9

Thinking Strategically (1): Interdependence, Decision Making and the Theory of Games

A US newspaper at the end of the 1990s[1] carried a story originating in Hollywood. At a Christmas Eve dinner party in 1997, actor Robert De Niro asked singer Tony Bennett if he would be willing to sing 'Got the World on a String' in the final scene of a film that De Niro would be acting in and which was to be produced by Warner Brothers. He was referring to the project that became the 1999 hit comedy *Analyze This*, in which the troubled head of a crime family, played by De Niro, seeks the counsel of a psychotherapist, played by Billy Crystal. In the script, both the mob boss and his therapist are big fans of Bennett's music. Bennett said he would be interested, and that was that … for a year.

Then his son and agent, Danny Bennett, received a phone call from Warner Brothers to discuss terms. They proposed a fee of $15,000 for Bennett Sr for singing the song. For an hour's work it was a very reasonable offer, and one any singer (or his agent) would be expected to accept in a semi-quaver. Unfortunately, the Warner negotiator let slip that the film was already in the can except for the final scene and the song, and the script clearly led up to this particular song and singer at the ending. Bennett Jr managed to get Warner Brothers up to $200,000. Had they made the offer to Bennett a year earlier, before filming had begun, they would have been €185,000 better off. As they say: in life, timing is everything!

The point of this story is that the payoff to many actions depends not only on the actions themselves but also on when they are taken and how they relate to actions taken by others. In Chapters 5–8, economic decision makers confronted an environment that was essentially fixed. This chapter will focus on cases in which people and especially firms must consider the effect of their behaviour on others. For example, an imperfectly competitive firm will in many circumstances want to weigh the likely responses of rivals when deciding whether to cut prices or to increase marketing expenditure. *Interdependencies* of this sort are the rule rather than the exception in economic and social life. To make sense of the world we live in, then, we must take these interdependencies into account.

An analytical method for handling this type of problem is what is known as game theory. Its origins may be found in a book published in 1944, written by John von

1 *New York Times*, 2 May 1999.

Neumann and Oskar Morgenstern, *The Theory of Games and Economic Behavior*.[2] They started from the premise that much economic behaviour can be analysed as a choice of a strategy in situations where people's interests do not coincide, so that *conflict between decision makers* is inevitable. Then, in the early 1950s, John Nash,[3] a mathematician at Princeton, produced a couple of path-breaking papers dealing with the concept of an *equilibrium in a game* – meaning, loosely, an outcome that is stable and predictable given the motives of, and constraints facing, the players. Modern game theory has been built on these foundations, and Nash was subsequently awarded the Nobel Prize in Economics in 1994.

The theory of games

In chess, tennis, or any other game, your payoff from a given move depends on *what your opponent does in response*. In choosing your move, therefore, you must anticipate your opponent's responses, how you might respond and what further moves your own response might elicit.

Consider the following problem that shows how this idea applies in economics. You have decided to open a small supermarket in your home-town neighbourhood, where there is already an established store belonging to a major national chain. The reason is that you have good information that there is 'cash on the table' in the form of profits to be appropriated if you can attract a sufficient number of customers from the incumbent. You do so because you estimate that you can offer a better value-for-money service. You could do this by undercutting the prices of the incumbent. You could do this simply by offering a different choice of goods. You could do this by offering a service that will attract a sufficient number of higher-income shoppers to you who are not satisfied with the one-size-fits-all offerings of the established chain. The market share you hope to achieve makes the proposal profitable. But will you achieve it? That depends on how the incumbent firm reacts.

It could decide that the loss of market share is such that it must respond by lowering prices (increasing value for money). It could decide that there is room in the market for both of you, and it might be happy (if you go upmarket) to leave the upper end of the market (with all the problems of dealing with better-off and more demanding purchasers) to you. It could decide that if you succeed in this venture it is probable that others will imitate you in other local markets, threatening the financial viability of its operations as a whole, and so launch a price war designed to force you out, on the basis that the sight of a corpse hanging from a gibbet deters imitation. Whether or not you enter the market, and the strategy you adopt in the market, will reflect your opinion as to what the other side will do in response to your decision. It's not at all clear that it makes sense to enter just because you see a profitable opportunity in the form of 'cash on the table'. In order to analyse and to predict outcomes in such situations, in which the payoffs to different actors depend on the actions their opponents undertake, economists and other behavioural scientists have devised the mathematical theory of games.

In this chapter we will first introduce the basic elements of game theory, and use them in a variety of hypothetical situations in order to explain some aspects of how people and firms behave. In the next chapter we will use the insights and tools devel-

2 Von Neumann and Morgenstern (1944).

3 Nash's sad life (he was diagnosed paranoid schizophrenic) was the subject of the movie *A Beautiful Mind*. For an economist, unfortunately, the movie is marred by its failure to make clear the significance, simple elegance and enormous analytical implications of his exposition of what is now known as the concept of a Nash equilibrium (see p. 281).

oped here to look at competition in markets where the number of firms competing with each other is small, and in which, therefore, decision making has to recognise the pervasive effects of interdependency.

basic elements of a game the players, the strategies available to each player and the payoffs each player receives for each possible combination of strategies

The three elements of a game

Any game has three **basic elements**: the *players*, the list of possible actions (or *strategies*) each player can choose from and the *payoffs* the players receive for each combination of strategies. How these elements combine to form the basis of a theory of behaviour will become clear in the context of Examples 9.1–9.3.

Example 9.1 Should Lufthansa spend more money on advertising?

Suppose that Lufthansa and Alitalia are the only air carriers that serve the Frankfurt–Milan route. Each currently earns an economic profit of €6,000 per flight on this route. If Lufthansa increases its advertising spending in this market by €1,000 per flight and Alitalia spends no more on advertising than it does now, Lufthansa's profit will rise to €8,000 per flight and Alitalia's will fall to €2,000. If both spend €1,000 more on advertising, each will earn an economic profit of €5,500 per flight. This reflects the fact that although the advertising by each will offset the impact of the other's advertising, higher advertising spending by both increases overall demand for tickets. These payoffs are symmetric, so if Lufthansa stands still while Alitalia increases its spending by €1,000, Lufthansa's economic profit will fall to €2,000 per flight and Alitalia's will rise to €8,000. If each must decide independently whether to increase spending on advertising, what should Lufthansa do?

