CHAPTER 6

Strategic rivalry

Chapter contents

Learning outcomes

By the end of this chapter you should understand:

Economic theory

- LO1 Monopolistic competition
- LO2 Natural and strategic entry barriers
- LO3 Oligopoly and interdependence
- LO4 The kinked demand curve model
- LO5 Game theory and strategic behaviour
- LO6 Auction theory

Business application

- LO7 Why it may be better for leading technology firms to co-operate on standards, rather than compete
- LO8 Why supermarkets use blind auctions to prevent co-operation between suppliers
- LO9 How an understanding of oligopolies can be used to assess competition within the market for local bus services

At a glance Strategic rivalry

The issue

Firms in perfect competition earn normal economic profits. But can firms avoid direct price competition, say by product differentiation, and, if so, what are the consequences for pricing and profits? In addition, in markets where there are only a small number of large players, should firms compete or try to co-operate with each other? Co-operation leads to increased profits; competition does not.

The understanding

Many firms in highly competitive markets, such as bars, restaurants and hairdressing, differentiate themselves by location, style and range of products or services. Prices then often vary across differentiated providers, but this may not necessarily lead to supernormal profits. We will address these issues using the model of monopolistic competition.

In terms of co-operation, or competition, we will examine the concept of strategic interdependence. For example, while co-operation is likely to lead to increased profits, it is not necessarily the correct option. If you decide to be friendly and your rival is aggressive, then they will win. So, given that your rival is aggressive, it is best if you are also aggressive. This is an essential part of the understanding; optimal strategies are developed from an understanding of what your rival is going to do, not from what you would like to do. This is known as strategic interdependence. The strategy of one firm is dependent upon the likely strategy of its rivals. We will explore these ideas more fully by examining game theory.

The usefulness

An understanding of monopolistic competition provides insights into the consequences for prices and profits resulting from product positioning and differentiation, especially in service sector markets characterized by numerous small-scale providers.

An understanding of strategic interaction from the perspective of game theory is extremely powerful. Government uses game theory when designing auctions for telecommunications licences. Sporting associations and team owners use game theory and auctions when selling television rights. Car dealerships use game theory when selling second-hand cars, and so should you. Finally, supermarkets use it to reduce the price that they have to pay for own-label products by applying game theory to auctions.

6.1 Business problem: will rivals always compete?

A good competitor can control their rivals. In sport, Formula 1 drivers try to achieve this from pole position and, in war, armed forces try to gain control through air supremacy. In fact any successful competitor, whether it be in sport, war, politics or business, will ordinarily have a good strategy.

An important recognition is that competition is expensive. War is hugely expensive, particularly in terms of lost lives. Ferrari's annual racing budget exceeds $200 million. Competition in business is also expensive. In monopoly, with no competition, profits are higher and more sustainable than in the highly competitive environment of perfect competition.

So, if competition is expensive, should rivals always compete? The answer depends on the expected response of your rival. Consider this old, but illuminating, true story. When the Spanish arrived in Central America in the seventeenth century they were greeted by fearsome-looking locals, sporting war paint and shaking menacing spears in the air – a clear declaration that they were willing to compete with the Spanish invaders. In response, most of us would sensibly pull up the anchor and sail away. The Spanish burnt their boats and walked onto the beach. If a fight between the Spanish and the Incas started, the Spanish had

to fight or die: no boats, no escape plan. The local Incas quickly understood the Spanish soldiers' need and desire to win and retreated inland. So, by committing to a fight, the Spanish influenced the behaviour of their rivals. This is a significant point for business.

In perfect competition, the behaviour of one firm will not influence its rivals. Each firm is a price-taker and it can sell any amount of output at the market price. If the market price is £10, there is no point starting a price war and selling at £5 because you can sell everything at £10. There is said to be no **strategic interdependence**. We will also assume that there is no strategic interdependence when we discuss monopolistic competition. However, under *oligopoly*, if one firm begins a competitive move, such as starting a price war, then this will have immediate implications for its rivals. The actions of one firm are linked to the actions of its rivals. Strategic interdependence exists.

Strategic interdependence exists when the actions of one firm will have implications for its rivals.

In developing your understanding we will begin by introducing the model of monopolistic competition. While not directly addressing the issue of strategic interdependence, it does examine the profitability of many small firms under product differentiation. As such, it provides an insight into how firms in near-perfect competition try to deal with competitive rivalry. We then develop the analysis through an examination of the characteristics of an oligopolistic market. In discussing why oligopolies exist, we will consider both natural and strategic entry barriers. Finally, we will turn our discussion to strategic responses and in so doing develop your understanding of game theory. We will then utilize the insights from game theory to understand the operation and optimal design of auctions.

6.2 Monopolistic competition

We begin with an examination of **monopolistic competition**, which for the most part is an industry much like perfect competition except for the existence of product differentiation. So, we are still assuming a large number of competitors, freedom of entry and exit, but not homogeneous products. Rather, firms produce similar goods or services which are differentiated in some way.

Monopolistic competition is a highly competitive market where firms may use product differentiation.

There are many examples of monopolistic competition and they all must relate to differentiation in some form or other. Bars can be differentiated by location, the beers or other drinks offered for sale, type of food served, or theme, such as a cocktail or sports bar. Shops can be differentiated by distance. Local shops sell newspapers and many people will not walk more than 300 yards for a paper. They will, however, drive a number of miles to access a supermarket. Even bread, a fairly standard product, is differentiated: brown, white, soft, with seeds, with fruit, and different varieties from around the world. Even your classes are differentiated by day of the week and time of day.

Importantly, because each supplier offers a similar but not identical product, each supplier does not face a perfectly elastic (horizontal) demand line, as they would in perfect competition. Instead, the element of differentiation lowers the degree of substitutability between rival offerings – and results in each firm facing a downward-sloping demand line.

The result of this differentiation is for each small firm to have a monopoly over the differentiated version of the product or service that it provides. We, therefore, have lots of small firms offering similar but slightly different competitive offerings to consumers with varied tastes and preferences. This combination of competition and monopoly gives rise to the term 'monopolistic competition'. In Box 6.1 the move by Starbucks into 'drive-thru' outlets highlights an attempt to further differentiate Starbuck's offer and meet the needs of a particular type of coffee consumer.

Each monopolistic firm can influence its market share to some extent by changing its price relative to its rivals. By lowering drink prices a bar may attract some customers from its rivals, but it will not attract all the rivals' customers. Differentiation will lock in some customers to the more expensive provider; for example, if one bar provides beers while another specializes

Box 6.1

Starbucks to open 200 drive-thrus for roadside caffeine fix

Starbucks announced that it will open 200 'drive-thrus' in Britain over the next five years. Car drivers will order their triple-shot frappuccinos or skinny caramel lattés by speaking into a microphone and then drive forward to pick up their coffee from a hatch – all from the seat of their car.

Drive-thrus are big business in America – two-thirds of McDonald's turnover comes from car-based diners and Starbucks has 2500 outlets, but they have had limited success in Britain. Kris Engskov, the new UK managing director of Starbucks, insisted customers had already embraced the idea. It has been experimenting with 10 roadside shops over the last three years.

'This is absolutely about customers asking for this. The drive-thru meets a customer need,' he said, pointing out that many commuters drove to work without passing a shop and parents enjoyed the ability to buy a coffee without having to park their car and take out the children from their car seats.

Mr Engskov said the new outlets were not a sign that the company was abandoning the high street, at a time when many retailers were struggling. 'We'll continue to develop there, but we need to be flexible. Coffee purchase is driven by convenience, be it a drive-thru or a kiosk, or retail.' The company suggested that 100 new shops could be opened in addition to the drive-thrus over the next five years.

Analysts said the move was proof that the high-street coffee market was becoming saturated. Neil Saunders, managing director at Conlumino, said: 'The coffee shop market competition is intense in the UK. If you educate people about drive-thru it is possible they will embrace it.'

in fruit and alcoholic cocktails. Cheap prices in the beer bar will not attract drinkers who have a strong taste and preference for cocktails.

Monopolistic competition also requires an absence of economies of scale. Without the ability, or need, to exploit size and scale, a monopolistic industry will be characterized by a large number of small firms. We will see that, when we discuss oligopoly in the next section, the existence of economies of scale can lead to a small number of large players.

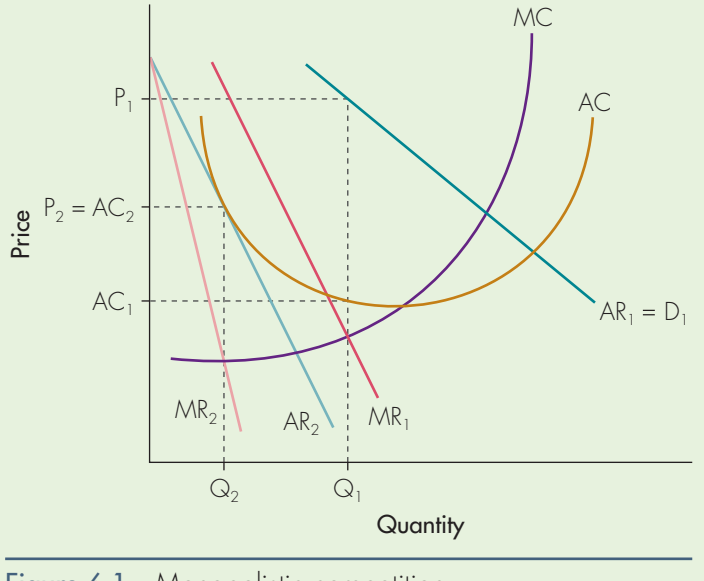


Figure 6.1 Monopolistic competition

The demand curve for the firm depends upon the industry demand curve, the number of firms and the prices charged by these firms. A bigger industry demand, with a fixed number of firms, will result in a higher demand for each firm. An increase in the number of firms will lead to a reduced share of the market for each firm. The price of a firm, relative to its rivals, will also determine its level of demand.

In Figure 6.1, we have drawn a diagram depicting a firm's supply decision under monopolistic competition. Initially, the firm faces an average revenue line of AR_1 and marginal revenue line MR of MR_1. Under profit maximization, the firm will produce Q_1 units and sell at a price of P_1. With an average cost per unit of AC_1, the firm will make $(P_1 - AC_1) \times Q_1$ profit. These supernormal profits will attract entry into

the market. As more firms enter this market, the firm will lose market share and the demand curve for the firm will move back towards the origin. Entry stops when each firm is breaking even. This is when the new demand line, AR_2, just touches the average cost line at a tangent. The firm now makes Q_2 units at a price of P_2. Economic profits are now zero since $P_2 - AC_2 = 0$, and therefore entry into the industry stops.

