to buy goods, so that everyone maximises the benefits they achieve relative to the costs of achieving them.

These last two are collectively known as allocative efficiency. In any economic activity, allocative efficiency will be increased as long as doing more of that activity (and hence less of an alternative) involves a greater marginal benefit than marginal cost. Allocative efficiency will be achieved when all such improvements have been made.

Economic efficiency is achieved when each good is produced at the minimum cost and where individual people and firms get the maximum benefit from their resources.

Equity

Equity is where income is distributed in a way that is considered to be fair or just. Note that an equitable distribution is not the same as an equal distribution and that different people have different views on what is equitable.

Even though the current levels of production and consumption might be efficient, they could be regarded as unfair, if some people are rich while others are poor. Another microeconomic goal, therefore, is that of equity. Income distribution is regarded as equitable if it is considered to be fair or just. The problem with this objective, however, is that people have different notions of fairness. A rich person may well favour a much higher degree of inequality than will a poor person. Likewise, socialist governments will generally be in favour of a greater redistribution of income from the rich to the poor than will conservative governments. Equity is therefore described as a value judgement: notions of equity will depend on the values of individuals or society.

- SDL: QR code for information on Utilitarianism

https://go.gov.sg/basics-of-utilitarianism

Source: http://www.rsrevision.com/Alevel/ethics/utilitarianism/index.htm

X-inefficiency

The major criticism of monopoly has traditionally been that of the monopoly's power in selling the good. The firm charges a price above MC (see the Figure below). This is seen as allocatively inefficient because at the margin consumers are willing to pay more than it is costing to produce and yet the monopolist is deliberately holding back, so as to keep its profits up.

But monopolies may also be inefficient for another reason: they may have higher costs. Why is this?

- Higher costs may be the result of X inefficiency.
- Without competitive pressure on profit margins, cost control may become lax.
- The firm may employ too many staff and spend on prestigious buildings and equipment. There may be less effort to keep technologically up to date, to research new products, or to develop new domestic and export markets.
- The more comfortable the situation, the less may be the effort which is expended to improve it.
- The outcome is that consumers pay higher prices and the firm moves even further away from the efficient, competitive, outcome.

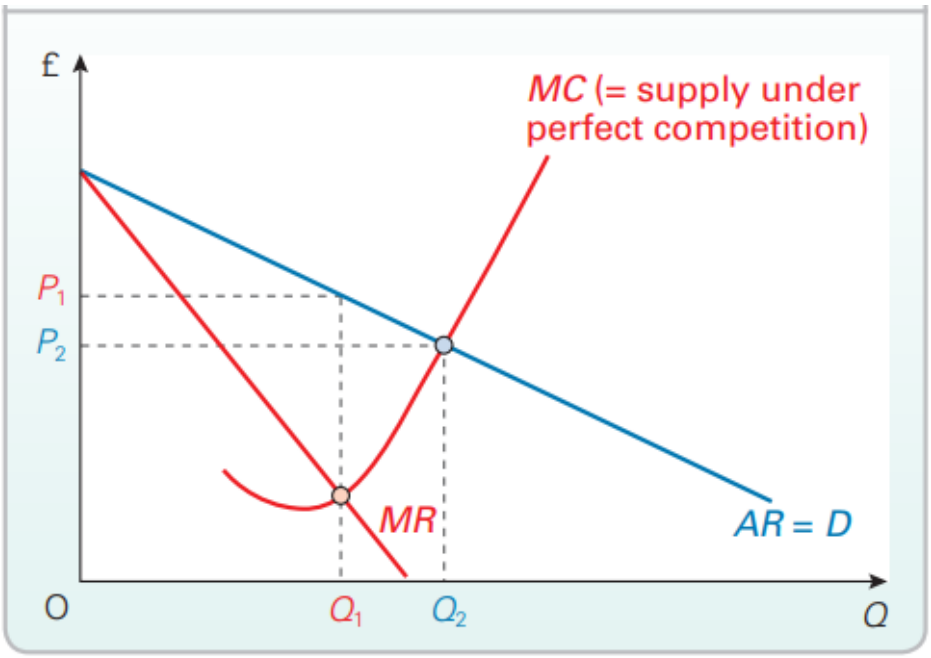
Another reason for X-ineffciency could be due to the principal -agent problem where people (principals), as a result of lack of knowledge, cannot ensure that their best interests are served by their agents. For example, workers may be able to get away with not working very hard, preferring instead an easy life. Similarly, given the divorce between the ownership and control of a company, managers (agents) may pursue goals different from those of shareholders (principals). Thus X inefficiency is likely to occur.

So how can principals tackle the problem? There are two elements in the solution:

- The principals must have some way of monitoring the performance of their agents. For example, a company might employ efficiency experts to examine the operation of its management.
- Second, there must be incentives for agents to behave in the principals' interests. For example, managers' salaries could be closely linked to the firm's profitability.

In a competitive market, managers' and shareholders' interests are more likely to coincide. Managers have to ensure that the company remains efficient or it may not survive the competition and they might lose their jobs. In monopolies and oligopolies, however, where supernormal profits can often be relatively easily earned, the interests of shareholders and managers are likely to diverge. Here it will be in shareholders' interests to institute incentive mechanisms that ensure that their agents, the managers, are motivated to strive for profitability.

Following the financial crisis in 2007/8 and subsequent recession, there were significant reductions in X inefficiency in many countries. To cope with falling sales, and a fall in both sales and profits, many firms embarked on cost-cutting programmes. Much out-of-date plant was closed down, and employment was reduced. Those firms that survived the recession (and many did not) tended to emerge both more competitive and more efficient. A further factor in the reduction in X inefficiency has been the growth in international competition. Even if a firm has monopoly power at home, the growth in global markets and e-commerce, and reductions in customs duties and other barriers to trade, provide fiercer competition from abroad.