Think of this situation as a game. The players are the two airlines, each of which must choose one of two strategies: to raise spending by €1,000 or to leave it the same. The payoffs are the economic profits that correspond to the four possible scenarios resulting from their choices. One way to summarise the relevant information about this game is to display the players, strategies and payoffs in the form of a simple table called a **payoff matrix** (see Figure 9.1).

payoff matrix a table that describes the payoffs in a game for each possible combination of strategies

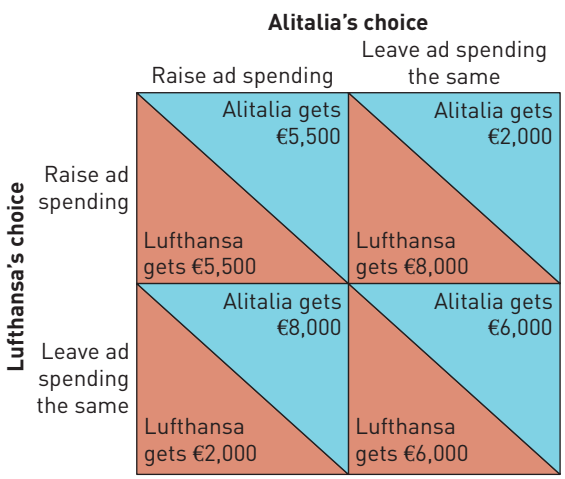


Figure 9.1 The Payoff Matrix for an Advertising Game.

Given the payoff matrix in Figure 9.1, what should Lufthansa do? The essence of strategic thinking is to begin by looking at the situation from the other party's point of view. Suppose Alitalia assumes that Lufthansa will raise its spending on advertising (the top row in Figure 9.1). In that case, Alitalia's best bet would be to follow suit (the left column in Figure 9.1). Why? Because Alitalia's economic profits, given in the upper-left cell of Figure 9.1, will be €5,500 as compared with only €2,000 if it keeps spending level (see the upper-right cell).

Alternatively, suppose Alitalia assumes that Lufthansa will keep spending unchanged (that is, Lufthansa will choose the bottom row in Figure 9.1). In that case, Alitalia would still do better to increase spending, because it would earn €8,000 (the lower left cell) as compared with only €6,000 if it keeps spending level (the lower-right cell). In this particular game, no matter which strategy Lufthansa chooses, Alitalia will earn a higher economic profit by increasing its spending. And since this game is perfectly symmetric, a similar conclusion holds for Lufthansa: no matter which strategy Alitalia chooses, Lufthansa will do better by increasing its spending on ads.

dominant strategy one that yields a higher payoff no matter what the other players in a game choose

dominated strategy any other strategy available to a player who has a dominant strategy

When one player has a strategy that yields a higher payoff no matter which choice the other player makes, that player is said to have a **dominant strategy**. Not all games involve dominant strategies, but both players in this game have one, and that is to increase spending on ads. For both players, to leave ad spending the same is a **dominated strategy** – one that leads to a lower payoff than an alternative choice, regardless of the other player's choice.

Notice, however, that when each player chooses the dominant strategy, the resulting payoffs are smaller than if each had left spending unchanged. When Lufthansa and Alitalia increase their spending on ads, each earns only €5,500 in economic profits as compared with the €6,000 each would have earned without the increase. (We'll say more about this apparent paradox below.)

Nash equilibrium

Nash equilibrium any combination of strategies in which each player's strategy is his or her best choice, given the other players' strategies

A game is said to be in equilibrium if each player's strategy is the best he or she can choose, given the other players' chosen strategies. This definition of equilibrium is sometimes called a **Nash equilibrium**, after the Nobel Laureate John Nash. When a game is in equilibrium, no player has any incentive to deviate from his or her current strategy.

If each player in a game has a dominant strategy, as in Example 9.1, equilibrium occurs when each player follows that strategy. But even in games in which not every player has a dominant strategy, we can often identify an equilibrium outcome. Consider, for instance, the following variation on the advertising game in Example 9.1.

Example 9.2 Should Alitalia or Lufthansa spend more money on advertising?

Once again, suppose that Lufthansa and Alitalia are the only carriers serving the Frankfurt–Milan route, and that the payoffs are as in Figure 9.2. Has Lufthansa a dominant strategy? Has Alitalia? If each firm does the best it can, given the incentives facing the other, what will be the outcome of this game?

In this game, with these payoffs, no matter what Lufthansa does, Alitalia will do better to raise its ad spending, so raising the advertising budget is a dominant strategy for Alitalia. Lufthansa, however, does not have a dominant strategy. If Alitalia raises its spending, Lufthansa will do better to stand still; if Alitalia stands still, however,

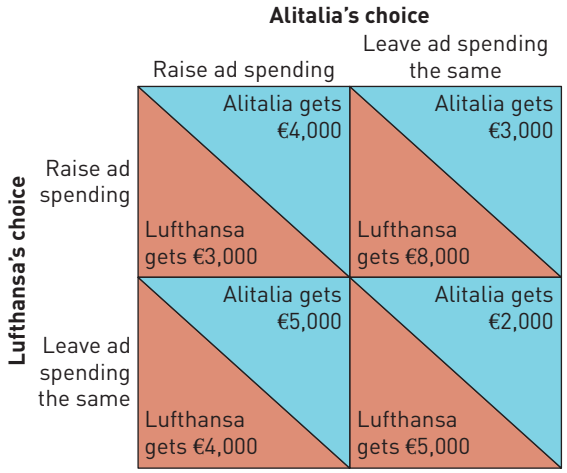
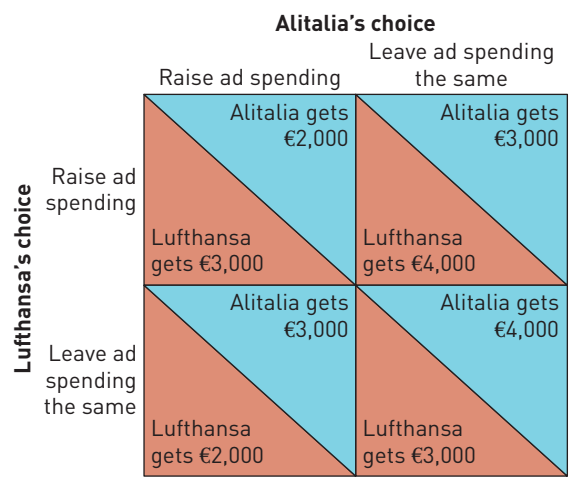


Figure 9.2 Equilibrium When One Player Lacks a Dominant Strategy.