Excess capacity

The monopolistic long-run equilibrium has some important features. First, the **tangency equilibrium** results in average costs being above minimum average costs. In comparison with perfect competition, long-run equilibrium in monopolistic competition does not result in firms operating at minimum average total costs. Therefore, monopolistic competition is not productively efficient. In fact, firms in monopolistic competition operate with excess capacity. They could increase output and reduce costs.

Tangency equilibrium occurs when the firm's average revenue line just touches the firm's average total cost line.

This productive inefficiency might suggest that the excess capacity in monopolistic competition is bad for society. It may be, but it is also important to recognize that monopolistic competition delivers greater choice for consumers that have varied tastes and preferences. So, in assessing whether monopolistic competition is good or bad for society, it is necessary to consider the gains from increased choice against the costs of excess capacity and inefficient production.

Market power

In long-run equilibrium, firms in monopolistic competition have some monopoly power because price exceeds marginal cost. In perfect competition, freedom of entry and exit ensures that in long-run equilibrium price, average cost and marginal cost are equal. There is no market power in perfect competition. Firms in perfect competition are indifferent between serving a new customer and turning them away. This is because the revenue from one extra sale is equal to the cost of the sale ($P = MC$). In monopolistic competition, the revenue from one more sale is always higher than the costs ($P > MC$). Firms in monopolistic competition will always be willing to sell to one more customer. This in part may explain why firms in monopolistic competition, such as food outlets, bars and hairdressers, are willing to engage in promotional activities such as advertising as a means of drawing in extra customers.

The characteristics of monopolistic competition – product differentiation, few opportunities for economies of scale, zero economic profits, but yet some power over pricing – are those we often associate with service sector businesses, such as bars, restaurants, local grocery stores, hairdressers, estate agents and fast-food outlets. As such, the model of monopolistic competition has some merit in being able to explain the characteristics of many service sector industries. However, apart from a simple consideration of product differentiation, the model does not provide much of an insight into strategic interdependence. This is principally because monopolistic competition still assumes a large number of small players. As such, each firm is small relative to the market, and its competitive actions have only limited consequences for all of its rivals. This negligible impact results in strategic interdependence being almost entirely ignored. We will address this concern by considering oligopolies and, in particular, game theory.

6.3 Oligopoly theory: natural and strategic entry barriers

An oligopoly is a market with a small number of large players. Unlike in perfect competition, each firm has a significant share of the total market and therefore faces a downward-sloping demand curve for its product. Firms in oligopolies are price-setters as opposed to price-takers. Obvious examples of oligopolies include supermarkets, banks and the soft drinks market.

Oligopolies are often referred to as highly concentrated industries, implying that competition is concentrated in a small number of competitors. A simple measure of concentration is the

Table 6.1 Supermarket market shares

Supermarket	Percentage market share
Tesco	31
Asda	17
Sainsbury's	16
Morrisons	12
Co-operative	7

Source: Kanter (2011).

Table 6.2 Most and least concentrated UK industries

Most concentrated industries (5-firm CR > 80%)	Least concentrated industries (5-firm CR < 10%)
Sugar	Metal forging
Tobacco	Plastic pressing
Gas distribution	Furniture
Banking	Construction
Soft drinks	Structural metal products

Source: ONS

N-firm concentration ratio, CR, is a measure of the industry output controlled by the industry's N largest firms.

N-firm concentration ratio, which is a measure of the total market share attributed to the N largest firms. Table 6.1 presents the market shares for the leading five UK supermarkets. The five-firm concentration ratio is 83 per cent. Table 6.2 lists the most and least concentrated industries for the UK economy.

A natural question to ask is why are some industries, such as soft drinks, highly concentrated and others, such as furniture, not? The key to the answer lies in recognizing the importance of entry barriers.

Entry barriers can exist for natural or strategic reasons.

Natural entry barriers

Exogenous costs of the firm are outside its control.

The costs for a firm can be exogenously or endogenously determined. Our natural entry barriers are concerned with **exogenous costs**, so let us concentrate on them first.

The fact that exogenous costs are outside the firm's control does not mean that these costs are uncontrollable; rather, the firm does not influence the price of labour, machines, raw materials and the production technology used. For example, the price of labour is a market price determined outside the firm's control. The level of costs associated with a particular industry, as we saw with monopolies, can create an entry barrier.

In Figure 6.2, we have the long-run average cost curve LRAC and the minimum efficient scale. (We considered these in Chapter 3.) At the minimum efficient scale, MES, the average cost is

The minimum efficient scale (MES) is the minimum scale of operation, or size of factory, that is needed in order to operate at lowest cost. If, however, the firm chooses a lower level of operation, then average costs will be higher. If the MES is very high, it can act as a barrier to entry.

Figure 6.2 Economies of scale and natural entry barriers

£10. But with a much smaller plant, Q_1, the cost per unit rises to £20. In order to enter and compete in the industry it is essential to build a plant that is at least as big as the MES. In oligopolies, the MES is large when compared to the overall market. For example, if we have 50 million customers and the MES is 10 million units per year, then we might reasonably expect 50m/10m = 5 firms in the market.

If we consider supermarkets, it is easy to see why natural barriers to entry may exist. In the case of supermarkets, the big players have in excess of 500 stores each. So the MES must be around 500 stores. This level of scale is probably essential when trying to negotiate discounts from product suppliers, optimizing marketing spend and building efficient distribution systems to move stock from suppliers to the stores. Given that the UK is a small island with around 60 million inhabitants, it is sensible that we should only see a small number of large supermarket chains. Four large players operating at 500-plus stores is all that the UK market is capable of supporting. So, it is the natural, or exogenous, cost characteristics, coupled with the market size that leads to a natural entry barrier and the creation of an oligopoly.

Strategic entry barriers

What happens if the MES is not very big when compared with the market size? Entry is easier and aids competition. Consider the case of soft drink manufacturers. If you wish to enter the soft drinks market, then you need to buy a bottling plant and a big steel factory to house it in and a warehouse; and a couple of trucks for deliveries will also help. The cost will not exceed £5 million. (It is amazing what you can learn when taking summer jobs as a student.) For many businesses £5 million is not a huge sum of money. The MES is not big and, therefore, the entry barrier into the market is limited. So, as a firm inside the market, how do you prevent entry? Easy – you change the cost characteristics of the industry and make the MES bigger, or, as the economist would say, you **endogenize** the cost function.

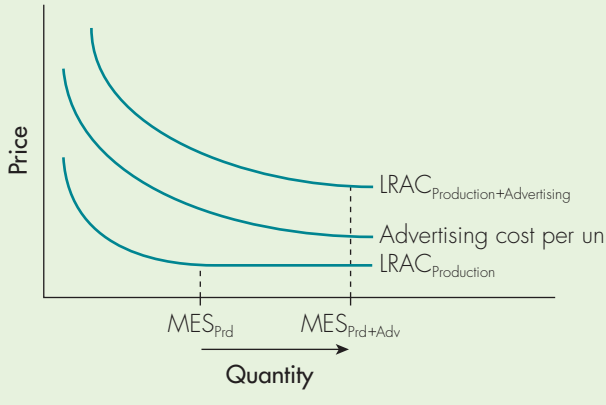
If costs are **endogenized**, the firms inside the industry have strategically influenced the level and nature of costs.

A **sunk cost** is an expenditure that cannot be regained when exiting the market.

Coca-Cola and Pepsi are clear examples of how to achieve this strategy. The core assets for these companies are not production facilities; rather, they are brand names. A successful brand may cost £100 million or more to buy, or develop through advertising. Therefore, the entry barrier is not a £5 million factory, it is instead a £100 million brand.

Figure 6.3 illustrates these points. $LRAC_{Production}$ is the cost curve that relates to production only. $LRAC_{Production+Advertising}$ is the cost curve when we consider production and advertising together. The MES for production is much smaller than the MES for production and advertising. Therefore, by strategically changing the cost nature of the soft drinks industry, from production based to managing brands, the dominant players can try to prevent entry.

Perhaps more important, the £100 million brand development fee is a **sunk cost**. This means that if the entrant decided to exit the market after spending £100 million on brand development, it would be unlikely to sell the asset on. The asset has no value to any other business and so the cost is sunk. In contrast, the production facility could be sold on. A soft drinks manufacturer may not buy the plant, but some other food processing company could be interested in the facility. This asset can be sold on, so its costs are not sunk. As a consequence, the need for a brand simultaneously increases the size of entry into the market and it makes it more risky as the asset cannot be sold on. The investment is lost.



When the MES is naturally low, entry can be easy. Incumbents can change this by altering the cost characteristics of the industry. One suggestion is to move away from production and build in large investments in intangible assets such as brand names. This can substantially increase the MES and reduce entry.

Figure 6.3 Strategic entry barriers

Box 6.2

How Britain lags behind continental competitors

Heathrow is the world's busiest two-runway airport and is currently running at 98 per cent of its capacity. Not only is it limited to two runways, but the British Airports Authority (BAA) faces a restriction on how these runways are used, with Heathrow limited to 480 000 flights a year. As a result it takes very little for the airport to grind to a halt, especially during bad weather.

Heathrow's major competitors for hub traffic are in a far better position. Last October Frankfurt airport opened its fourth runway, increasing its capacity from 83 take-offs and landings an hour to potentially 126 an hour. Charles de Gaulle Airport in Paris also has four runways, while Schiphol Airport in Amsterdam now has six.

Barajas airport in Madrid also has four runways and is emerging as a major international hub, especially for traffic to South America. Elsewhere Dubai airport, which has four runways, has cemented its position as a significant aviation stopping point.

The lack of runway capacity not only means that Heathrow is more prone to delays than its competitors, but Britain is also in danger of failing to exploit the growing market in China in particular. Heathrow for example only has two routes to China, while Frankfurt serves four destinations and Amsterdam six. More alarmingly, London remains without any direct connection to 12 cities in mainland China that are predicted to be among the 25 global cities with the highest gross domestic product (GDP) in the world by 2025.

Adapted from an article by David Millward in *The Telegraph*, 19 January 2012. © Telegraph Media Group Limited 2012.

A **contestable** market is one where firms can enter and exit a market freely.