- SDL: QR code for information on X-efficiency

https://go.gov.sg/x-inefficiency

Five Forces Strategic Model

McGuigan, Moyer and Harris (2005) provide a good overview on how firms could approach their decision-making to develop sustained competitive advantage in their respective markets. Figure 2-1 provides a diagrammatic representation of how firms can determine their competitive advantage using Michael Porter's Five Forces Strategic Model (Porter, 1998). With this knowledge, firms can achieve competitive advantage through a set of strategies based on several considerations. The various elements in the illustration are elaborated upon in the ensuing paragraphs.

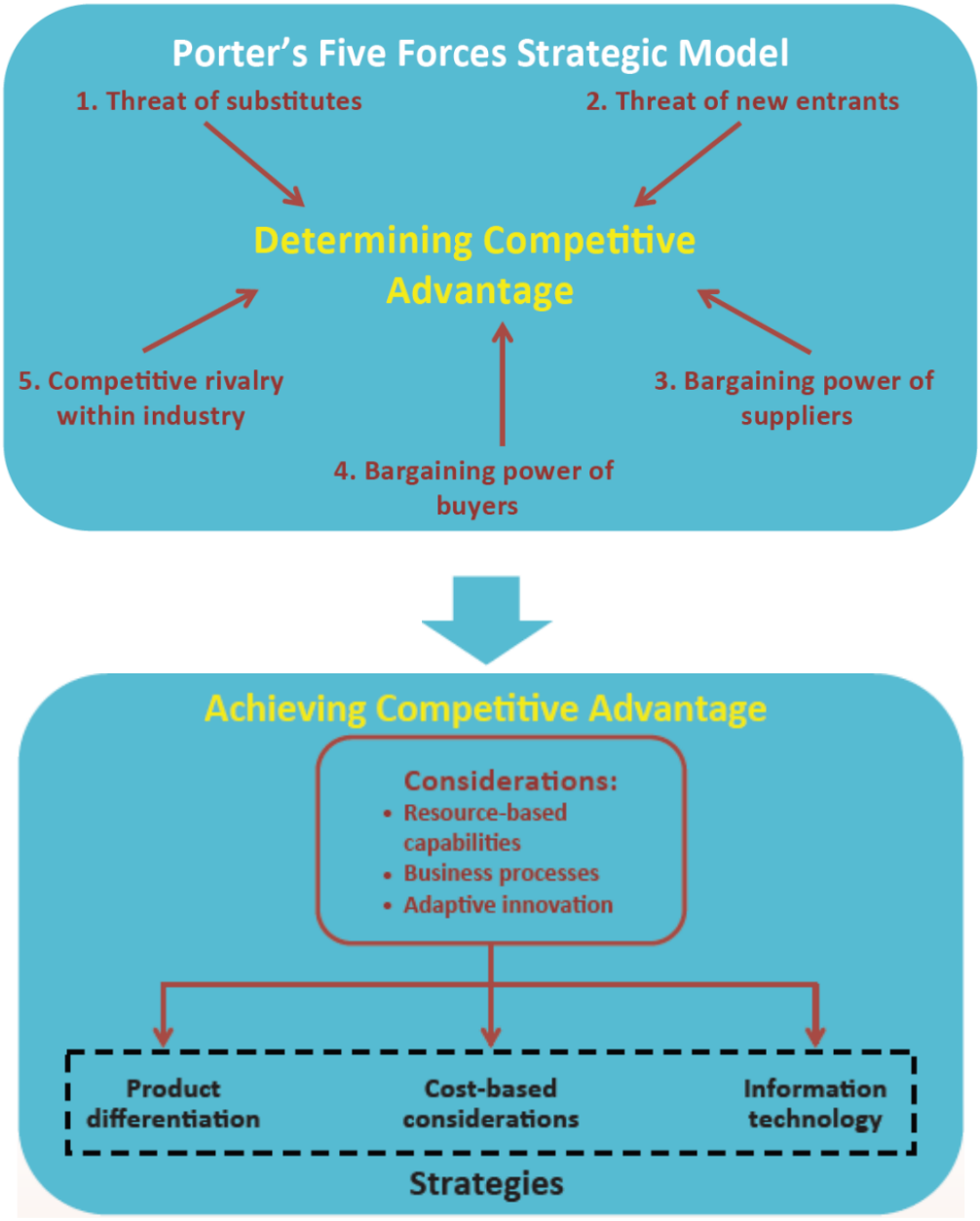


Figure 2–1: Determining and Achieving Competitive Advantage

Determining Competitive Advantage

Five Forces Strategic Model

Michael Porter's Five Forces Strategic Model (Porter's Five Forces) is a conceptual framework for identifying the threats from competition in a relevant market. Incumbent firms attempt to secure competitive advantage through their choice of management strategy. This framework provides a basic structure that highlights the relationships between competitors within an industry, potential competitors, suppliers and buyers.

Competitive advantage is a function of either providing comparable buyer value more efficiently than competitors (low cost) or performing activities at comparable cost but in unique ways that create more buyer value than competitors and, hence, command a premium price (differentiation). These strategies will be analysed in greater detail in the next sub-section on achieving competitive advantage. First, let us take a closer look at how Porter's Five Forces serves as a useful starting point for firms to determine the degree of competitive advantage.

Porter's Five Forces conceptualizes management strategy in terms of the likelihood of sustained profitability for a particular industry or line of business. Figure 2-1 displays Porter's Five Forces: the threat of substitutes, threats of new entrants, power of buyers, power of suppliers and competitive rivalry in the industry.

Threat of substitutes: First, a firm's profitability (particularly that of an incumbent's) is determined by the threat of substitutes. Is the product generic, like burgers, soft drinks and canned food? Or is it branded, like McDonald's, Coca-Cola and Campbell's soup? The more brand loyalty, the lower the threat of substitutes and the higher the incumbent's firm profitability will be. Also, the more distant the substitutes are outside the relevant market, the less price-sensitive demand will be, and larger the mark-ups and profit margins.

The closeness or distance of substitutes depends on consumer perception created by advertising, branding and the segmentation of customers into separate distribution channels. For example, one-stop flight service and non-stop flight service in airlines are different products with different purposes.