Equilibrium

Lufthansa will do better to spend more. But even though Lufthansa hasn't a dominant strategy, we can still predict what is likely to happen in this game. After all, Lufthansa's managers know what the payoff matrix is, so they can predict that Alitalia will spend more on ads (since that is Alitalia's dominant strategy). Thus the best strategy for Lufthansa, given the prediction that Alitalia will spend more on ads, is to keep its own spending level. If both players do the best they can, taking account of the incentives each faces, this game will end in the lower-left cell of the payoff matrix in Figure 9.2: Alitalia will raise its spending on ads and Lufthansa will not. When both players are positioned in the lower-left cell, neither has any incentive to change its strategy. Therefore the choices corresponding to the lower-left cell in Figure 9.2 satisfy the definition of a Nash equilibrium, a combination of strategies for which each player's choice is the best available option, given the choice made by the other player.

Exercise 9.1 What should Lufthansa and Alitalia do if their payoff matrix is modified as follows?



RECAP The theory of games

The three elements of any game are the players, the list of strategies from which they can choose and the payoffs to each combination of strategies. Players in some games have a *dominant strategy*, one that yields a higher payoff regardless of the strategies.

Equilibrium in a game occurs when each player's strategy choice yields the highest payoff available, given the strategies of other players. Such a combination of strategies is called a *Nash equilibrium*.

prisoner's dilemma a game in which each player has a dominant strategy and, when each plays it, the resulting payoffs are smaller for each than if each had played a dominated strategy

The prisoner's dilemma

The game in Example 9.1 belongs to an important class of games called the **prisoner's dilemma**. In the prisoner's dilemma, when each player chooses his dominant strategy, the result is unattractive to the group of players as a whole.

The original prisoner's dilemma

Example 9.3 recounts the original scenario from which the prisoner's dilemma drew its name.

Example 9.3 Should the prisoners confess?

Two prisoners, Horace and Jasper, are being held in separate cells for a serious crime that they did in fact commit. The prosecutor, however, has only enough hard evidence to convict them of a minor offence, for which the penalty is one year in jail. Each prisoner is told that if one confesses while the other remains silent, the confessor will be released without prosecution, and the other will spend 20 years in prison. If both confess, they will get an intermediate sentence of five years. (These payoffs are summarised in Figure 9.3.) The two prisoners are not allowed to communicate with one another. Have they a dominant strategy? If so, what is it?

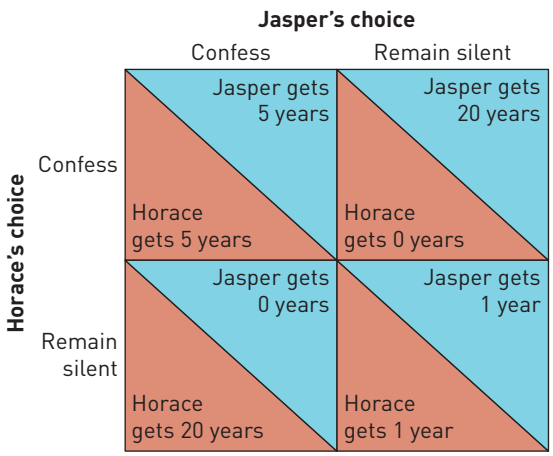


Figure 9.3 The Payoff Matrix for a Prisoner's Dilemma.

Equilibrium

They have a dominant strategy. It is for each prisoner to confess. No matter what Jasper does, Horace will get a lighter sentence by speaking out. If Jasper confesses, Horace will get five years (upper-left cell in Figure 9.3) instead of 20 (lower-left cell). If Jasper remains silent, Horace will go free (upper-right cell) instead of spending a year in jail (lower-right cell). Because the payoffs are perfectly symmetrical: Jasper will also do better to confess, no matter what Horace does. The difficulty is that, when each follows his dominant strategy and confesses, both will do worse than if each had said nothing. When both confess, they each get five years (upper-left cell) instead of the one year they would have received by remaining silent (lower-right cell). Hence the name of this game: the prisoner's dilemma (or, indeed, prisoners' dilemma).

Prisoner's dilemmas in everyday life

The prisoner's dilemma is one of the most powerful metaphors in all of human behavioural science. Countless social and economic interactions have payoff structures analogous to the one confronted by the two prisoners. Some of those interactions occur between only two players, as in the examples just discussed; many others involve larger groups. But regardless of the number of players involved, the common thread is one of conflict between the narrow self-interest of individuals and the broader interests of larger communities. In Economic naturalist 9.1 we look at the apparently irrational behaviour of fans at some sports games.[4]

Economic naturalist 9.1 Why do people at rugby games stand up on one side in all-seater stadiums and obscure each other's view at critical moments in the game, while soccer fans seem to remain seated when a score is imminent?

The answer lies in how points are scored, but also reflects a prisoner's dilemma in the case of rugby. For those who do not follow the code, which is played with 15 players on each side and an oval ball, the highest points are scored by touching the ball down over the opponent's goal line and this can take place at the edge of the field. In the case of soccer, of course, it's just a case of booting the ball into the goal in the centre of each end line. When players in rugby look like scoring at the edge of the field, the fans on that side all jump to their feet. As a result no one sees any better what is happening near the score line than if they had remained seated ... but it's always in someone's interest to stand ... so all stand.

The prisoner's dilemma concept will help you understand and answer some questions that seem to suggest that people behave irrationally. Consider Exercise 9.2.

Tit-for-tat and the repeated prisoner's dilemma

When all players cooperate in a prisoner's dilemma, each gets a higher payoff than when all defect. So people who confront a prisoner's dilemma will be on the lookout for ways to create incentives for mutual cooperation. What they need is some way to

4 A reviewer of an earlier draft of this chapter suggested that this example should be dropped because some readers on the European continent would not understand the point as they had never been at a rugby game. We understand that the EU Sports Commissioner is to ensure that this instance of cultural deprivation will be rectified by subsidising rugby in Mitteleuropa, but in the meantime we hope that a redraft will make the point clearer.

Exercise 9.2 **Use the prisoner's dilemma model to explain the following three scenarios.**

1. A fire breaks out in the orchestra pit in a theatre during the performance of a play. The next day newspapers comment on the numbers killed and injured in the rush to leave the auditorium, and the numbers who died from smoke inhalation because the doors were jammed by those rushing out, and castigate the audience for panicking and behaving irrationally, when they could all have left the building safely if they had done so row by row.
2. You are invited to a party and return home afterwards with laryngitis developed by having to shout for two hours to make yourself heard. Many other guests suffer similarly. Now if only they had all chosen to speak quietly …
3. It was reported at the end of 2004 that (as many have suspected) the use of mobile phones on planes does not pose a safety hazard. Consequently legal restrictions on their use would in all probability be lifted. In 2008 the EU Commission decided to amend European regulations to permit the use of mobile phones under certain conditions in aircraft. How likely is it that all airlines will completely lift the restriction even if it is no longer legally binding on them to impose it?

repeated prisoner's dilemma a standard prisoner's dilemma that confronts the same players repeatedly

tit-for-tat a strategy for the repeated prisoner's dilemma in which players cooperate on the first move, then mimic their partner's last move on each successive move

penalise players who defect. When players interact with one another only once, this turns out to be difficult to achieve. But when they expect to interact repeatedly, new possibilities emerge.