The existence of sunk costs is important because without them markets are **contestable**. With freedom to enter and exit, contestable markets proxy perfectly competitive markets. So, even if the market has only a small number of large players, the absence of sunk costs enables potential rivals to threaten future entry. The only way to prevent entry is to make it look unattractive, with low levels of profit. So, contestable markets, even with oligopolistic structures, only produce normal economic profits.

Examples of contestable markets

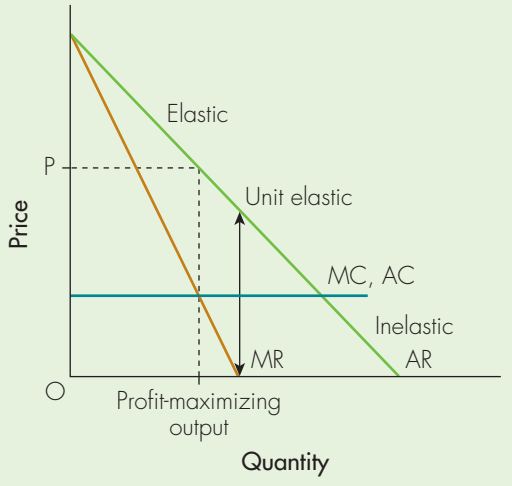
The airline industry is commonly used as an example of contestability. An aircraft does not represent a sunk cost. A jumbo jet can be used on a route between Heathrow and New York. It can equally be used on a route between Heathrow and Hong Kong. There are no costs in moving the asset (aircraft) between the two routes, or any other route. Therefore, the airline can quickly and easily move the aircraft to the most profitable route. This ability should keep profits low on all possible routes, as the threat of entry by rivals is very real, with no entry barriers.

Competition between airports is also facilitated by the ability of airlines to move capacity and airports which are unable to provide airlines with future growth opportunities are likely to lose out; see Box 6.2.

6.4 Oligopoly theory: competition among the big ones

Now that we have an understanding of why oligopolies exist, it is important to understand how competition occurs between rival firms within an oligopoly. A simple fact is that firms in an oligopoly are torn between a desire to compete and the benefits of colluding. The following discussion illustrates this point.

Optimally, all firms in an oligopoly should agree to co-operate and act as one monopolist, as this generates the highest level of profits. This is known as a cartel and is illustrated in



Marginal cost has to be positive. It is not possible to produce one more unit of output for a negative amount of money. Resources such as labour will have to be paid for. Under profit maximization MR = MC, therefore if MC has to be positive, MR also has to be positive in order for the two to be equal. From the above, positive marginal revenue is only associated with output levels where demand is price elastic. With price-elastic demand, reducing the price and expanding output will lead to higher total revenues. Since costs are constant, revenues will grow more quickly than costs and profits will increase for the individual firm. With constant cost levels, the individual firm can expand output, raise revenues and therefore boost profits.

Figure 6.4 Collusion versus competition

Figure 6.4. For simplicity, assume all firms face identical constant marginal and average costs. These are shown as a horizontal line in Figure 6.4. The profit-maximizing output occurs where MR = MC. This output maximizes the joint profits of all the firms in the cartel, acting as a monopoly. However, each firm will quickly recognize that it can undercut the market price and raise its own profits at the expense of its rivals. Why?

The answer rests in an understanding that a profit-maximizing monopoly will only operate in the price-elastic region of its demand curve. Marginal cost has to be positive, because it is impossible to produce an additional unit of output without incurring additional costs. Therefore, if profits are maximized when MC = MR, then, because MC is positive, MR must also be positive. If marginal revenue is positive, reducing the price to sell one more unit has made a positive contribution to total revenue. We saw in Chapter 2 that cutting prices and raising total revenue only occurs when demand is price elastic.

Therefore, a single firm within the cartel illustrated in Figure 6.4 can see that its marginal and average costs are constant. However, reducing prices will generate greater revenues because demand is price elastic. The individual firm can, therefore, earn more profit by cheating on its cartel colleagues and expanding output. Unfortunately, any member of the cartel could recognize that, being on the elastic part of the demand curve, it could also drop its own prices and raise revenues. Therefore, all rivals would respond by dropping their prices, leaving the cartel and in effect competing with each other. This is strategic interdependence in action. Should firms in oligopoly co-operate with each other and act as a monopoly, or compete with each other and start a price war?

When a cartel might work

Some basic points at this stage help in understanding when a cartel can work and when competition will prevail. Collusion is likely to fail when there is:

- a large number of firms
- product differentiation
- instability in demand and costs.

Collusion is much harder when there are many firms in the industry: co-ordination and enforcement is too complex and it is easy for firms to blame each other for cheating. If the product is not standardized, perhaps differentiated in some way, then collusion is unlikely to work. Differentiation is a means of reducing substitutability. Why agree on price fixing when

Table 6.3 Ten highest EU cartel fines per case since 1969

Year	Case name	Amount in €million
2008	Car glass	1,384
2009	Gas	1,106
2007	Elevators and escalators	832
2010	Airfreight	799
2001	Vitamins	791
2008	Candle waxes	676
2010	LCD	648
2010	Bathroom fittings	622
2007	Gas insulated switchgear	539
2007	Flat glass	487

Source: European Competition Commission Cartel Statistics.

your products are not near-substitutes? Finally, collusion benefits from stability in demand and costs. If the equilibrium is changing frequently, then the cartel has frequently to adjust its agreed prices. It is costly to co-ordinate and the variation in market conditions provides firms with the cover needed to cheat and not get caught.

Examples of price fixing include the Organization of Petroleum Exporting Countries (OPEC), which meets on a frequent basis to agree oil production levels for all member countries. By managing oil production, OPEC is seeking to influence oil supply in the world and ultimately set the world price for oil. Since this is an agreement between countries it is not illegal, although perhaps it is not desirable.

Recent commercial examples include the agreement between British Airways and Virgin to fix fuel surcharges on transatlantic flights. Sony and Hitachi were suspected of agreeing to fix the price for LCD screens used in the Nintendo DS; and in Europe both Unilever and Proctor and Gamble have been fined for fixing the price of detergents (see Box 6.3). In all these cases the number of large competitors is small, the product displays little differentiation and costs are relatively stable, all of which provide a possible mechanism for co-ordinating price increases. Table 6.3 presents further examples ranked by the size of the fine imposed by the European Union (EU) Competition Commission. Again a quick consideration of each case would suggest fairly homogeneous products and large economies of scale, leading to a small number of firms and relatively stable costs and demand.

Price fixing can have economy-wide implications and in many countries and economic regions cartels are considered an illegal activity. Within the EU, suspected cartels are investigated by the European Competition Commission, which under antitrust legislation has the power to seek penalties in the courts for up to 10 per cent of a company's global turnover. In practice big headline cases are most likely to suffer the 10 per cent penalties, while the vast majority of cases pay fines which equal less than 1 per cent of their global turnover. Any company involved in a cartel can seek immunity from prosecution under the Commission's leniency policy. The leniency policy provides protection to companies that inform on other members of the cartel and/or assist in the investigation and prosecution of a cartel. In order to gain immunity under the leniency policy, then a company must be the first to inform the Commission about the cartel. If a company is not the first to inform the Commission, then a reduction in penalties can be achieved if that company provides the Commission

with evidence which reinforces its ability to prove the existence of the cartel. Again the first company to provide evidence gains most, with a possible penalty reduction of 30–50 per cent, the second company can gain a reduction of 20–30 per cent and subsequent companies up to 20 per cent. In addition to placing large fines on the companies involved in cartels, a number of countries have begun to make company directors face criminal prosecution and, where guilty, serve prison sentences.

Figure 6.5 provides data on the number of suspected cartels investigated between 2007 and 2010 by the EU Competition Commission and the number of decisions where the case was proven. While the number of investigations has been increasing the number of decisions has remained fairly constant.

Figure 6.5 Cartel investigations and decisions

Source: EU Competition Commission, Cartel Data.

Box 6.3

Unilever and P&G fined $457 million by EU for detergent cartel

Unilever and Procter & Gamble Co. (P&G) agreed to pay €315.2 million ($457 million) in fines to end a European Union probe into price fixing of laundry detergent.

P&G, the maker of Ariel washing powder, was fined €211.2 million and Unilever will pay €104 million for agreeing with Henkel KGaA, the German maker of Persil, to fix prices of the detergent in eight countries over a three-year period, the European Commission said today in an emailed statement.

Henkel was not fined because it was the first company to supply evidence to regulators. Antitrust agencies across Europe have been investigating cosmetics and detergent manufacturers for agreements to fix or increase prices. The commission said it reduced fines on the other two companies because they co-operated in the probe and agreed to settle.

'Henkel, Procter & Gamble and Unilever engaged in their anti-competitive practices at their own initiative and at their own risk,' Joaquin Almunia, the EU's competition chief, said. Almunia said the companies agreed not to cut prices when they shrank the size of packaging for laundry detergent and then later agreed to increase prices.

Unilever spokesman Trevor Gorin said the amount it has to pay was 'within the provision made by Unilever in its 2010 results'. Procter & Gamble spokeswoman Marina Barker said it had 'previously taken an appropriate financial reserve' to cover the fine and strengthened its global compliance program.

The three companies started co-ordinating prices in 2002, the Commission said, when they put into practice an industry-wide initiative to improve environmental performance by reducing the weight of washing powder and its packaging.

The price-fixing deal covered Belgium, France, Germany, Greece, Italy, Portugal, Spain and the Netherlands, the Commission said.

In 2010, Italy fined Unilever, P&G and 13 other companies for co-ordinating price increases for cosmetics. It did not fine Henkel because it was the first to inform regulators of the cartel. German units of Unilever, Henkel and Sara Lee were fined about €37 million by the country's cartel office in February 2008 for fixing toothpaste and detergent prices.

6.5 Competition among rivals

We now understand that oligopolies are industries characterized by a small number of large firms and that entry barriers are a likely cause of them. We now need to develop a framework which will enable an understanding of how firms within an oligopoly will decide to compete or co-operate.

A **kinked demand curve** shows that price rises will not be matched by rivals, but price reductions will be.