Threat of entry: A second force determining the likely profitability of an industry or product line is the threat of potential entrants, which students would have learnt in some detail in H2 Economics. The higher the barriers of entry, the more profitable an incumbent firm will be. Barriers to entry can arise from several factors, such as the consideration of high capital costs, economies of scale and absolute cost advantages, brand loyalty, access to distribution channels, and product differentiation.

Bargaining power of customers and suppliers: The profitability of incumbent firms is determined, in part, by the bargaining power of customers and suppliers. Customers (e.g., Boeing and Airbus) in the market for large aircraft engines are highly concentrated. On the other hand, customers are extremely fragmented in the market for restaurant food. If industry capacity equals

or exceeds demand, concentrated customers can force price concessions which reduce incumbent firms' profits. Meanwhile, fragmented customers have little bargaining power. Suppliers will have more bargaining power to drive up the input costs for incumbent firms and reduce their profitability when there are few suppliers in the industry.

Competitive rivalry in the industry: McGuigan et al. (2005) offers a refreshing take on the effect of mutual interdependence on competition. It is commonly thought that fewer competitors may lead to greater rivalries between the few firms. However, the authors suggest firms may go out of their way to avoid intense competition instead of engaging in fierce rivalries which would incur high costs without a resultant gain in market share.

Measures of the extent of competition include:

- Measures of industry concentration such as 3/5/7-firm concentration ratio
- Measure of Industry Competitiveness such as the Rothschild Index
- Measures of Pricing Behaviour such as the Lerner Index

Achieving Competitive Advantage

According to McGuigan et al. (2005), to achieve a sustained competitive advantage, three considerations must be taken into account: resource-based capabilities, business processes and adaptive innovation.

The first element, resource-based capabilities, analyses how firms can secure differential access to key resources such as patents or distribution channels. As an example, from its humble beginnings as an Internet bookseller that contracted out its warehousing and book delivery service, Amazon managed to become the preferred agent for Internet sales in general. That is, Amazon acquired enough regular customers searching for office products, tools and toys so much so that companies like Toys "R" Us adopted Amazon as their internet sales channel.

Competitive strategy also includes designing business processes that are difficult to imitate and capable of creating unique value for targeted customers. Such business processes may include ways to reduce inefficiencies within the organisation and customise products for the needs of different customers. Competitive strategy also provides a way for sustaining a firm's profitability though innovation. As industries emerge and evolve into other product spaces, firms must anticipate these changes and plan how they will sustain their position in the industry and, ultimately, shift their business to new industries. IBM, the dominant mainframe leasing company in the 1970s, reinvented itself twice - first in the 1980s as a PC manufacturer, and a second time in the 1990s as a systems solution provider. In contrast, some firms like Kodak became outdated.

With the above considerations in mind, firms will have to find a way to create sustainable competitive advantages. A firm may establish a **product differentiation strategy**, a **lowest delivered-cost strategy**, or an **information technology (IT) strategy**. A **product differentiation strategy** usually involves competing on capabilities, branding or product endorsements. Coca-Cola is by far the world's most widely recognized brand, with almost 80% of

sales outside the US. It is followed closely by Gillette, P&G's Pampers, Nestle, Nescafe and Kellogg's, all with 50 percent of their sales outside their home markets. These branded products command a price premium worldwide simply because of the product image and lifestyle associated with their successful branding.

The strategy used by firms, whether focused on differentiation, cost or IT, will depend on a firm's choice of competitive scope - that is, the number and type of products, market segments, the number of geographic locations, and the network of horizontally and vertically integrated businesses the firm may choose to invest in. The composition of a firm's resource capabilities, its business opportunities and a detailed knowledge of its customers integrate to determine the firm's competitive scope. Competitive scope decisions are especially pivotal for **cost-based strategies**. As an example, a firm like Southwest Airlines with a focused cost strategy must limit its business plan to focus narrowly on point-to-point, medium-distance non-stop routes. In contrast, Dell's cost leadership strategy allows it to address a wide scope of PC products at incredibly low prices that affected its competitors, as evidenced by IBM's exit from the PC market in 1999.

Finally, firms can seek their sustainable competitive advantage among relevant market rivals by pursuing an **information technology (IT) strategy**. Southland Corporation's 7-Eleven -Eleven convenience stores in 6,000 locations across Japan provide a good example of this strategy. On a daily basis, data from every convenience store is centrally analysed to determine market demand for various meals. This information is subsequently utilised by 7-Eleven to determine what products they would place on their shelves in the upcoming week, in order to maximise demand and revenue. Additionally, IT allows 7-Eleven to conduct controlled experiments on consumers; this is done by implementing different pricing and packaging strategies in different stores across the country before analysing their effects on consumer spending.

SDL: QR codes on examples of Porter's Five Forces in real life

https://www.channelnewsasia.com/watch/inside-storm/how-grab-beat-uber-southeast-asia-1537776

https://www.channelnewsasia.com/watch/inside-storm/saving-japan-airlines-1525351

https://www.channelnewsasia.com/watch/inside-storm/how-haier-eclipsed-american-giant-1532176

FOR NOTE TAKING:

2. STRATEGIES WITH RESPECT TO OTHER FIRMS' DECISIONS (including strategies arising from game theory and the economics of cooperation: prisoner's dilemma, Nash equilibrium)

Introduction

Oligopoly occurs when just a few firms between them share a large proportion of the industry. There are, however, significant differences in the structure of industries under oligopoly and similarly significant differences in the behaviour of firm. Because there are only a few firms under oligopoly, each has to take account of the others. This means that they are mutually dependent: they are interdependent. Each firm is affected by its rivals' actions. If a firm changes the price or specification of its product, for example, or the amount of its advertising, the sales of its rivals will be affected. The rivals may then respond by changing their price, specification or advertising. No firm can afford to ignore the actions and reactions of other firms in the industry. It is impossible, therefore, to predict the effect on a firm's sales of, say, a change in its price without first making some assumption about the reactions of other firms. Different assumptions yield different predictions. For this reason there is no one single theory of oligopoly. Firms may react differently and unpredictably.