A **repeated prisoner's dilemma** is a standard prisoner's dilemma that confronts the same players not just once but many times. Experimental research on repeated prisoner's dilemmas in the 1960s identified a simple strategy that proves remarkably effective at limiting defection. The strategy is called **tit-for-tat**, and here is how it works. The first time you interact with someone, you cooperate. In each subsequent interaction you simply do what that person did in the previous interaction. Thus, if your partner defected on your first interaction, you would then defect on your next interaction with her. If she then cooperates, your move next time will be to cooperate as well.

Incentives Matter

The success of tit-for-tat requires a reasonably stable set of players, each of whom can remember what other players have done in previous interactions. It also requires that players have a significant stake in what happens in the future, for it is the fear of *retaliation* that deters people from defecting.

RECAP The prisoner's dilemma

The *prisoner's dilemma* is a game in which each player has a dominant strategy, and in which the payoff to each player when each chooses that strategy is smaller than if each had chosen a dominated strategy. Incentives analogous to those found in the prisoner's dilemmas help to explain a broad range of behaviour in business and everyday life – among them, excessive spending on advertising, cartel instability, standing at concerts and shouting at parties. Cooperation in repeated prisoner's dilemmas can often be sustained by the *tit-for-tat* strategy, in which players cooperate on the first move and mimic their partner's previous move thereafter.

Games in which timing matters

In the games discussed so far, players were assumed to choose their strategies simultaneously, and which player moved first didn't particularly matter. For example, in the prisoner's dilemma, players would follow their dominant strategies even if they knew in advance what strategies their opponents had chosen. But in other situations, such as the negotiations between Warner Brothers and Tony Bennett described at the beginning of this chapter, timing is of the essence.

When players move simultaneously (or can be modelled as doing so) the approach to the game and its outcome based on a simple payoff matrix is inadequate, and what is described as an extensive form of the game becomes necessary. In graphic terms, the payoff matrix is replaced by a decision tree.

The ultimatum bargaining game

To illustrate this, we use a simple example of timing in a game at the level of individual behaviour: the so-called 'ultimatum game'.

Example 9.4 Should Michael accept Tom's offer?

Tom and Michael are subjects in an experiment. The experimenter begins by giving €100 to Tom, who must then propose how to divide the money between himself and Michael. Tom can propose any division he chooses, provided the proposed amounts are whole euros and he offers Michael at least €1. Suppose Tom proposes €X for himself and €$(100 - X)$ for Michael, where X is a whole number no larger than 99. Michael must then say whether he accepts the proposal. If he does, each will get the proposed amount. But if Michael rejects the proposal, each player will get zero, and the €100 will revert to the experimenter. If Tom and Michael know they will play this game only once, and each wants to make as much money for himself as possible, what should Tom propose?

A payoff matrix is not a useful way to summarise the information in this game, because it says nothing about the timing of each player's move. For games in which timing matters, a **decision tree (or game tree)** is more useful. This is called an 'extended' form of the game. This type of diagram describes the possible moves in the sequence in which they may occur, and lists the final payoffs for each possible combination of moves.

The decision tree for the game in Example 9.4 is shown in Fig. 9.4. At A, Tom begins the game by making his proposal. At B, Michael responds to Tom's proposal. If he accepts (the top branch of the tree), Tom will get €X and Michael will get €$(100 - X)$. If he refuses (the bottom branch of the tree), both will get nothing.

decision tree (or game tree) a diagram that describes the possible moves in a game in sequence and lists the payoffs that correspond to each possible combination of moves

ultimatum bargaining game one in which the first player has the power to confront the second player with a take-it-or-leave-it offer

In thinking strategically about this game, the key for Tom is to put himself in Michael's shoes and imagine how he might react to various proposals. This reflects 'interdependence' affecting the player's choice of move. Because he knows that Michael's goal is to make as much money as possible, he knows that Michael will accept his offer no matter how small, because the alternative is to reject it and get nothing. For instance, suppose that Tom proposes €99 for himself and only €1 for Michael (see Fig. 9.5). At B, Michael's best option is to accept the offer. This is a Nash equilibrium, because neither player has any incentive to deviate from the strategy he chose.

This type of game has been called the **ultimatum bargaining**

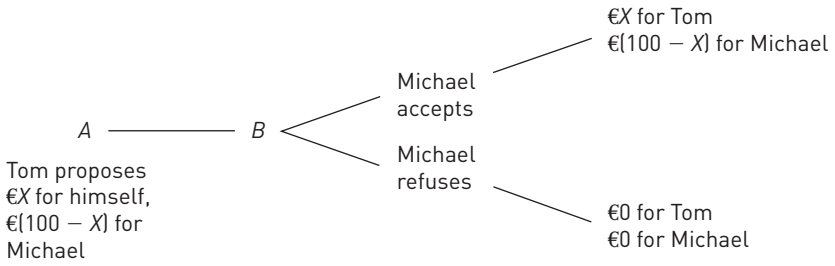


Figure 9.4 Decision Tree for Example 9.4. This decision tree shows the possible moves and payoffs for the game in Example 9.4 in the sequence in which they may occur.

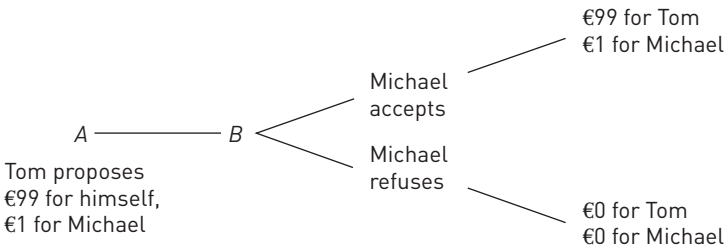


Figure 9.5 Tom's Best Strategy in an Ultimatum Bargaining Game. Because Tom can predict that Michael will accept any positive offer, Tom's income-maximising strategy at *A* is to offer Michael the smallest positive amount possible, €1.

game,[5] because of the power of the first player to confront the second player with a take-it-or-leave-it offer. Michael could refuse a one-sided offer from Tom, but doing so would make him worse off than if he accepted it.