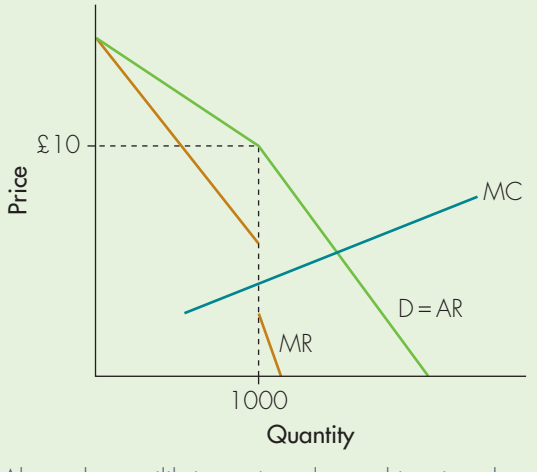
Economists' earliest attempts to model oligopolies involved the **kinked demand curve**, shown in Figure 6.6. The idea behind the kinked demand curve is that price rises will not be matched by rivals, but price reductions will be matched. The kinked demand curve is therefore often used to explain the pricing behaviour of competing petrol stations. Since car drivers can always drive on to the next filling station, each petrol station has a number of nearby competitors. If one station increases prices, then all others will hold prices and attract additional traffic. If a station cuts prices, then more traffic will flow to that station and competing outlets will counter the move by matching the price cut. It is only when the price of oil changes that all petrol stations move prices together.

At the price of £10, there is no point in a firm changing its prices. If it increases prices, all rivals will hold their prices; but if the firm drops prices, all rivals will also reduce their prices. Therefore, above the price of £10 demand is price elastic and below demand is inelastic, thus leading to the kinked demand curve.

The marginal revenue line is vertical at the profit-maximizing output. This is because the demand curve changes slope at this output level. The difference between the elastic and inelastic demand curves leads to a stepped change in the marginal revenue.

As a result, the demand curve has a different shape above and below the current market price:

1. If the firm raises its price, rivals will keep their prices constant. The firm will, therefore, lose customers when it raises prices. As a result, demand above the current market price is elastic.
2. In contrast, if the firm reduces its prices, all rivals will match the price reduction. The firm will not gain more demand by reducing prices. Demand below the current market price is therefore inelastic.



Above the equilibrium price, demand is price elastic; competitors do not follow price increases. Below the equilibrium price, demand is inelastic; competitors match price cuts.

Figure 6.6 Kinked demand curves

We will see below that economists question the theoretical merits of the kinked demand curve, but it provides a reasonable starting point for understanding some real-world examples. The pricing of petrol, or at least the reduction in petrol prices, can be explained using the kinked demand curve. Once one petrol supplier announces a price reduction, all other petrol suppliers respond with similar price reductions in order to protect their market share. We might therefore argue that demand is inelastic for price reductions. Similarly, no firm would increase prices without full knowledge that other firms would follow. This occurs in the petrol market because of the cost of oil. So price rises only occur when all firms face increased input costs and are therefore willing to increase prices together. But no firm would make a decision to be more expensive than its rivals. Furthermore, because of the vertical portion of the marginal revenue line, the change in the marginal cost of oil has to be quite large in order to deliver a change in the equilibrium price of petrol. Therefore, because of the kinked demand line, modest daily changes in oil prices are unlikely to feed into erratic daily price changes at the petrol pumps.

Box 6.4

EDF 'throws first punch' in energy price war

Experts are predicting an 'energy price war' as pressure mounts on the Big Six providers following an announcement by EDF Energy that it will slash its gas prices by 5 per cent.

The firm said the cut meant its standard dual-fuel tariff would be the cheapest on the market – but the typical cost for households is still £166 or 16 per cent higher than EDF's average bill of £1037 in September 2010.

EDF's move comes shortly after smaller companies Ovo and Co-operative Energy announced plans to cut their prices.

Consumer groups welcomed the cut, but pointed to the round of price rises last autumn. 'EDF has thrown the first punch in the energy price war to come,' said Mark Todd, director of the independent price comparison service Energyhelpline.com. 'The reduction is less than expected, but it is quicker, and for that millions of homeowners concerned about winter bills will be relieved.'

Overall, suppliers put prices up in the past 18 months by 21 per cent – or an average of £224 – adding £2.24 billion on to household energy bills. The latest cut will mean that bills of EDF Energy customers on a dual-fuel tariff will drop from £1241 to £1203.

Richard Lloyd, executive director of consumer organization Which?, said: 'This gas price cut will be welcome news for millions of consumers with already squeezed household budgets. But it follows a hike of 15 per cent last November. Now the pressure is on for the rest of the major suppliers to follow suit.' Ann Robinson, director of consumer policy at uSwitch.com, added: 'Pressure to cut prices has been mounting, and now one of Britain's biggest energy suppliers has let the cork out of the bottle.'

Adapted from an article in *The Scotsman*, 12 January 2012.

In Box 6.4 the case of energy price cuts is discussed. When EDF cut its energy prices, the almost perfect substitutability between suppliers raised the strong expectation that all other competitors would follow.

In contrast to the petrol market, Box 6.5 provides an example of how firms reacted to Netflix's decision to enter the UK market. Lovefilm, as a close competitor in the streaming market for films, immediately cut prices. BSkyB, the dominant supplier of movies but using satellite technology, retained its price position. The difference between the pricing strategy of energy suppliers and BSkyB probably reflects the degree of substitutability. Energy is very homogeneous and so the market demand is very elastic below the equilibrium price; therefore all suppliers follow price cuts. Films via satellite do not require a good broadband connection and are easily accessible. As such they are differentiated and therefore not perfect substitutes for those offered by cheaper rivals. Market demand is likely to be less elastic below the equilibrium price.

Problems with the kinked demand curve

The kinked demand model has a number of positive features. First, the demand curves for the firm are based on potential or expected responses from the firm's rivals. Hence, strategic interdependence is a feature of the model. Second, the model predicts stability in pricing. This occurs because of strategic interdependence; rivals will react to price changes in a way that makes them ineffective. Also, price stability occurs because, even when the firm's costs increase, as a result of the vertical portion of the firm's MR line the profit-maximizing output and price are unlikely to change. Only when costs change by a large amount will the intersection of marginal cost and marginal revenue move from the vertical portion of the marginal revenue line.

The major drawback associated with the kinked demand curve is that it does not explain how the stable price is arrived at in the first place. There must be a prior process that determines the price. The kinked demand curve merely explains the stability once the price is set. We therefore need an approach that understands strategic interdependence more fully.

Box 6.5

Netflix sparks price war with UK launch

US online DVD rental company Netflix launched in Britain and Ireland on Monday, taking on BSkyB's premium drama and movies offerings and prompting Amazon-owned rival Lovefilm to offer a new cut-price service.

In its first expansion outside the Americas, which the company has said will push it into a loss this year, Netflix said its prices and instant access to a broad range of online entertainment would attract new customers.

Lovefilm, which has 2 million customers in its core British market, immediately announced Lovefilm Instant – an Internet streaming-only offer to undercut Netflix – in addition to its current offer that combines streaming and DVD rental by post.

Netflix Chief Executive Reed Hastings told Reuters in an interview that BSkyB would be its main competition. 'Lovefilm is not the enemy. When you talk about big entertainment businesses, Sky Atlantic and Sky Movies are huge, and our advantage is we are much lower priced than the Sky packages, and it is all on demand – click and watch,' he said.

Co-founded by Hastings in 1997, Netflix created the US market for DVD rental by post but has suffered more recently as it shifts to lower-margin instant online delivery. Nonetheless, Hastings said Netflix had no option but to press ahead aggressively with the new delivery technology, describing DVD postal delivery as being 'a little bit like travelling by horse and buggy'.

'In the long term, Internet TV – the idea that you can click and watch anything you want – is such a powerful concept that we are investing heavily,' he said.

Netflix is offering unlimited online access to tens of thousands of hours of movies and drama for £5.99 per month in Britain and €6.99 (£5.76) in Ireland, plus a month's free trial. The new streaming-only package from Lovefilm, which said on Monday it had had a record number of subscribers signing up in the fourth quarter, will cost £4.99 per month.

BSkyB charges £20 per month for an entertainment package that includes Sky Atlantic, a US-focused drama channel launched a year ago that includes exclusive rights to HBO's back catalogue, including the popular *Game of Thrones*. Europe's biggest satellite broadcaster demands that customers sign up for contracts, and have a set-top box and connection to a Sky dish. Sky Movies costs £16 per month on top of the basic television package.

Both Netflix and Lovefilm can deliver their content via a wide range of Internet-connected devices such as games consoles, tablets and Blu-ray players as well as computers and smart televisions.

Adapted from an article by Georgina Prodhan and Matt Cowan on Reuters, 9 January 2012.

6.6 Game theory

Game theory seeks to understand whether strategic interaction will lead to competition or co-operation between rivals.

In response to this challenge, economists have now turned to **game theory** as a means of understanding strategic interdependence. In economic jargon, a game has players who have different pay-offs associated with different strategic options. In the business sense, we could have two firms (players): they could start a price war and compete against each other or they could try to co-operate with each other (strategic options). Each combination has different profit outcomes (pay-offs) for the two firms.

The original version of game theory is known as the prisoners' dilemma, where two criminals have to decide to co-operate or compete with each other in order to win their freedom. The prisoners' dilemma is similar in style to the end game in the television show *Golden Balls*, where opposing players have to decide to steal or share, in order to win the cash prize.

The prisoners' dilemma

Two criminals, Robin Banks and Nick Scars, are arrested by the police. There is little evidence against the criminals and they face a short spell in prison if convicted. The police decide to offer each prisoner a deal. If they provide evidence against their fellow criminal, then they will go free. The dilemma facing the prisoners is illustrated in Figure 6.7.

The matrix of sentences represents the possible pay-offs to each prisoner. If they both stay silent, then they will receive a short sentence. If Nick Scars stays silent and Robin Banks provides evidence, then Nick Scars receives a long sentence and Robin Banks goes free. Sitting in separate cells, with no ability to communicate, both prisoners are most likely to provide evidence and receive medium sentences. They will cheat, or compete with each other, when it would have been in their interests to co-operate and stay silent. Just as with the game *Golden Balls*, sharing is attractive, but it is possibly outweighed by the gains of stealing – but only if the other player does not steal as well.

Robin Banks

Nick Scar	Stays silent	Betrays
Stays silent	Nick Scar: short sentence Robin Banks: short sentence	Nick Scar: long sentence Robin Banks: goes free
Betrays	Nick Scar: goes free Robin Banks: long sentence	Nick Scar: medium sentence Robin Banks: medium sentence

Figure 6.7 The prisoners' dilemma

To understand why competing, rather than co-operating, with a rival is preferable, we need to understand the importance of the Nash equilibrium.