Competition and Collusion

The interdependence of firms in an oligopolistic market pulls them in two very different directions:

- Each firm, by carefully studying the market and its rivals' strategy may believe that, by competing, it can gain a greater share of industry profits.
- On the other hand, firms may conclude that competition will be destructive and lead to lower profits: i.e. through retaliatory price-cutting. So instead, they may prefer to collude with each other by making agreements about price, output, product design, etc. By acting together as if they were a monopoly, the firms could take actions that jointly maximise industry profits and share these profits between them.

Tacit collusion: price leadership

One form of tacit collusion is where firms keep to the price set by an established leader. The leader may be the largest firm: the one dominating the industry. This is known as dominant firm price leadership. Alternatively, the price leader may simply be the one that has proved to be the most reliable one to follow: the one that is the best barometer of market conditions. This is known as barometric firm price leadership.

An alternative to following an established leader is to follow an established set of simple 'rules of thumb'. These rules do not involve setting MC equal to MR, and thus may involve an immediate loss of profit. They do, however, help to prevent an outbreak of competition, and thus help to maintain profits into the longer term. One example of a rule of thumb is average cost pricing. Here, producers simply add a certain percentage for profit on top of average costs. Thus, if average costs rise by 10 per cent, prices will automatically be raised by 10 per cent. This is a particularly

useful rule of thumb in times of inflation, when all firms will be experiencing similar cost increases. Another rule of thumb is to have certain price benchmarks. Thus clothes may sell for $19.95, $24.95 or $49.95 (but not $18.31 or $36.42). If costs rise, then firms simply raise their price to the next benchmark, knowing that other firms will do the same. Rules of thumb can also be applied to advertising (e.g. you do not criticise other firms' products, only praise your own); or to the design of the product (e.g. lighting manufacturers tacitly agreeing not to bring out an everlasting light bulb).

Factors favouring collusion

Collusion between firms, whether formal or tacit, is more likely when firms can clearly identify with each other or some leader and when they trust each other not to break agreements. It will be easier for firms to collude if the following conditions apply:

- There are only very few firms all well known to each other.
- They are not secretive with each other about costs and production methods.
- They have similar production methods and average costs and are thus likely to want to change prices at the same time and by the same percentage.
- They produce similar products and can thus more easily reach agreements on price.
- There is a dominant firm.
- There are significant barriers to entry and therefore little fear of disruption by new firms.
- The market is stable. If industry demand or production costs fluctuate wildly, it will be difficult to make agreements, partly due to difficulties in predicting and partly because agreements may frequently have to be amended. There is a particular problem in a declining market where firms may be tempted to undercut each other's prices in order to maintain their sales.
- There are no government measures to curb collusion.

Non-collusive oligopoly: assumptions about rivals' behaviour

Even though oligopolists might not collude, they will still need to take account of rivals' likely behaviour when deciding their own strategy. In doing so, they will probably look at rivals' past behaviour and make assumptions based on it. There are three well-known models, each based on a different set of assumptions.

The Cournot model: firms choose quantity and the market determines the price

One of the earliest models of oligopoly was developed by the French economist Augustin Cournot in 1838. The simplest version of the Cournot model has the following assumptions.

- Each firm has to choose an output level for a given period without knowing its rivals' production plans (although, except in the case of new firms, they will know how much their rivals have produced in the past). In other words, firms have to make decisions about production simultaneously.
- Production has long lead times and is relatively inflexible. For example, imagine a business investing in a factory or unit that has a specific production capacity. Once the building work begins and the specialised machinery has been ordered and installed, it is difficult for the firm to alter its planned output.

- Whereas output has long lead times, the market price adjusts instantly so that each firm is able to sell all the output it produces.
- The good is homogenous and each firm has the same costs. This means that all the firms in the market sell their output for the same price.

This combination of flexible prices and inflexible output creates an interesting strategic environment. The price the firm receives for its output, in any given period, depends on the production decisions of other firms as well as its own.

To calculate its profit-maximising output it has to estimate the most likely output its rivals will produce. The Cournot model assumes that each firm expects its rival(s) to produce the same amount in the current period as it did in the previous period.

The Bertrand model: firms set prices and the market determines the quantity sold

Another famous model of oligopoly was developed by the French economist Joseph Bertrand in 1883. He criticised the Cournot model as he argued that firms are more likely to set prices and let the market determine the quantity sold. Bertrand again took the simple case of a duopoly where both firms have the same costs of production. However, the conclusions of the model apply equally to oligopolies with three or more firms. It is based on the following assumptions:

- Each firm has to choose its price without knowing the price set by the other firm. It assumes its rival will charge the same price in the current period as it did in the previous period.
- Firms have to set prices in advance and decisions cannot be easily changed: i.e. prices are inflexible.
- The good is homogenous – the only thing that customers care about when they purchase the product is its price.
- Each firm can adjust its output instantly and has no capacity constraints. Therefore, if a firm charges a lower price than its rival it can immediately supply the entire market.

The model predicts that each firm will keep reducing its price until all supernormal profits are competed away. The reason for this result is simple. If firm A assumes that its rival, firm B, will hold price constant, then firm A predicts that by undercutting this price by a small amount it will gain the whole market, which it can instantly supply. By following the same line of reasoning firm B will be forced to respond by cutting its price. The model, therefore, predicts a price war with prices being reduced until they equal average total cost, with only normal profits remaining.

This outcome is very different from the one predicted by the Cournot model. It is referred to as the Bertrand Paradox because the result seems counterintuitive: i.e. a duopoly results in an outcome very similar to that of perfect competition. The prediction changes significantly if product differentiation and/or limits in the ability of the firm to supply the entire market (i.e. capacity constraints) are introduced into the model. Firms may also seek to collude long before profits have been reduced to a normal level. Alternatively, firms may put in a takeover bid for their rival(s).