Example 9.5 illustrates the importance of the *timing of moves* in determining the outcome of the ultimatum bargaining game.

Example 9.5 What should Michael's acceptance threshold be?

Suppose we change the rules of the ultimatum bargaining game slightly so that Michael has the right to specify *in advance* the smallest offer he will accept. This means that Michael, rather than Tom, moves first. Once Michael announces this number, he is bound by it. If Tom's task is again to propose a division of the €100, what amount should Michael specify?

This seemingly minor change in the rules completely alters the game. Once Michael announces that €Y is the smallest offer he will accept, his active role in the game is over. If Y is €60 and Tom proposes €X for himself and €$(100 - X)$ for Michael, his offer will be rejected automatically if X exceeds 40. The decision tree for this game is shown in Fig. 9.6.

5 Experiments with the ultimatum game have uncovered something that may not surprise you. When classroom experiments are played using sociology students, literature students and similar groups as test populations, the offers that are made are usually much closer to a 50/50 split than when they are carried out using economics students. In our experience applying this game in class, economics and business students have more 70/30 or 90/10 outcomes than other students. Figure that out! Does economics make you 'rational', or do more 'rational' people take economics?

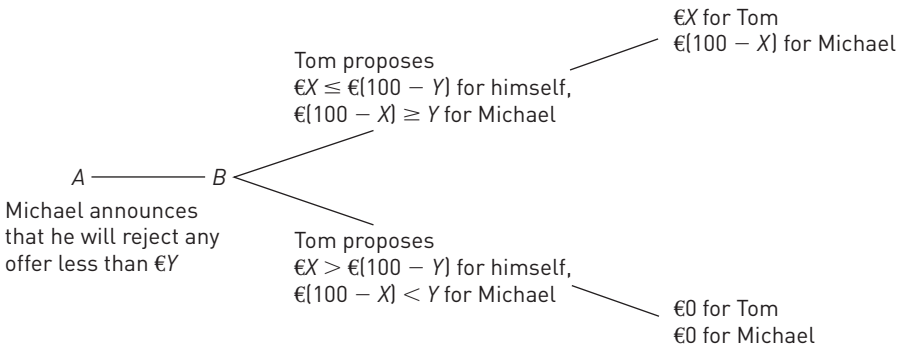


Figure 9.6 The Ultimatum Bargaining Game with an Acceptance Threshold. If Michael can commit himself to a minimum acceptable offer threshold at A, he will fare dramatically better than in the standard ultimatum bargaining game.

When Michael announces that €Y is the smallest offer he will accept, the best Tom can do is to propose €(100 – Y) for himself and €Y for Michael. If he proposes any amount less than €Y for Michael, both will get nothing at all. Since this reasoning holds for any value of Y less than 100, Michael's best bet is to announce an acceptance threshold of €99 – the largest whole number that is less than €100. The equilibrium outcome of the game will then be €99 for Michael and only €1 for Tom, exactly the opposite of the outcome when Tom had the first move.

Credible threats and promises

Why couldn't Michael have threatened to refuse a one-sided offer in the original version of the game? While nothing prevented him from doing so, such a threat would not have been credible. In the language of game theory, a **credible threat** is one that is in the threatener's interest to carry out when the time comes to act. The problem in the original version of the game is that Michael would have no reason to carry out his threat to reject a one-sided offer in the event that he actually received one. Once Tom announced such an offer, refusing it would not pass the cost–benefit test.

credible threat a threat to take an action that is in the threatener's interest to carry out

credible promise a promise that is in the interests of the promisor to keep when the time comes to act

The concept of a credible threat figured prominently in the negotiations between Warner Brothers managers and Tony Bennett over the matter of Bennett's fee for performing in *Analyze This*. Once most of the film had been shot, managers knew they couldn't threaten credibly to refuse Bennett's salary demand, because at that point adapting the film to another singer would have been prohibitively costly. In contrast, a similar threat made before production of the movie had begun would have been credible.

Just as in some games credible threats are impossible to make, in others **credible promises** are impossible.

Example 9.6 Should the business owner open a remote office?

The owner of a thriving business wants to start up an office in a distant city. If she hires someone to manage the new office, she can afford to pay a weekly salary of €1,000 – a premium of €500 over what the manager would otherwise be able to earn – and still earn a weekly economic profit of €1,000 for herself. The owner's concern is that she

will not be able to monitor the manager's behaviour. The owner knows that by managing the remote office dishonestly, the manager can boost his take-home pay to €1,500 while causing the owner an economic loss of €500 per week. If the owner believes that all managers are selfish income maximisers, will she open the new office?

The decision tree for the remote office game is shown in Fig. 9.7. At *A*, the managerial candidate promises to manage honestly, which brings the owner to *B*, where she must decide whether to open the new office. If she opens it, they reach *C*, where the manager must decide whether to manage honestly. If the manager's only goal is to make as much money as he can, he will manage dishonestly (bottom branch at *C*), since that way he will earn €500 more than by managing honestly (top branch at *C*).

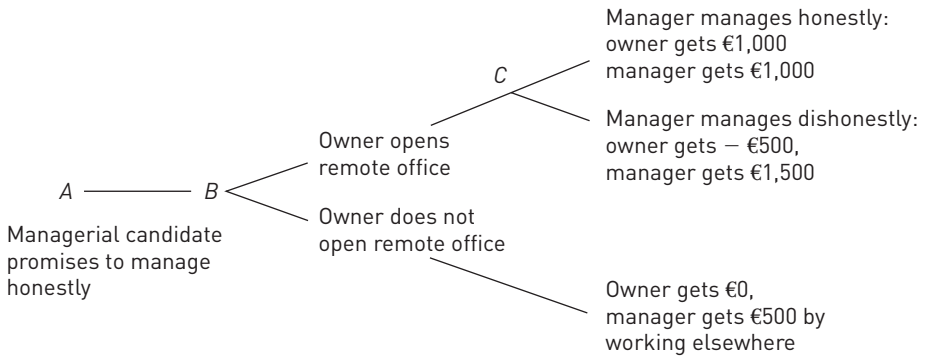


Figure 9.7 Decision Tree for the Remote Office Game. The best outcome is for the owner to open the office at *B* and for the manager to manage the office honestly at *C*. But if the manager is purely self-interested and the owner knows it, this path will not be an equilibrium outcome.

So if the owner opens the new office, she will end up with an economic loss of €500. If she had not opened the office (bottom branch at *B*), she would have realised an economic profit of zero. Since zero is better than –€500, the owner will choose not to open the remote office. In the end, the opportunity cost of the manager's inability to make a credible promise is €1,500: the manager's forgone €500 salary premium and the owner's forgone €1,000 return.