The Nobel Laureate John Nash proved that the optimal solution for any game must result in each player making an optimal decision given the potential response of its rival. This is now known as the **Nash equilibrium**. The important point to note from the Nash equilibrium is that each firm considers what its rivals can do before deciding on its own strategy. A player does not simply decide what it wants to do. For example, Liverpool or Barcelona do not decide to run on the pitch and kick the ball in the back of the opposition's net. Clearly, this is what they want to do. Instead, they think about what their rivals will do, how they play, what formation they might use and who their opponent's key players are. Liverpool or Barcelona can then develop a football strategy based on what their rivals are going to do. The Nash equilibrium is just formalizing this obvious decision-making process by saying, 'Consider your rival's likely behaviour before you decide what you are going to do'.

Firm A

Firm B	Co-operate	Price war
Co-operate	50:50	20:60
Price war	60:20	30:30

The numbers in each box are the pay-offs to each firm (firm B is always on the left and firm A on the right). The Nash equilibrium is where both firms choose to start a price war, earning £30 million each. This is because when choosing its strategy A examines B's options: if B tries to co-operate, A's best response is to start a price war; and if B starts a price war, A's best response is again to start a price war. B will come to the same conclusion when examining its response to A.

Figure 6.8 Game theory, pay-off matrix

Now let us examine a price war game in Figure 6.8, using Nash's argument. Firm A looks at firm B and sees that B can do one of two things: co-operate or start a price war. We can begin by examining what happens if B decides to co-operate. If A then also co-operates, it will earn £50 million, but if A begins a price war, then it will earn £60 million. Firm A now thinks about B's other option, which is to start a price war. If A tries to co-operate, it will only earn £20 million, but if A also takes up the option of a price war, then it will earn £30 million. Firm A now knows that, whatever B does, it is always optimal for A to start a price war. Firm B will go through a similar decision-making process and come to the same conclusion – that whatever A does, B will start a price war. The Nash equilibrium has both firms embarking on a price war earning £30 million each.

In this example, each firm's optimal decision is independent of its rival's decision. A's optimal decision is to cheat, regardless of whether B cheats or co-operates. A is known as having a **dominant strategy** and, given that our example has symmetric pay-offs for B, then B also has a dominant strategy.

Nash equilibrium occurs when each player does what is best for themselves, given what their rivals may do in response.

Dominant strategy is a player's best response, whatever its rival decides.

When each player has a dominant strategy, the Nash equilibrium will be unique – only one cell in the pay-off matrix will provide an equilibrium solution. However, this unique equilibrium is not necessarily optimal. In the case of the prisoners' dilemma, both players would be better off if they co-operated.

Repeated games

In a single-period game, the game is only played once. In a repeated game, the game is played a number of rounds.

A credible commitment or threat has to be one that is optimal to carry out.

Starting a price war or displaying 'non-cooperative' behaviour is a general response in a **single-period game**. Therefore, as a rule, whenever you play a game once, as our rivals did in Figure 6.6, or strategically interact with someone once, then cheat. For example, consider buying a second-hand car from the classified ads. You see a car and go to meet the owner. You will say the car is not perfect and the owner will tell you that the car is fantastic. It does not matter whether the car is good or not; you are both displaying non-co-operative behaviour. You both do this because you do not expect to meet again to buy or sell cars in the future. It is a one-period game, so you both cheat. You would like the price to fall; they would like the price to rise.

The way to move from a non-co-operative Nash equilibrium to a co-operative Nash equilibrium is to play the game repeatedly and use a strategy known as 'tit-for-tat'. Under tit-for-tat, you will co-operate with your rival in the next round if they co-operated with you in the last round. If they cheated on you in the last round, you will never co-operate with them again.

In the game above, if A and B co-operate they both receive £50 million. If, in the next round, A decides to cheat and start a price war, it will earn £60 million, or £10 million more than from co-operation. But in the next rounds B will always commit to a price war, so the most A can earn is £30 million. Firm A has the choice of gaining £10 million in the next round and then losing £50 million – £30 million = £20 million for every round afterwards. Therefore, short-term gains from cheating are outweighed by the long-term losses of a repeated game.

However, in order for tit-for-tat to work, the threat to always display non-co-operative behaviour, if your rival cheated in the last round, has to be a **credible commitment**.

Recall the Spanish invaders who burnt their boats – their threat to fight the local Incas, rather than sail off to a safer shore, was very credible when they no longer had any boats!

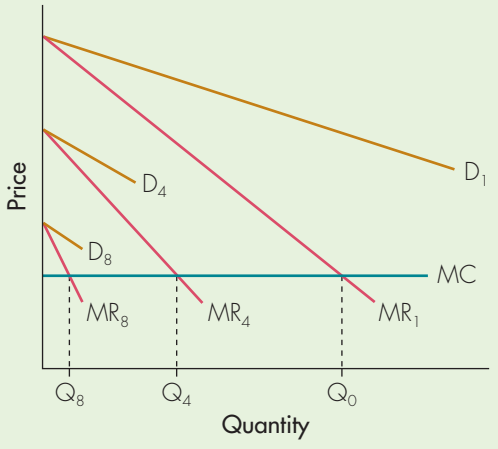
For a business illustration, let us go back to the car example. This time consider buying a car from a dealer of one of the major manufacturers. With a second-hand car they usually provide a warranty. They do this because they value your repeat business. The dealer does not want to sell you a bad car. Instead, they would like you to feel secure in the fact that the car is good and they will fix any problems. They are not cheating; they are trying to co-operate. In fact, by offering warranties they are making a credible commitment to provide you with a trouble-free car. They are willing to do this because the potential revenue streams from your repeat business outweigh any gains from selling you a bad car at an expensive price.

Finally, we can consider the market for love. Marriage is a repeated game. If one partner cheats by seeing someone else, then divorce is a fairly robust method of never agreeing to co-operate with the cheating partner again. In the singles market, in contrast, seeking co-operation for fun with someone you find attractive could be a one-period game if you only expect to see them once. If they ask what you do, it is better to cheat. Claiming to be a catwalk model or a professional footballer are better options than admitting to being an indebted student.

In summary, strategic decisions require an understanding of the potential responses. If a firm, or individual, plays a game once, they should cheat. If they play repeatedly, then they should try to co-operate for as long as their rivals co-operate.

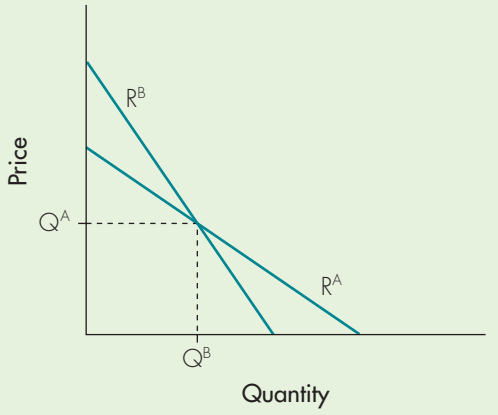
6.7 Game theory extensions: reaction functions

The prisoners' dilemma is a simplification and the existence of joint dominating strategies is not always assured. We therefore need to understand how interdependent firms should react



If firm A assumes that B produces zero output, then A will produce Q_0 output. If A assumes that B will produce 4 units of output, then A faces a residual demand of D_4 and will produce Q_4 output. Assuming that B produces 8 units of output, then A will produce Q_8.

Figure 6.9 Duopoly and residual demand



R^A and R^B represent the reaction functions for firms A and B. Each firm faces the same costs and same market, so the reaction functions are symmetric. The reaction functions show how each firm reacts to a change in output by its rival. In equilibrium, each firm's assumption about its rival is correct and each firm produces an identical level of output because the reaction functions are symmetric. Therefore $Q^A = Q^B$.

Figure 6.10 Reaction functions

to the expected behaviour of their rivals. We can achieve this by considering a market with two firms – known as a duopoly.

Assume two firms, A and B, face an industry demand D_1 and constant marginal costs MC. This situation is illustrated in Figure 6.9. Firm A must decide how much to produce based on what it expects firm B to produce. To begin the analysis, A assumes that B produces nothing. A, therefore, faces the entire industry demand D_1 and the associated MR_1. As a profit-maximizer, A selects the output Q_0, where MC is equal to MR_1. If A now assumes that B produces four units, then A faces the **residual demand** line D_4 and the associated marginal revenue line MR_4. The profit-maximizing output for A is now Q_4. We can continue allowing A to alter its assumption about B. So, if A assumes that B produces eight units, then A faces the residual demand D_8 and the marginal revenue MR_8. The profit-maximizing output for A is now Q_8.

Residual demand is equal to the market demand less the amount produced by the firm's rivals.

The model depicted in Figure 6.9 is referred to as a **Cournot model**, after the French economist Augustin Cournot. Under a Cournot model, each firm treats its rival's output as a given. In our example, A assumed B's output was 0, 4 and then 8. If we continued the analysis by enabling A to consider each possible output by B, we would understand how A would react to every possible output choice available to B. This would derive the **reaction function** for A. Similarly, the analysis can be repeated in order to derive the reaction function for B.

In a Cournot model, each firm treats its rival's output as a given.

A reaction function shows that a firm's profit-maximizing output varies with the output decision of its rival.

Figure 6.10 presents the reaction functions for A and B. R^A is the reaction function for A and R^B is the reaction function for B. Both reaction functions slope down, indicating the negative relationship between the output choices made by A and B. If B decreased its output, then A would react by increasing its output. Importantly, A would increase its output by less than B's reduction. This ensures that output falls overall and that the price increases in the market. Since A is not cutting its output, it now receives a higher revenue on all its previous units.

The equilibrium output occurs where both reaction functions intersect. This is a Nash equilibrium since each firm is making an optimal decision based on what its rival is expected to do. This equilibrium is also sub-optimal, just as in the case of the prisoners' dilemma. This

is because each firm takes its rival's output as a given and then determines its own profit-maximizing output. There is no consideration of what effect this level of output will have on the rival's profits. As such, overall output is increased beyond the profit-maximizing output of a monopoly, which would maximize joint profits.

An alternative to the Cournot model is the Bertrand model. Under a Bertrand model, firms treat the prices of rivals as given. Again, it is possible to derive reaction functions. This time, firm A assumes a price level for B and then chooses a price level for itself which maximizes its own profits. It is simple to understand that the Nash equilibrium occurs where both firms set a price equal to marginal cost. This is because, if B is assumed to set a price above marginal cost, A can go slightly below and gain the entire market. In reaction, B will go slightly lower than A. So, in equilibrium, A and B will choose a price equal to marginal cost and earn normal profits. Since the Bertrand model predicts a perfectly competitive outcome for a duopoly, economists tend to prefer the output-based approach of the Cournot model.