Nash equilibrium

The equilibrium outcome in either the Cournot or Bertrand models is not in the joint interests of the firms. In each case, total profits are less than under a monopoly or cartel. But, in the absence of collusion, the outcome is the result of each firm doing the best it can, given the assumptions it makes about what its rivals are doing. The resulting equilibrium is known as a Nash equilibrium, after John Nash, a US mathematician (and subject of the film A Beautiful Mind) who introduced the concept in 1951.

Game Theory

Game theory is the branch of economics which studies strategic decision-making. It was originally developed in the 1920s and grew rapidly during World War II in response to a need to develop formal ways of thinking about military strategy. Much of the pioneering work in game theory was done by mathematician John von Neumann (Nicholson & Snyder, 2007). John Nash also made important contributions to the field; one of which is the Nash equilibrium which we will be studying.

Game-theoretic models help simplify complex strategic situations, enabling us to get to the heart of the problem. Like many models of economics, agents are assumed to be rational; all economic agents act according to their own self-interest.

Game theory can be applied to many strategic interactions in life: military strategy, the nuclear arms race and the depletion of common resources. More importantly for our purposes, game theory provides us with a framework to analyse how firms in an oligopoly utilise the strategies we have discussed in the preceding section when they compete against one another.

Strategic interdependence: simultaneous and sequential games

The essence of a game is the interdependence of player strategies. There are two distinct types of strategic interdependence: sequential and simultaneous. In the former the players move in sequence, each aware of the others' previous actions. In the latter the players act at the same time, each ignorant of the others' actions.

A general principle for a player in a **sequential**-move game is to look ahead and reason back. Each player should figure out how the other players will respond to his current move, how he will respond in turn, and so on. The player anticipates where his initial decisions will ultimately lead and uses this information to calculate his current best choice.

In contrast to the linear chain of reasoning for sequential games, a game with **simultaneous** moves involves a logical circle. Although the players act at the same time, in ignorance of the others' current actions, each must be aware that there are other players who are similarly aware, and so on. The thinking goes: "I think that he thinks that I think . . ." Therefore, each must figuratively put himself in the shoes of all and try to calculate the outcome. His own best action is an integral part of this overall calculation. The circular reasoning is brought to a conclusion using a concept of equilibrium developed by the Princeton mathematician John Nash. We look for a set of choices, one for each player, such that each person's strategy is best for him when all others

are playing their stipulated best strategies. In other words, each picks his best response to what the others do.

Simultaneous single-move games

In a competitive oligopoly market depends, in part, on how it thinks its rivals will react to its decisions. If this competition is a one-off event, then it can be modelled as a simultaneous single-move game. This type of game is also called a single-period or one-shot game. Since the assumptions of single-move games (is aware of choices made to rivals and can make its own decisions independently) are like those found in the Bertrand and Cournot models of oligopoly. Economists have reinterpreted them as examples of simultaneous single-move games.

Sometimes one person's best choice is the same no matter what the others do. This is called a "dominant strategy" for that player. When we say that an outcome is an equilibrium, there is no presumption that each person's privately best choice will lead to a collectively optimal result.

The following example illustrates the various profits two firms (X and Y) could earn from charging two different prices - £2 and £1.80. To keep the example simple, we assume the firms have identical costs, products and demand and can only choose one or other of the two prices. Let us initially consider firm Y's position. Should it set its price at £2 or £1.80? Which decision would make it the most profit?

No matter which of the two prices firm Y assumes that firm X will charge, firm Y's best response is always to charge £1.80 as this will yield the highest possible profits. Charging £1.80 is a dominant strategy for firm Y. If we now look at the game from firm X's viewpoint, we get the same result. No matter what price firm X assumes that firm Y will charge, its best response is always to charge £1.80. Therefore charging £1.80 is also a dominant strategy for firm X. Because both firms have a dominant strategy, the outcome of the game is easy to predict. Both firms charge £1.80 and earn £8 million in profit, as illustrated in cell D. This is the dominant strategy equilibrium of the game. This game is an example of the prisoners' dilemma.

Table 8.1 Profits for firms X and Y at different prices

		X's price	
		£2.00	£1.80
Y's price	£2.00	A £10m, £10m	B £5m, £12m
	£1.80	C £12m, £5m	D £8m, £8m

More complex simultaneous single-move games

In many instances, one or both firms will not have a dominant strategy. In these cases, a firm's best response will vary depending on what it thinks its rival will do. Take the example shown in Table 8.2. This is very similar to the example in Table 8.1, but has a different profit structure. Let us once again consider firm Y's position. If firm Y assumes that firm X chooses a price of £2, its best response is to charge £1.80, earning £20 million in profits as shown in cell C. However, if it assumes that firm X chooses a price of £1.80, its best response is to charge £2, earning £15 million in profits as shown in cell B. Hence, its best response changes depending on what price it thinks firm X will charge. Accurately predicting firm X's decision is important for firm Y if it wants to maximise its profits. If its belief turns out to be wrong, it will make less profit. What is the most effective way of anticipating what your rival will do? The answer is for firm Y to try to examine the decision from the perspective of firm X. Can it successfully put itself in its rival's shoes and analyse the competition from their viewpoint? If firm Y looks at the pricing decision from firm X's point of view it will see that firm X actually has a dominant strategy. If firm Y charges £2 it can see that firm X's best response is to charge £1.80 (making a profit of £6 million rather than £5 million). If firm Y charges £1.80, firm X's best response is also to charge £1.80 (making a profit of £4 million rather than £3 million). Therefore, firm Y can predict with a high level of certainty that firm X will charge £1.80 – its dominant strategy. Firm Y's best response, therefore, is to charge £2.00 and make a profit of £15 million rather than £12 million. This combination of prices in cell B is the equilibrium in the game.

Some games can be much more complicated than the one shown in Table 8.2. For example, neither firm could have a dominant strategy; there could be more than two firms and more than two choices. How can we predict the most likely outcome in these circumstances? At what point will every firm have no incentive to change its strategy?