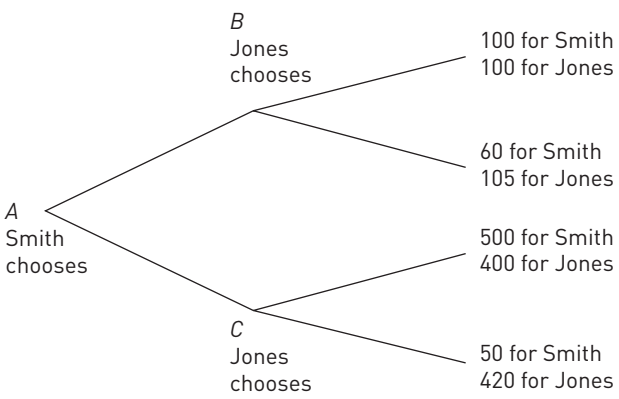
The commitment problem here is that a potential manager of the distant office can promise to behave correctly … but lacks any mechanism to make the promise credible, since it will pay the candidate for the job to behave opportunistically.

Commitment problems

Games like those in Exercise 9.3 (below), as well as the prisoner's dilemma, the ultimatum bargaining game and the remote office game, confront players with a **commitment problem**, a situation in which they have difficulty achieving the desired outcome because they cannot make credible threats or promises. If both players in the prisoner's dilemma (Example 9.3) could make a binding promise to remain silent, both would be assured of a shorter sentence; hence the logic of the underworld code of *omertà*, under which the family of anyone who provides evidence against a fellow mob member is killed. A similar logic explains the adoption of military arms control agreements, in which opponents sign an enforceable pledge to curtail weapons spending.

commitment problem
a situation in which people cannot achieve their goals because of an inability to make credible threats or promises

Exercise 9.3 Smith and Jones are playing a game in which Smith has the first move at *A* in the following decision tree. Once Smith has chosen either the top or bottom branch at *A* Jones, who can see what Smith has chosen, must choose the top or bottom branch at *B* or *C*. If the payoffs at the end of each branch are as shown, what is the equilibrium outcome of this game? If, before Smith chose, Jones could make a credible commitment to choose either the top or bottom branch when his turn came, what would he do?



The commitment problem in a game can be solved if the potential beneficiary can find some way of committing himself to a course of action in the future. For example, suppose firm *A* wants to discourage firm *B* from price cutting, and knows that to do so involves acting in a way that makes *B* confident that *A* will not overtly or tacitly engage in price cutting itself. It could sell firm *B* a 'put' option, whereby firm *B* could oblige firm *A* to buy specified quantities of its output at some critical price below today's price. A tacit promise not to cut prices would be made credible by this **commitment device**.

commitment device a way of changing incentives so as to make otherwise empty threats or promises credible

Business owners seem well aware of commitment problems in the workplace and have adopted a variety of commitment devices to solve them. Consider, for example, the problem confronting the owner of a restaurant. She wants her table staff to provide good service so that customers will enjoy their meals and come back in the future. And since good service is valuable to her, she would be willing to pay waiters extra for it. For their part, waiters would be willing to provide good service in return for the extra pay. The problem is that the owner cannot always monitor whether the waiters do provide good service. Her concern is that, having been paid extra for it, the waiters may slack off when she isn't looking. Unless the owner can find some way to solve this problem, she will not pay extra, the waiters will not provide good service, and she, they and the diners will suffer. A better outcome for all concerned would be for the waiters to find some way to commit themselves to good service.

Restaurateurs in many countries have tried to solve this commitment problem by encouraging diners to leave tips at the end of their meals. The attraction of this solution is that the diner is *always* in a good position to monitor service quality. The diner should be happy to reward good service with a generous tip, since doing so will help to ensure good service in the future. And the waiter has a strong incentive to provide good service, because he knows that the size of his tip may depend on it.

The various commitment devices just discussed – the underworld code of *omertà*, the tip for the waiter – all work because they change the material incentives facing the

decision makers. But, as Example 9.7 illustrates, sometimes this simple calculus of incentives is not a complete explanation.

Example 9.7 Will Federico leave a tip when dining on the road?

Federico has just finished a €30 dinner at Ristorante Stendhal, just off the Milan–Ancona autostrada near Parma, some 300 km from home. The meal was superb, and the waiter provided good service. If Federico cares only about himself, will he leave a tip?

Once the waiter has provided good service, there is no way for him to take it back if the diner fails to leave a tip. In restaurants patronised by local diners, failure to tip is not a problem, because the waiter can simply provide poor service the next time a non-tipper comes in. And no one wants to appear mean in front of people who might care. But the waiter lacks that leverage with out-of-town diners eating alone. Having already received good service, Federico must choose between paying €30 or €35 for his meal. If he is an essentially selfish person, the former choice may be a compelling one. But if you know that the waiter depends for much of his living on tips you are likely to tip anyway, even if not overgenerously, for the same reason as most people do not engage in shoplifting even when they know they would get away with it: our moral sense overrides our instinct for self-advancement.

RECAP Games in which timing matters

The outcomes in many games depend on the *timing* of each player's move. For such games, the payoffs are best summarised by a *decision tree* rather than a payoff matrix.

The inability to make credible threats and promises often prevents people from achieving desired outcomes in many games. Games with this property are said to confront players with *commitment problems*. Such problems can sometimes be solved by employing *commitment devices* – ways of changing incentives to facilitate making credible threats or promises.

The strategic role of preferences

In all the games we have discussed so far, players were assumed to care only about obtaining the best possible outcome for themselves. Thus each player's goal was to get the highest monetary payoff, the shortest jail sentence, the best chance of survival, and so on. The irony, in most of these games, is that players do not attain the best outcomes. Better outcomes can sometimes be achieved by altering the material incentives selfish players face, but not always.

If altering the relevant material incentives is not possible, commitment problems can sometimes be solved by altering people's psychological incentives. In a society in which people are strongly conditioned to develop moral sentiments – feelings of guilt when they harm others, feelings of sympathy for their trading partners, feelings of outrage when they are treated unjustly – commitment problems arise less often than in more narrowly self-interested societies.

Exercise 9.4

In a moral society, will the business owner open a remote office?

Consider again the owner of the thriving business who is trying to decide whether to open an office in a distant city. Suppose the society in which she lives is one in which all citizens have been strongly conditioned to behave honestly. Will she open the remote office?

Are people fundamentally selfish?