Stackelberg models and first-mover advantage

First-mover advantage ensures that the firm which makes its strategic decision first gains a profitable advantage over its rivals.

A Stackelberg model is similar to the output approach of Cournot, but firms do not make strategic decisions simultaneously.

Until now we have assumed that both players make simultaneous decisions. It is also interesting to consider the nature of the Nash equilibrium when one firm acts as the leader and other firms then act as followers. In such scenarios it is possible to identify a **first-mover advantage**.

First-mover advantage can be examined using a **Stackelberg model**, which is similar to a Cournot model in its examination of output, but differs in enabling one firm to make its decisions first, rather than simultaneously with its rival. Let us assume that firm A is the leader and firm B is the follower. A now has a considerable advantage over its rival. In full knowledge that B will react to A's decision, it is clear to A that the equilibrium must be located on B's reaction function. A must therefore choose an output which maximizes its own profits and is located on B's reaction function. If A goes higher than the Cournot equilibrium output, B must reduce output and this helps to support a higher price and greater profits for A.

Under a Stackelberg model, A's marginal revenue in Figure 6.9 will be higher than under Cournot. This is because A knows that B will support the market price by reducing its output Q^B in response to an increase in Q^A. A will therefore choose a higher level of profit-maximizing output. In the case of Figure 6.10, A's reaction function R^A becomes steeper and intersects R^B higher up and in equilibrium $Q^A > Q^B$, with A earning higher profits than under a Cournot equilibrium. Of course, this equilibrium is only feasible if A's output decision constitutes a sunk cost and is thereby a credible commitment to produce at Q^A. If B suspects that A has incurred no sunk costs, then it will be likely to increase output and A will follow with a cut in output. The equilibrium will then revert to the Nash–Cournot solution.

A business example may help to illustrate the complexities of the model. If a leader is planning to build a production facility, then the Stackelberg model would suggest that the leader can gain a first-mover advantage by building a bigger facility. The followers will then observe the leader's productive capacity and follow with a smaller facility. If additional profits do accrue from being first, then these can be reinvested in additional plant, R&D and new product lines. As such, first-mover advantages become persistent advantages. Of course, there are risks with first-mover advantages. Costs can be high, risks can be unknown and followers can learn from your mistakes.

6.8 Business application: compete, co-operate or gain a first-mover advantage?

If we return to our game theory illustration in Figure 6.8, the most desirable box for firm A is top right, where it earns 60. However, from our discussion we know that A will never find

itself in this box. In a one-period game its rival will also compete and the two firms will earn 30 each, while in a repeated game both firms will try to co-operate and earn 50 each. Earning 60 in the top right is a situation where firm A competes and B decides to be friendly. A, therefore, dominates its rival B and in so doing controls the market. So, how do you convince your rival not to compete? We now know that the answer to this question rests on gaining a first-mover advantage.

This is a problem which taxed Sony and Toshiba, who battled for supremacy in the high definition DVD market. Sony developed and launched Blu-ray, while Toshiba led the HD DVD project. The competing approaches used different recording formats and were incompatible with each other.

The race to win market share can be viewed as a game. If Toshiba and Sony had agreed to cooperate and develop the same format, then movie-makers and consumers would have been very happy. Movie-makers would have felt assured that they could sell high-definition DVDs of their films, and consumers would have been happy to purchase a high-definition DVD player and television to view the films. The market would have grown and Sony and Toshiba would have shared a higher level of overall profits. This would be the top-left box of Figure 6.8.

In contrast, if Sony and Toshiba continued competing, movie-makers did not know which format to support and consumers ran the risk of buying a machine that could only play one format of discs. The market was slow to grow, and both firms earned reduced profits. This would be the bottom-right box of Figure 6.8.

Alternatively, if one company had won enough support that it became commercially unattractive for the remaining competitor to continue, then the winning firm would have been a monopoly and earned huge profits. Depending upon which firm won, this would be the top-right or bottom-left box of Figure 6.8.

In order to try to win, Sony and Toshiba sought out and gained the support of leading film studios. At times, some film studios changed sides and the balance of power between Blu-ray and HD DVD was finely balanced. Fortunately for Sony, it possessed a strategic option which offered the chance of first-mover advantage – Playstation 3 (PS3). By building Blu-ray into the PS3, Sony accelerated the adoption of its technology into many households around the world. In contrast, Toshiba's hopes of being adopted rested on the family decision to upgrade the trusted and reliable DVD player. By going first, or quickest, into households Sony gained a commanding lead in the market. Film studios realized and switched allegiance from Toshiba to Sony. Blu-ray is now the dominant format for high definition films.

6.9 Business application: managing supply costs – anonymous auctions for supermarket contracts

We have seen that, in repeated games, firms are likely to behave co-operatively. This presents a substantial risk to supermarkets who repeatedly run auctions to provide them with products. In particular, because supermarkets are retailers, they do not ordinarily manufacture their 'own-labelled' products. Instead, they ask competing manufacturers to bid for contracts. Today, it might be next month's lemonade contract; tomorrow, it might be fish fingers or soap powder. The firm that can produce the product most cheaply wins the contract. With supermarkets coming to the market repeatedly, it is in the interest of competing manufacturers to co-operate with each other. For example, rival manufacturers of fish fingers could agree to split the market. When bidding for supermarket X's contract, company A would never undercut company B. In return, when bidding for supermarket Y's contract, B would never undercut A.

For a supermarket, this is a serious problem. The way to stop it is to prevent co-operation. Supermarkets try to achieve this by organizing blind auctions over the Internet. The fish finger contract opens for bidding at 2.00 p.m. on Wednesday and companies make bids. The web page shows the amount of it, but it does not say who made it. The bidders now find it difficult to co-operate. In fact, it is now very easy to cheat because only the supermarket knows who you are. In this example, supermarkets can see the problem of co-operation and take steps to prevent its occurrence.

There is, however, a problem with the supermarket's strategy. In generating competition among its suppliers, it runs the risk of pushing some of them out of business. Therefore, in the long run the supermarkets could end up with monopoly suppliers in their key product markets rather than competitive industries, and we saw in Chapter 5 that such a situation could be dangerous.

6.10 Business data application: competition in the bus market

In 2011 the UK Competition Commission reported on an investigation into the market for local bus services. The market was found to be highly concentrated and a number of factors led to the conclusion that there was likely to be an adverse effect on competition. We can use some key learning points from this chapter to explore and understand many of the issues raised by the Competition Commission.

First, the Competition Commission found that majority of local bus services are highly concentrated. While there are 1245 bus operators in the UK, the five-firm concentration ratio for local bus services was 69 per cent. In fact, so concentrated is the market, that only another five companies have a share of the market which exceeds 1 per cent. This highly concentrated industry reflects the impact of merger activity, where on average 14 bus-operating companies have merged per year for the past 20 years.

Figure 6.11 presents market share data for the largest operators in urban areas. For the vast majority of urban areas, the largest company has a market share which is at least 50 per cent or more. Therefore, not only is the UK market highly concentrated among five large players, but each local market is dominated by one big operator.

Profitability was also investigated. Figure 6.12 presents data on the increases in operating costs and ticket revenues. During the period under investigation costs have generally increased faster than revenues. However, further analysis indicated that profit margins are good, in particular, for the largest operators the average rate of return over five years was estimated at 13.6 per cent, almost 4 per cent higher than the estimated cost of capital.

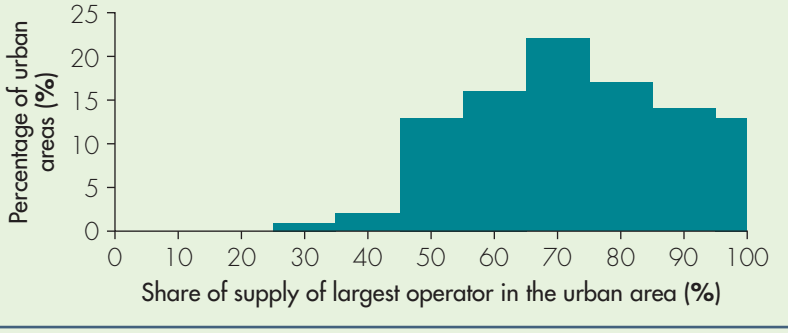


Figure 6.11 Market share of largest bus operators

Source: Competition Commission, Local Bus Services Market Investigation, Provisional Findings, May 2011.

Three types of competition were identified and examined by the Competition Commission, head-to-head, potential and new entrant. Head-to-head competition occurs between rival operators where their routes overlap in part, or as a whole. Potential competition is the threat effect from operators in other areas who may redeploy some of their buses onto routes in another area and in competition with the incumbent bus company. New entrants are bus operators who are not nearby to a local market and who may decide to expand their operations by entering new markets where there is already a competitor.

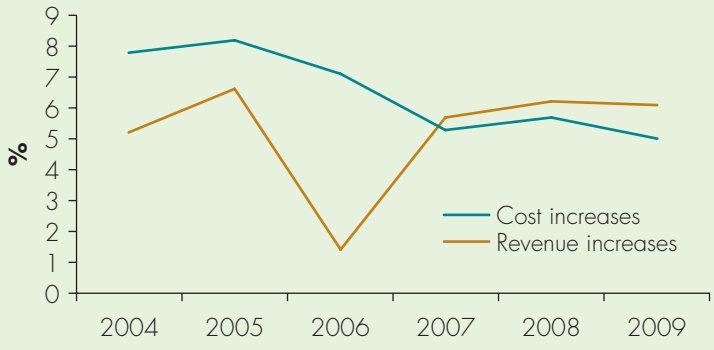


Figure 6.12 Cost and revenue increases in the local bus services industry

Source: Competition Commission, Local Bus Services Market Investigation, Provisional Findings, May 2011.

Bus operators were found to avoid head-to-head competition. Not many overlapping routes were found and where they existed the partial overlaps were small. Historically, head-to-head competition in the local bus market has been intense and short-lived. Competition tends to be almost predatory with the incentive to remove the competition as quickly as possible. Competition is often characterized by increased frequency of service, rather than fare reductions, or improved quality. In effect, rivals seek to starve each other of passengers. Head-to-head competition tends to be unstable with services changing, operators exiting and the services changing yet again. For this reason, bus operators were found to avoid head-to-head competition.