Table 8.2 A more complicated game

		X's price	
		£2.00	£1.80
Y's price	£2.00	A £18m, £5m	B £15m, £6m
	£1.80	C £20m, £3m	D £12m, £4m

Nash equilibrium and expected behaviour

Nash equilibrium is the position that results from everyone making their optimal decision based on their assumptions about their rivals' decisions. The dominant strategy equilibrium in the prisoners' dilemma and the equilibrium in Table 8.2 are both examples of a Nash equilibrium. In each case, neither firm has an incentive to change its decision as it is choosing its best price in response to the price chosen by its rival. In fact, all dominant strategy equilibria (i.e. where both firms have a dominant strategy) are examples of Nash equilibria. Identifying any dominant strategies, if they exist, makes it easier to find the Nash equilibrium. In many games, there is more than one Nash equilibrium. In these cases, it is more difficult to predict the most likely outcome.

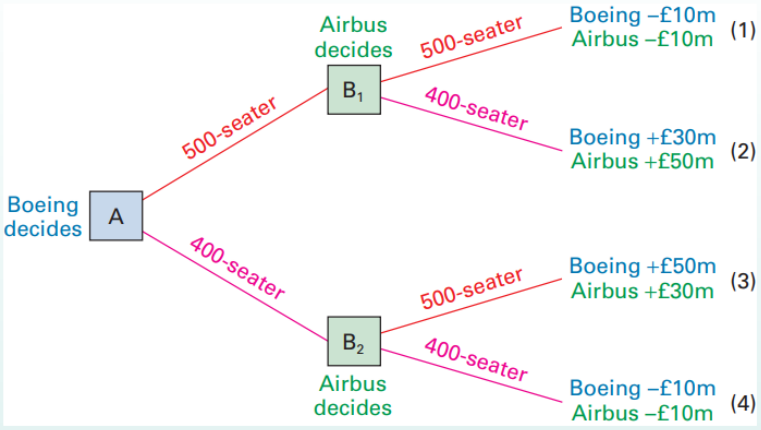
If a firm's actual behaviour was different from its expected behaviour, then the decisions of its rivals do not represent a Nash equilibrium. In these circumstances, what the firm perceives to be its best response, based on the expected behaviour of its rival, proves not to be the case when the actual behaviour of the other firm is observed. The firm will have an incentive to change its behaviour.

Sequential-move games

So far, we have looked at simultaneous games: where firms take decisions at the same time without seeing the decision of the other firm(s). However, in many real-world competitive environments, one firm (the first mover) makes and implements a decision (i.e. it produces a certain output, sets a particular price or introduces a new product) before its rivals (the second movers). The second movers are then able to observe the actions of the first mover before deciding on their best response. These strategic environments can be studied by using sequential-move games.

Take the case of a new generation of large passenger aircraft that can fly further without refuelling. Assume that there is a market for a 500-seater version of this type of aircraft and a 400-seater version, but that the market for each size of aircraft is not big enough for the two manufacturers, Boeing and Airbus, to share it profitably. Let us also assume that the 400-seater market would give an annual profit of £50 million to a single manufacturer and the 500-seater would give an annual profit of £30 million, but that if both manufacturers produced the same version, they would each make an annual loss of £10 million. Assume that Boeing is the first mover and announces which plane it will build: the 400-seater or the 500-seater. Airbus then has to respond to the decision and decide which plane it will build. This scenario can be illustrated as a sequential-move game and is shown in Figure 8.11.

Figure 8.11 A decision tree



Sequential-move games are typically illustrated in 'extensive form' by use of a decision tree, which identifies the possible sequence of events. The small square on the left of the decision tree shown in Figure 8.11 is Boeing's decision point (point A). If it decides to build the 500-seater plane, we move up the top branch. Airbus would now have to make a decision (point B1). If it too decides to build the 500-seater plane, we would move to outcome 1: a loss of £10 million for both manufacturers. Clearly, with Boeing building a 500-seater plane, the best response for Airbus would be to choose the 400-seater plane: we would move to outcome 2, with Boeing making a profit of £30 million and Airbus a profit of £50 million. Airbus would be very pleased! Boeing's best strategy at point A, however, would be to build the 400-seater plane. We would then move to Airbus's decision point B2. In this case, Airbus's best response is to build the 500-seater plane. Its profit would be only £30 million (outcome 3), but this is better than a £10 million loss if it too built the 400-seater plane (outcome 4).

With Boeing deciding first, the Nash equilibrium will thus be outcome 3. There is clearly **a first-mover advantage** here. Once Boeing has decided to build the more profitable version of the plane, the best response for Airbus is to build the less profitable one. Naturally, Airbus would like to build the more profitable one and be the first mover. Which company succeeds in going first depends on how advanced they are in their research and development and in their production capacity.

In a sequential-move game, a second mover could threaten or promise to behave in a certain way in an attempt to influence the behaviour of the first mover. For example, in the above game Airbus could announce that it was going to build a 400-seater plane irrespective of what Boeing decides to do. Why would Airbus do this? If Boeing believed Airbus' announcement then its best move is to build a 500-seater plane, making a profit of £30 million as opposed to a loss of £10 million. Hence, the announcement influences Boeing's behaviour in a manner that is favourable to Airbus – it earns greater profits. However, there is a problem with Airbus' announcement – Boeing will probably not believe it! If Boeing actually built a 400-seater plane, Airbus' best move would be to build a 500-seater plane. Boeing can clearly see that it is not in Airbus' own self-interest to do what it said it was going to do. Therefore the strategy is not credible and Boeing will build the 400-

seater plane. Could Airbus take some irreversible actions so it is committed in advance to building the 400-seater plane? The key to the success of this policy is that Boeing must believe it: it must be credible. If this were possible, then by limiting its own options, Airbus could actually make greater profits. In some circumstances, inflexibility can actually improve the competitive position of the firm by altering its rivals' expectations about how it will behave.

The aircraft example is the simplest version of a sequential move game, with just two companies and each one making only one key decision. In many business situations, much more complex trees could be constructed. The 'game' would be more like one of chess, with many moves and several options on each move. If there were more than two companies, the decision tree would be more complex still.