The assumption that people are 'self-interested' in the narrow sense of the term does not always capture the full range of motives that govern choice in strategic settings. Researchers have found that tipping rates in restaurants patronised mostly by out-of-town diners are essentially the same as in restaurants patronised mostly by local diners.

Reflect also on how you would behave in some of the other games we have discussed. In the ultimatum bargaining game, what would you do if your partner proposed €99 for himself and only €1 for you? Would you reject the offer? If so, you are not alone. Two findings of extensive laboratory studies of the ultimatum bargaining game challenge the assumption that most players are narrowly self-interested. First, the most common proposal by the first player in this game is not a 99/1 split, but a 50/50 split. And, second, on the few occasions when the first player does propose a highly one-sided split, the second player typically rejects it. Subjects who reject the offer often mention the satisfaction they experienced at having penalised the first player for an 'unfair' offer.

Incentives Matter

Indeed, there are many exceptions to the outcomes predicted on the basis of the assumption that people are self-interested in the most narrow sense of the term. People who have been treated unjustly often seek 'revenge' even at ruinous cost to themselves. Every day people walk away from profitable transactions whose terms they believe to be 'unfair'.

In 1982 Argentina, pursuing a claim of sovereignty over the islands, mounted a surprise invasion of the British crown colony of the Falklands Islands (aka the Malvinas). The Argentine junta, in common with many other observers, were surprised by the British decision to spend vast sums, lose lives and risk the core of the Royal Navy's surface fleet to recover the desolate colony. After all, as the Argentine writer Jorge Luis Borges observed, the Falkland War made about as much sense as two bald men fighting over a comb.[6] It looked like a case of other values taking precedence over narrow self-interest. Possibly true: Mrs Thatcher was no ordinary Prime Minister, and rejoiced in the nickname of the 'Iron Lady'. However, at the time, Spain was putting pressure on Britain over Gibraltar (British since 1713), and Britain was facing difficult negotiations with China over the future administration of Hong Kong after its inevitable cession to China. And the UK government was facing internal opposition from the unionised coal miners who were threatening general strikes if the industry was rationalised. In these circumstances, does it seem so economically irrational to demonstrate that you will not be trampled on?

Preferences as solutions to commitment problems

Economists tend to view preferences as ends in themselves. Taking them as given, they calculate what actions will best serve those preferences. This approach to the study of behaviour is widely used by other social scientists and by game theorists, military strategists, philosophers and others. In its standard form, it assumes purely self-interested preferences for present and future consumption goods of various sorts, leisure pursuits and so on. Concerns about fairness, guilt, honour, sympathy and the like typically play no role.

Preferences clearly affect the choices people make in strategic interactions. Sympathy for one's trading partner can make a businessperson trustworthy even when material incentives favour cheating. A sense of justice can prompt a person to incur the costs of retaliation, even when incurring those costs will not undo the original injury.

6 Quoted in Barnstone (1993).

It can also induce people to reject one-sided offers, even when their wealth would be increased by accepting them.

Note, however, that although preferences can clearly shape behaviour in these ways, that alone does not solve commitment problems. The solution to such problems requires not only that a person *have* certain preferences, but also that others have some way of *discerning* them. Unless the business owner can identify the trustworthy employee, that employee cannot land a job whose pay is predicated on trust. Unless the predator can identify a potential victim whose character will motivate retaliation, that person is likely to become a victim. And unless a person's potential trading partners can identify him as someone predisposed to reject one-sided offers, he will not be able to deter such offers.

From among those with whom we might engage in ventures requiring trust, can we identify reliable partners? If people could make *perfectly* accurate character judgements, they could always steer clear of dishonest persons. That people continue to be victimised, at least occasionally, by dishonest persons suggests that perfectly reliable character judgements are either impossible to make or prohibitively expensive.

Vigilance in the choice of trading partners is an essential element in solving (or avoiding) commitment problems, for if there is an advantage in being honest and being perceived as such, there is an even greater advantage in only *appearing* to be honest. After all, a liar who appears trustworthy will have better opportunities than one who glances about furtively, sweats profusely and has difficulty making eye contact. Indeed, the liar will have the same opportunities as an honest person but will get higher payoffs because the liar will exploit them to the full.

In the end, the question of whether people can make reasonably accurate character judgements is an empirical one. Experimental studies have shown that, even on the basis of brief encounters involving strangers, subjects are adept at predicting who will cooperate and who will defect in prisoner's dilemma games. For example, in one experiment in which only 26 per cent of subjects defected, the accuracy rate of predicted defections was more than 56 per cent. One might expect that predictions regarding those we know well would be even more accurate.

Do you know someone who would return an envelope containing €1,000 in cash to you if you lost it at a crowded concert? If so, then you accept the claim that personal character can help people to solve commitment problems. As long as honest individuals can identify at least some others who are honest and can interact selectively with them, honest individuals can prosper in a competitive environment.

RECAP The strategic role of preferences

Most applications of the theory of games assume that players are 'self-interested' in the narrow sense of the term. In practice, however, many choices, such as leaving tips in out-of-town restaurants, appear inconsistent with this assumption.

The fact that people seem driven by a more complex range of motives makes behaviour more difficult to predict but also creates new ways of solving commitment problems. *Psychological incentives* can often serve as commitment devices when changing players' material incentives is impractical. For example, people who are able to identify honest trading partners and interact selectively with them are able to solve commitment problems that arise from lack of trust.

Summary

- Economists use the mathematical theory of games to analyse situations in which the payoffs of one's actions depend on the actions *taken by others*. Games have three basic elements: the *players*; the list of *possible actions*, or *strategies*, from which each player can choose; and the *payoffs* the players receive for those strategies. The *payoff matrix* is the most useful way to summarise this information in games in which the timing of the players' moves is not decisive. In games in which the timing of moves does matter, a *decision tree* summarises the information in a much more useful format.
- A *dominant strategy* is one that yields a higher payoff regardless of the strategy chosen by the other player. In some games, such as the prisoner's dilemma, each player has a dominant strategy. The equilibrium occurs in such games when each player chooses his or her dominant strategy. In other games, not all players have a dominant strategy.
- Although the equilibrium outcome of any game is any combination of choices in which each player does the best he can, given the choices made by others, the result is often unattractive from the perspective of players as group. The prisoner's dilemma has this feature. The *incentive structure* of this game helps explain such disparate social dilemmas as excessive advertising, military arms races and failure to reap the potential benefits of interactions requiring trust.
- Individuals can often resolve these dilemmas if they can make *binding commitments* to behave in certain ways. Some commitments, such as those involved in military arms control agreements, are achieved by altering the material incentives confronting the players. Other commitments can be achieved by relying on psychological incentives to counteract material payoffs. Moral sentiments such as guilt, sympathy and a sense of justice often foster better outcomes than can be achieved by narrowly self-interested players. For this type of commitment to work, the relevant moral sentiments must be discernible by one's potential trading partners.
- Building on the idea of payoffs and games enables economists to construct models that indicate the importance of such things as beliefs and modes of competition in understanding how *small-number markets operate*.
- These models yield interesting and plausible conclusions that explain some features of *market behaviour* that are not explained by the simple models of perfect competition or monopolistic competition.