Threats from potential competition and actual new entrant competition were also found to be limited due to entry barriers. Sunk costs were found to be significant. Bringing a route to profitability requires substantial investment in promotional activities and running services at below optimal capacity. Unlike the sale of a bus, or the transfer of q bus to an alternative route, investing in the setup and development of routes cannot be recouped once a decision to exit is taken. Therefore with significant sunk costs the threat of potential and new competition is constrained. Further entry barriers were also identified, including access to suitable depot sites and bus stations. Finally, threats of competitive retaliatory action from incumbents highlights the importance of strategic interdependence in highly concentrated markets. If incumbent bus operators are willing to compete at a loss to drive out competition, then a new entrant will be inclined to stay away from the market.

The Competition Commission did not find any significant cost economies related to scale. However, they did note that with scale comes the advantage of offering passengers network connections and attractive multi-journey tickets. A small new entrant is unlikely to have multiple routes and so cannot offer a network travel solution to multiple destinations across an urban area. Without the scale and benefits of a network, the opportunity to sell discounted multi-journey tickets is also reduced. As such, small-scale new entrants are placed at a significant disadvantage to large-scale incumbents.

The Competition Commission also explored co-ordinated effects: were the local bus service companies acting together, rather than competing? Given the small number of large competitors, the relatively homogeneous nature of bus travel and the stability in supply and demand, cartel-like behaviour could be possible. There was some evidence that bus operators in one area did not bid for new contracts against companies in other areas. However, there were also sound commercial reasons for not doing so, such as the cost of servicing the distant geographic region from a distant bus depot. Therefore, evidence in support of a co-ordination effect was deemed by the Competition Commission to be weak.

In summary, the Competition Commission when investigating the local bus services market covered a number of areas with which you should now be familiar. These areas included

market concentration, profitability, sources of competition, entry barriers, sunk costs, strategic interdependence and co-ordination/cartels. By using these concepts in a structured manner it is possible to understand the competitive dynamics of the market and, in the case of the Competition Commission, to arrive at the conclusion that the characteristics of the market for local bus services may lead to an adverse effect upon competition. You as a business person may be required to do the same and, like new bus operators, decide whether it is financially sound to enter a new market which already contains large dominant competitors.

6.11 Appendix: auction theory

Auctions have become a popular pastime. The online auction site eBay offers for sale everything from the mundane to the bizarre. If you are trying to find something, eBay is generally worth a search, even for those of us who are not addicted to bidding online. Amazingly, if all the transactions across the world on eBay were added together, this auction site would be the world's fourth largest economy; and auction fever does not stop with eBay. Where home makeover shows once dominated television programme-making, auction format television shows now lead the schedules. With the likes of *Flog It*, individuals are invited to bring along heirlooms and see what they can make in an auction.

While clearly an attraction of auctions is the risky, almost gambling-based adrenalin of seeing what you have to pay to gain an item, or what you can gain by selling an item, the uncertainty is also a very important part of the experience. However, while eBay and *Flog It* might be a bit of fun, for firms auctions are serious commercial activities and, just as with eBay and the like, auctions for commercial services have grown in popularity. Supermarkets use auctions to place orders for own-label items. Sporting associations use auctions to license live television rights, and governments use them to license railway operators, mobile telecommunications and even the right to run lotteries. Fortunately, game theory can provide an understanding of optimal behaviour in auctions. Under a Nash equilibrium, each player will make an optimal bid based on what they believe their rivals will do in response.

The purpose of this section is to provide you with an understanding of auctions. It will begin by explaining the four main types of auction format and introduce the important concepts of private versus common values. With these basic blocks of knowledge in place, the discussion assesses auctions from both a buyer's and a seller's perspective. Understanding optimal bidding strategies under each auction format will enable a seller to assess the auction format that will deliver the greatest revenue; and recognizing the problem of the winner's curse will provide a cautionary note to bidders.

Auction formats

There are seen to be four auction formats: the English auction, the Dutch auction, the first-price sealed-bid auction and the second-price sealed-bid auction.

In an English auction, bids begin low and are increased incrementally until no other bidder is willing to raise the bid. Bids can either be cried out by the auctioneer, with bidders nodding, or waving their papers in acceptance, or they can be input electronically, as is the case with eBay. In a Dutch auction, prices start high and are gradually reduced until a bidder accepts the price and wins the auction. This type of auction is commonly used in Holland to sell flowers and agricultural produce. Under the first-price sealed bid auction, bidders must submit a single bid, usually in writing. Bidders have little idea what anyone else has bid, and the highest bidder wins. The second-price sealed bid is a variation on the first-price auction. Again, bids are submitted in writing, but the highest bidder pays the price of the second-highest bid.

Common versus private values

Auctions can also differ in the values held by bidders. With **private values** each bidder forms a private, probably subjective, view of the item for sale. This would be especially true with an item on eBay such as a watch, suit or an antique. Some individuals will like the item, but others will love it! Each bidder knows their own value of the item, but they do not know the value of the item to the other bidders. Furthermore, each bidder is unlikely to change their assessment of the item's value, even when they become informed of other bidders' valuations.

Private values means each bidder has a private, subjective, value of an item's worth.

Common values means the value of the item is identical for all bidders, but each bidder may form a different assessment of the item's worth.

Under common values, an item is worth exactly the same to all bidders, but no bidder is sure what the item is truly worth. For example, as part of a game you might be shown a jar filled with coins. Along with your friends, you are asked to bid for the jar; the highest bid wins the jar. Clearly, in this example the jar is worth the same to each bidder, but no one is sure how much the jar is worth (without opening it and counting the coins). Real-life commercial auctions tend to be characterized by **common values** – the rights to an oilfield, to show live football games or to run a national lottery. The commercial value of the rights is common to all bidders, but what they are truly worth is presently unknown. Significantly, under common values a bidder might be willing to change their bid once they know all the bids. For example, a comparison of bids will help to inform bidders about the accuracy of their own valuation of the item for sale. If other bidders are bidding high, then a bidder might be led to believe that they have undervalued the item.

With this basic understanding of auction formats, we can now consider which is the best auction format for a seller. If we assume that a seller wishes to maximize their revenue, we need to find the auction format which results in the highest bid. We will therefore analyse bidding behaviour in each auction format under which bidders have private values.

English auction with private values

A second-hand Swiss watch is offered for sale. You value the watch at £1000, a rival bidder values the watch at £900. What is your optimal bidding strategy? Under a Nash equilibrium, you should consider what your rival will do in response. So, if your rival bids £500, offer £501. Your rival may back out of the auction and you win at £501, saving yourself £499. Or your rival may top your bid and you are no worse off, since it cost you nothing to bid and you gained nothing. This strategy of raising the bid should continue until either your rival quits, or you reach your maximum willingness to pay. Significantly, in English auctions the winning bid will always be a fraction higher than the second-highest valuation. For this example, you will win the auction with a bid of £901.

Second-price sealed bid auction with private values

Under this auction format each bidder's dominant strategy is to submit a bid equal to their maximum willingness to pay. So, in the case of the Swiss watch, you will bid £1000 and your rival will bid £900. Since the highest bidder pays the second-highest price, you will win the auction for £900, which is almost identical to the outcome from the English auction.

To see why submitting a bid equal to your maximum willingness to pay is optimal, consider the following:

- **Lowering the bid**. If you lower your bid below your maximum willingness to pay, this will only alter the outcome if your new lower bid is less than your rival's. For example, a bid of £950 will still ensure you win the auction and pay £900. But a bid of £850 will result in you losing the auction (and your rival gaining the item for £50 less than they were willing to pay). So, in simple terms, you cannot win by lowering your bid, you can only lose.

- **Raising your bid**. If you bid £1050, this will not help you if your rival is going to bid less than £1000, your maximum willingness to pay. You will still win the auction and still pay the second price. If your rival is going to bid more than £1050, then again raising your bid has no impact. However, if your rival was to bid between £1000 and £1050, say £1030, you would now win the auction, but at a penalty. You would now have to pay £30 more than your maximum value. So, raising your bid above your maximum willingness to pay can only harm you.

So, you should not raise or lower your bid, simply submit your maximum willingness to pay.

First-price sealed bid auction with private values

Again, we are bidding for the Swiss watch and you value it at £1000. Should you submit a bid equal to your maximum willingness to pay as in the second-price sealed bid auction? To answer this question, consider Figure 6.13. The line S has a positive slope indicating that an increase in your bid raises the probability of winning the auction. If you bid your maximum willingness to pay, £1000, the expected payment on winning the auction will be equal to the areas A + B + C + D + E + F. If you lowered your bid to, say, £900, your expected payment upon winning the auction will be E + F.

The expected value (the benefit) from winning at £1000 will be A + B + C + D + E + F; exactly equal to the expected payment. The expected value (the benefit) of winning at £900 will be made up of the expected value of £900, plus the expected value of saving £100. So the expected value will be E + F + D.

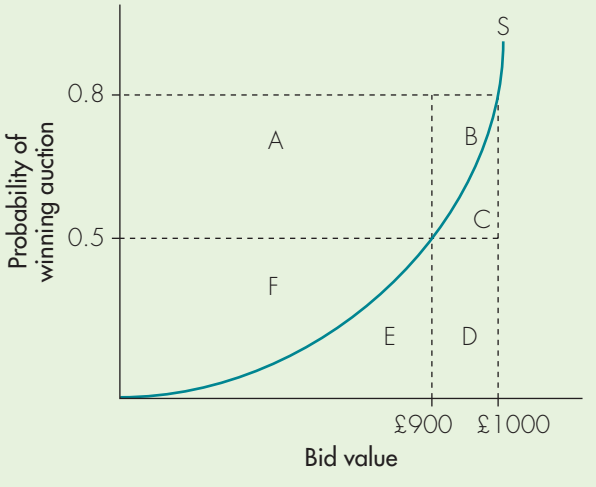


Figure 6.13 Optimal bidding under first-price sealed bid auction with private values

In the case of bidding £1000, the expected value equals the expected cost, so you break even. But when reducing your bid to £900, the expected value exceeds your expected payment by the area D. It is therefore always optimal to bid below your maximum willingness to pay. You reduce your chances of winning, but you raise your potential gains.

The question now becomes by how much should you reduce your bid below your maximum willingness to pay. The answer rests on understanding the likely behaviour of your rival bidders and recognizing the interdependence of your bids. While beyond the scope of this discussion, it can be shown in Nash equilibrium that the optimal bid is (N – 1)/N multiplied by the bidder's maximum willingness to pay, where N is the number of bidders. So, with two bidders, the bid should be a half of your maximum willingness to pay. The winning bid will turn out to be the expected value of the second-highest willingness to pay.