Assessing the simple theory of games

Game theory provides a very useful framework for helping us to think about competitive environments where there is strategic interdependence. It highlights the importance of each firm trying to think through situations from their rival's viewpoint in order to work out their own profit-maximising decision.

We have considered a number of quite simple games, with just two firms having to choose between just two different options. In reality, many oligopolistic markets will consist of a number of firms that each have to choose from multiple options on pricing, product design, advertising, etc. Therefore, it would be very difficult if not impossible for them to obtain precise information on

a. the pay-offs to all their rivals from all the possible actions they could take and
b. the impact of all the possible actions of their rivals on their own pay-offs.

The approach is useful, therefore, only in relatively simple cases, and even then, the estimates of profit from each outcome may amount to no more than a rough guess. Even if we assume that both firms have full information on all the relevant pay-offs, the outcome of real-world competition may still be different from that predicted by standard game theory. At a Nash equilibrium each firm assumes that its rivals behave in a rational manner: that they can consider all the pay-offs and successfully make decisions that maximise their own profits.

In reality, decision makers may make systematic errors, especially when faced with complicated problems. How sure can a firm be when working out its best response that its rival is in fact behaving in a rational manner? Could it mistakenly choose a suboptimal strategy? If firms believe there is a strong chance that their rivals will behave in an irrational manner, then the outcome of competition is much harder to predict.

In response to this uncertainty they might play it safe by choosing the strategy that minimises their losses from the worst-case scenario from the unpredictable behaviour of their rival. Such a strategy is known as **maximin**. Alternatively, if they were more risk loving, they could gamble and choose the outcome that maximises their pay-off from the best-case scenario. Such a strategy is known as maximax. Changing behaviour patterns over time. Behaviour may also change over time as firms learn about the consequences of their actions and the competitive environment

changes. For example, firms may compete hard for a time (in price or non-price terms) and then realise that it is making them all worse off. Firms may then start to collude and jointly raise prices and reduce advertising. Later, after a period of tacit collusion, competition may break out again. This may be sparked off by the entry of a new firm, by the development of a new product design, by a change in market demand, or simply by one or more firms no longer being able to resist the temptation to 'cheat'. In short, the behaviour of particular oligopolists may change quite radically over time as they find out new information.

Finally, we have been assuming that firms behave selfishly – that they make decisions with the sole purpose of maximising profits. In reality, people's actions are likely to be influenced by their moral values. Business people may be unwilling to behave ruthlessly or dishonestly, or to undertake profitable activities that they regard as unfair. Given the lack of perfect information, uncertainty about the rationality of rivals and varying objectives of firms, simple game theory cannot predict with any accuracy what price, output and level of advertising firms will choose in the real world.

Cooperative vs Non-cooperative

Cooperative game theory deals with how coalitions, or cooperative groups, interact when only the payoffs are known. It is a game between coalitions of players rather than between individuals, and it questions how groups form and how they allocate the payoff among players.

Non-cooperative game theory deals with how rational economic agents deal with each other to achieve their own goals. The most common non-cooperative game is the strategic game, in which only the available strategies and the outcomes that result from a combination of choices are listed. A simplistic example of a real-world non-cooperative game is rock-paper-scissors. Another example is the prisoner's dilemma.

The three elements of games

Players: Each decision maker in a game is called a player. Players may be individuals (as in online marketplaces such as eBay and Carousell), corporations (as in oligopolistic industries such as oil and pharmaceuticals), or entire nations. Players have the ability to choose from a set of possible actions. The number of players in a game may vary. For our purpose, we will only be looking at two-player games.

Strategies: A strategy is a plan of action for a player based on what the other player is doing. Since the game involves strategy, each player must consider what the other player would do and decide on the best course of action based on that consideration.

Payoffs: Payoffs are the returns that players receive when the game is over. They could refer to levels of utility, money or anything the players value. Players try to maximise the payoffs they earn at the end of the game.

The prisoner's dilemma:

To illustrate the elementary concepts of game theory, let us look at the classic example of the prisoner's dilemma. Consider two criminals, Bonnie and Clyde, who are imprisoned for a crime. However, there are no witnesses and the prosecutor is finding it difficult to make a case against them.

They are separated and given the following proposition: if both confess, they both get three years of imprisonment. If one confesses and the other remains silent, the one who confesses gets one year and the silent one gets 10 years. If both remain silent, they both get two years. Collectively, they are better off if they both remain silent. However, since they are separated, they cannot coordinate their actions ´ each must do the best he or she can, given what he or she thinks the other player will do. What will be the outcome of the game?

Note that this is a simultaneous game; both players need to decide their course of action concurrently. When their decisions have been made, the game ends. There are also sequential games where one player gets to move first, but this is not within the scope of this syllabus. Simultaneous games with a prisoner's dilemma can be represented using a payoff matrix like the one below.

The two players are Bonnie and Clyde, and the two possible actions they can take are to confess or remain silent. Their respective payoffs are represented in each cell of **Figure 2-2a**.

		Clyde (Player 2)	
		Confess	**Silent**
Bonnie (Player 1)	**Confess**	-3, -3	-1, -10
	Silent	-10, -1	-2, -2

Figure 2–2a: Prisoner's Dilemma Payoff Matrix

By convention, Bonnie is Player 1 and the payoffs associated with Player 1 are on the left of each cell. These are in red in the payoff matrix in **Figure 2-2b** below.

		Clyde (Player 2)	
		Confess	**Silent**
Bonnie (Player 1)	**Confess**	-3, -3	-1, -10
	Silent	-10, -1	-2, -2

Figure 2–2b: Player 1's Payoffs

Clyde is Player 2 and the payoffs associated with Player 2 are on the right. These are in blue in the payoff matrix in **Figure 2-2b** above. Now we will solve for the game by bearing in mind that each player does the best he or she can, given what the other player is doing. If Bonnie confesses, the best action for Clyde to take would be to confess. If Clyde chooses to remain silent, he will

receive 10 years as opposed to the case where he receives only three years if he confesses. In this scenario, the payoff for Clyde if she chooses her best action is underlined in **Figure 2-2c**.

		Clyde (Player 2)	
		Confess	**Silent**
Bonnie (Player 1)	**Confess**	-3, <u>-3</u>	-1, -10
	Silent	-10, -1	-2, -2

Figure 2–2c: Player 2's Strategy if Player 1 Confesses

If Bonnie chooses to remain silent, Clyde would have the incentive to confess since one year of imprisonment is better than two years. In this scenario, the payoff for Clyde if she chooses her best action is underlined in **Figure 2-2d**.

		Clyde (Player 2)	
		Confess	**Silent**
Bonnie (Player 1)	**Confess**	-3, -3	-1, -10
	Silent	-10, <u>-1</u>	-2, -2

Figure 2–2d: Player 2's Strategy if Player 1 Remains Silent

Regardless of what Bonnie does, Clyde's best bet is to confess. Therefore, we say that confessing is Clyde's dominant strategy. **A dominant strategy is the best response to all strategies the other player might choose.** We now turned to Bonnie's strategy against Clyde. If Clyde confesses, Bonnie confesses since three years of imprisonment is better than 10 years. In this scenario, the payoff for Bonnie if she chooses her best action is underlined in **Figure 2-2e**.

		Clyde (Player 2)	
		Confess	**Silent**
Bonnie (Player 1)	**Confess**	<u>-3</u>, -3	-1, -10
	Silent	-10, -1	-2, -2

Figure 2–2e: Player 1's Strategy if Player 2 Confesses

If Clyde remains silent, Bonnie will still confess since one year of imprisonment is better than two years. In this scenario, the payoff for Bonnie if she chooses her best action is underlined in **Figure 2-2f**.

		Clyde (Player 2)	
		Confess	**Silent**
Bonnie (Player 1)	**Confess**	-3, -3	-1, -10
	Silent	-10, -1	-2, -2

Figure 2–2f: Player 1's Strategy if Player 2 Remains Silent

Putting all four strategies from **Figures 2-2c** to **2-2f** together, we will get the following payoff matrix in **Figure 2-2g**, with confessing being the dominant strategy of both players.

		Clyde (Player 2)	
		Confess	**Silent**
Bonnie (Player 1)	**Confess**	-3, -3	-1, -10
	Silent	-10, -1	-2, -2

Figure 2–2g: Payoff Matrix with All Preferences

We now see that that the **equilibrium outcome** is for both players to confess. This is reflected by the top left-hand cell with two underlined payoffs. This equilibrium is known as a **Nash equilibrium** (each firm's best response function given the choice of the other). Collectively, (Silent, Silent) would be the best outcome for the two prisoners. However, due to coordination failure, they will choose (Confess, Confess) instead.

FOR NOTE TAKING:

Game theory applied to Price Competition

Armed with some basic understanding of game theory, let us apply the framework to study how competing firms in an oligopoly would behave. The payoffs we will use are arbitrary and you can construct your own. The important takeaway is for you to apply game theory to a wide variety of strategic interactions that take place in reality.

Consider two firms in the telecommunications industry: Firm S and Firm M. Firm S previously enjoyed a monopoly over the industry but had to compete with Firm M (a new entrant) when the telecom market was liberalised. Both have the option to either maintain or lower prices, and neither knows what the other is doing. If one lowers price while the other maintains it, the one who lowers their price can garner a large market share and earn higher profits. Meanwhile, the one who maintains their price will lose profits. If both cut prices, both lose profits. Finally, joint profits are highest if both maintain their prices.

The game can be represented by the payoff matrix below.

		M	
		Lower	**Maintain**
S	**Lower**	$2m, $2m	$5m, $1m
	Maintain	$1m, $5m	$4m, $4m

Figure 2–4: Prisoner's Dilemma Applied to Pricing Strategies

The Nash equilibrium we get is the one in the top left cell where both firms each earn $2 million in profits. The dominant strategy of both firms, regardless of what the other does, is to lower prices. Both firms are collectively better off if they choose to maintain prices ($4 million in profits for each). However, they do not do so; if they choose to maintain price, there is no guarantee that the other firm will maintain its prices. In fact, it would have an incentive to undercut the other party by choosing to lower prices as doing so would give it $5 million in profits as opposed to $4 million if it were to cooperate.

This is a classic prisoner's dilemma situation as both firms are actually worse off due to an inability to coordinate their actions. As discussed earlier in the section on firms' strategies, consumers are the ultimate beneficiaries of price competition. Can firms then collude and behave like a monopoly?

In the context of our above example, both firms would then make $4 million each. Fortunately for us and unfortunately for firms, such explicit cooperation is banned in most countries (notably the United States) with anti-trust laws. However, firms still manage to devise creative ways to cooperate implicitly.

SDL: QR code for more information on Competition and Consumer Commission of Singapore (CCCS)

SDL: QR code for more information on a real-life example - Singapore's Fresh chicken distributors fined

FOR NOTE TAKING:

Game theory applied to Advertising

In our final example of this section on game theory, we will apply the concepts we have learnt to study whether competing firms in an oligopoly choose to advertise. Consider two fast food chains, M and K who are deciding whether to advertise. Their payoff matrix is as follows:

		K	
		Don't Advertise	Advertise
M	Don't Advertise	$1.5m, $1.5m	$0, $2.5m
	Advertise	$2.5m, $0	$1m, $1m

Figure 2–5: Prisoner's Dilemma Applied to Advertising Decisions

If we solve for the Nash equilibrium, we will find that (Advertise, Advertise) is the only outcome of the game. Both firms earn more profits if they do not advertise: $1.5 million each compared to $1 million each. When both of them advertise (we assume they each spend $500,000 on advertising should they choose to advertise), they actually make less profits than before due to the amount spent on advertising. Their market shares remain the same and consumers do not enjoy lower prices. Thus, the money spent by each firm is deadweight loss to society. In this example, the money spent on advertising could have been put to better use.

FOR NOTE TAKING:

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