Dutch auction with private values

Under this type of auction, prices are called out and you bid when they have fallen to a level which is optimal for you to make a bid. In the case of our Swiss watch, you will not bid when prices are above your valuation of £1000. You will also not bid when the watch reaches the price of £1000, because you would not save yourself anything. Rather, you will let the price fall and try to maximize the difference between the price you pay and the price at which you value the item. In essence, you would be trying to maximize area D in Figure 6.13. But how far should you allow the price to fall? The answer to this question is the same as for the first-price sealed bid auction. You would consider the likely bidding behaviour of your rivals and as long as your rival had not accepted a higher price, you would bid (N – 1)/N multiplied by

your maximum willingness to pay. In Nash equilibrium, the price received by the seller would again be the expected value of the second-highest willingness to pay.

The revenue equivalence theorem

This brings us to an important result. Under all auction formats, the bidder with the highest willingness to pay wins, but they always pay a price roughly equal to the second-highest valuation. So, since the auction format does not alter the amount of revenue received by the bidder, we observe **revenue equivalence** across competing auction formats.

The revenue equivalence theorem states that under private values each auction format will generate the same level of revenue for the seller.

Auctions and common values: the problem of the winner's curse

Let us return to our jar filled with coins. The auction will be a first-price sealed bid auction. No bidder is better or worse at estimating the value of the jar of coins. Some will overestimate, others will underestimate, but on average (if the auction was repeated) all bidders would form an unbiased estimate of the jar's value. Each bidder also submits a bid which is increasing in their estimation of the jar's worth. So, the bidder with the highest valuation submits the highest bid and wins.

The problem with this type of auction for bidders is that the winner must by definition have formed an overly optimistic valuation of the jar of coins. They will therefore end up paying more for the jar than it is actually worth. So the **winner's curse** is that the winner actually loses. Knowing that the winner's curse exists will alter bidders' behaviour. If you think the jar is worth £100, you might then adjust your bid down to compensate for the risk of overestimating its worth and bid, say, £50. If all bidders are rational, they will all reduce their bids for this reason. In addition, bidders might reduce their bids further in order to maximize area D in Figure 6.13. Therefore, the problem for the seller in auctions with common values is that bidders will behave conservatively in order to avoid the winner's curse, leading to a lower sale price.

The winner's curse is where a winning bid exceeds the true value of the sale item.

Unlike the case with private values and first-price auctions, where the optimal bid increases with the number of bidders, e.g. when $N = 2$, $(N - 1)/N = 1/2$; and when $N = 3$, $(N - 1)/N = 2/3$, under common values and a first-price sealed bid auction, optimal bids will decrease with an increase in the number of bidders. For example, if there are three bidders and you win, you have outbid only two other people. However, if there are 101 bidders, then you have outbid 100 other bidders and your estimate must have been very wrong. So, with an increase in the number of bidders, individual bidders will behave more conservatively and reduce their bids by more to avoid the winner's curse.

What can sellers do to avoid this problem? Simple: the winner's curse and conservative pricing occur because of a lack of information. If bidders had more information regarding other bidders' valuations, then they could more appropriately gauge the accuracy of their own willingness to pay. English auctions offer a solution. As bids are called out, each bidder can observe the valuation and willingness to pay by other bidders. If bids rise quickly, pessimistic bidders can revise their valuation of the item and enter the bidding. Therefore, within an English auction and common values, the incentive to be conservative is removed and the final price is higher. This perhaps helps explain why the English auction is the most commonly observed format.

Summary

1. Under monopolistic competition, there are a large number of small firms, freedom of entry and exit, few opportunities for economies of scale, and the use of product differentiation.
2. Long-run equilibrium in monopolistic competition is a tangency equilibrium, which results in zero economic profits, excess capacity, above-minimum average costs and price in excess of marginal costs.
3. Oligopolies are marketplaces with a small number of large firms, typically four or five. UK banking, supermarkets and even the media industry are good examples.
4. An important feature of oligopolistic markets is strategic interaction. If one firm makes a strategic change, all other firms react. When one UK supermarket decided to open on Sundays, all other supermarkets followed.
5. Two interesting questions occur when examining oligopolies: (i) Why do oligopolies exist? (ii) How will firms compete with each other?
6. Oligopolies can exist because of exogenous economies of scale. The natural cost structure of the industry results in only a small number of large firms meeting the minimum efficient scale.
7. Alternatively, natural scale economies might be limited and so, in order to create entry barriers, existing firms might manipulate the cost characteristics of the industry by perhaps making advertising a large component of operating costs. This creates high levels of endogenous costs and reduces entry.
8. Sunk costs cannot be recovered when exiting a market. If large costs are associated with brand development, then these will be sunk. This increases the risk of entry and so can also lead to the creation of entry barriers.
9. Without sunk costs, markets are contestable. Potential rivals can threaten to enter a market. In order to limit entry, firms within the market will reduce prices and profits to make entry less attractive. As a result, even with a small number of large firms, contestable markets will approximate to perfect competition.
10. Game theory can be used to understand strategic interaction. Games consist of players, pay-offs and decision rules.
11. A Nash equilibrium is where players make an optimal decision based on what their rivals might do. In single-period games, the Nash equilibrium requires each player to cheat or display non-co-operative behaviour. In a multi-period game with no known end, the optimal strategy is tit-for-tat, where if you co-operated in the last round, your rival should co-operate with you in the next round. If not, you should never co-operate with them again.
12. Reaction functions illustrate a firm's best response given the possible responses of its rival.
13. A Cournot game involves firms making decisions over output. A Bertrand game involves firms making decisions over prices.
14. The Nash equilibrium for a Bertrand game has both firms charging a price equal to marginal cost.
15. The Stackelberg model illustrates first-mover advantages.

16. In the repeated environment of firms bidding for supermarkets' own-label contracts, it is likely that co-operation will occur, where rivals agree not to undercut each other on price. In order to prevent this and generate competition in the auction, supermarkets run blind auctions, where it becomes difficult for rivals to co-ordinate their bids. It even enables rivals to cheat on each other behind a cloak of secrecy.
17. There are four auction formats: English auction, first-price sealed bid auction, second-price sealed bid auction and Dutch auction.
18. Under private values, the value of an item differs across bidders. Under common values, the item has the same intrinsic value to each bidder, but bidders are unsure of the true value of the item.
19. Under private values, all four auction formats enable the bidder with the highest willingness to pay to win the auction. But they only pay the second-highest price. This is known as the 'revenue equivalence theorem'.
20. Under common values, bidders face the problem of the winner's curse, where the highest willingness to pay vastly exceeds the intrinsic value of the item.
21. To avoid conservative bidding under the winner's curse, an English auction format provides bidders with clearer information on the item's true value.

Learning checklist

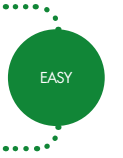
You should now be able to:

- Explain monopolistic competition
- Provide examples of oligopolies
- Explain the concept of strategic interdependence
- Identify natural and strategic entry barriers
- Understand the kinked demand curve model of oligopoly and provide a critical review
- Explain game theory, the concept of a Nash equilibrium and optimal strategies in single-period and repeated games
- Understand reaction functions
- Discuss the key differences between the Cournot, Bertrand and Stackelberg models
- Explain how game theory can be used to control the behaviour of rivals in auctions
- Identify the main types of auction and discuss the difference between common and private values
- Explain the revenue equivalence theorem and the winner's curse
- Examine and review Competition Commission reports on the degree of competition using economic concepts

Questions

connect

1. How do the assumptions of perfect competition and monopolistic competition differ?
2. List five industries which are likely examples of monopolistic competition.
3. How do the equilibrium conditions differ between perfect competition and monopolistic competition?



EASY

4. What are the main types of entry barrier that are likely to be associated with oligopoly?
5. Under a kinked demand line, is demand more or less elastic above and below the equilibrium price?
6. When is collusion likely to fail?
7. What is a Nash equilibrium?
8. In the single-period Prisoners' Dilemma, both prisoners confess. Is this optimal?
9. How might two strategically interdependent players be encouraged to co-operate with each other?

INTERMEDIATE

10. Is it possible and sensible to gain a first-mover advantage?
11. Monopolistic competition is sometimes criticized for displaying excess capacity. Explain why excess capacity exists in equilibrium and evaluate whether it is bad for society.
12. Do you consider it fair that whistle-blowers, who are the first to admit to being in a cartel, are immune from prosecution?
13. Assume your company is operating in a cartel, agreeing to raise prices and reduce output. If the cartel is ongoing, then the game is in effect repeated. Under what circumstances would your company cheat?

DIFFICULT

14. Electrical retailers promise to match each other's prices. Is this co-operation or competition?
15. A firm is considering whether it should be first to invest in a new market. Provide the company with your best economic advice.

Exercises

EASY

1. True or false?
   (a) A key aspect of an oligopolistic market is that firms cannot operate independently of each other.
   (b) Cartels may be workable if members enter into binding pre-commitments.
   (c) Under a kinked demand curve, demand is assumed to be price inelastic under a rise in prices.
   (d) In a one-period game, the strategy of tit-for-tat is optimal.
   (e) In a repeated game with no known end, it is always optimal to cheat.
   (f) With private values, an English auction format will raise the highest revenue for an item.

INTERMEDIATE

2. Suppose that there are two firms (X and Y) operating in a market, each of which can choose to produce either 'high' or 'low' output. Table 6.4 summarizes the range of possible outcomes of the firms' decisions in a single time period. Imagine that you are taking the decisions for firm X.
   (a) If firm Y produces 'low', what level of output would maximize your profit in this time period?
   (b) If you (X) produce 'high', what level of output would maximize profits for firm Y?
   (c) If firm Y produces 'high', what level of output would maximize your profit in this time period?

(d) Under what circumstances would you decide to produce 'low'?

(e) Suppose you enter into an agreement with firm Y that you both will produce 'low': what measures could you adopt to ensure that Y keeps to the agreement?

(f) What measures could you adopt to convince Y that you will keep to the agreement?

(g) Suppose that the profit combinations are the same as in Table 6.3, except that if both firms produce 'high' each firm makes a loss of 8. Does this affect the analysis?

Table 6.4 Firms' decisions

		Firm Y			
		Low output profits		High output profits	
	Profits:	X	Y	X	Y
Firm X	Low output profits	15	15	2	20
	High output profits	20	2	8	8

3. In what ways can an understanding of game theory be used to understand the development of competition between Sony and Toshiba in the market for high-definition DVD players?

DIFFICULT