Review questions

1. Explain why a military arms race is an example of a prisoner's dilemma.
2. Why did Warner Brothers make a mistake by waiting until the filming of *Analyze This* was almost finished before negotiating with Tony Bennett to perform in the final scene?
3. Suppose General Motors is trying to hire a small firm to manufacture the door handles for Opel and Holden saloon cars. The task requires an investment in expensive capital equipment that cannot be used for any other purpose. Why might the CEO of the small firm refuse to undertake this venture without a long-term contract fixing the price of the door handles?
4. Would you be irrational to refuse a one-sided offer in an ultimatum bargaining game if you knew that you would be playing that game many times with the same partner?

5. Describe the commitment problem that narrowly self-interested diners and waiters confront at restaurants located on interstate highways. Given that in such restaurants tipping does seem to assure reasonably good service, do you think people are always selfish in the narrowest sense?

Problems

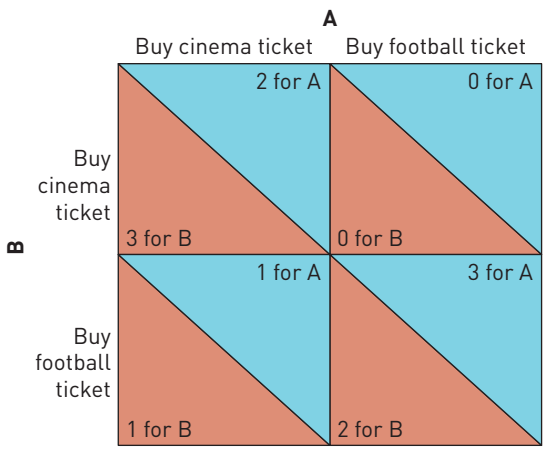
Problems marked with an asterisk (*) are more difficult.

1. In studying for his economics final, Sam is concerned about only two things: his grade and the amount of time he spends studying. A good grade will give him a benefit of 20; an average grade, a benefit of 5; and a poor grade, a benefit of 0. By studying a lot, Sam will incur a cost of 10; by studying a little, a cost of 6. Moreover, if Sam studies a lot and all other students study a little, he will get a good grade and they will get poor ones. But if they study a lot and he studies a little, they will get good grades and he will get a poor one. Finally, if he and all other students study for the same amount of time, everyone will get average grades. Other students share Sam's preferences regarding grades and study time.

   a. Model this situation as a two-person prisoner's dilemma in which the strategies are to study a little and to study a lot, and the players are Sam and all other students. Include the payoffs in the matrix.

   b. What is the equilibrium outcome in this game? From the students' perspective, is it the best outcome?

2. Consider the following 'dating game', which has two players, *A* and *B*, and two strategies, to buy a cinema ticket or a football ticket. The payoffs, given in points, are as shown in the matrix below. Note that the highest payoffs occur when both *A* and *B* attend the same event.



Assume that players *A* and *B* buy their tickets separately and simultaneously. Each must decide what to do knowing the available choices and payoffs but not what the other has actually chosen. Each player believes the other to be rational and self-interested.

   a. Does either player have a dominant strategy?

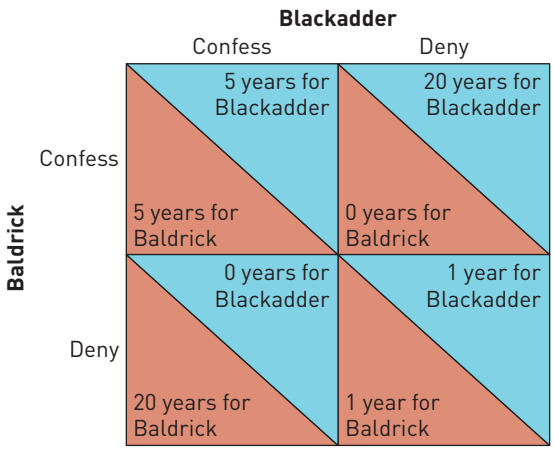
   b. How many potential equilibria are there? (**Hint:** To see whether a given combination of strategies is an equilibrium, ask whether either player could get a higher payoff by changing his or her strategy.)

c. Is this game a prisoner's dilemma? Explain.

d. Suppose player *A* gets to buy her ticket first. Player *B* does not observe *A*'s choice but knows that *A* chose first. Player *A* knows that player *B* knows she chose first. What is the equilibrium outcome?

e. Suppose the situation is similar to part (d), except that player *B* chooses first. What is the equilibrium outcome?

3. Blackadder and Baldrick are rational, self-interested criminals imprisoned in separate cells in a dark medieval dungeon. They face the prisoner's dilemma displayed in the matrix below.



Assume that Blackadder is willing to pay 1,000 ducats for each year by which he can reduce his sentence below 20 years. A corrupt jailer tells Blackadder that before he decides whether to confess or deny the crime, he can tell him Baldrick's decision. How much is this information worth to Blackadder?

4. The owner of a thriving business wants to open a new office in a distant city. If he can hire someone who will manage the new office honestly, he can afford to pay that person a weekly salary of €2,000 (€1,000 more than the manager would be able to earn elsewhere) and still earn an economic profit of €800. The owner's concern is that he will not be able to monitor the manager's behaviour and that the manager will therefore be in a position to embezzle money from the business. The owner knows that if the remote office is managed dishonestly, the manager can earn €3,100 while causing the owner an economic loss of €600 per week.

a. If the owner believes that all managers are narrowly self-interested income-maximisers, will he open the new office?

b. Suppose the owner knows that a managerial candidate is a devoutly religious person who condemns dishonest behaviour and who would be willing to pay up to €15,000 to avoid the guilt she would feel if she were dishonest. Will the owner open the remote office?

5. Imagine yourself sitting in your car in a university car park that is currently full, waiting for someone to pull out so that you can park your car. Somebody pulls out, but at the same moment a driver who has just arrived overtakes you in an obvious attempt to park in the vacated spot before you can. Suppose this driver would be willing to pay

up to €10 to park in that spot and up to €30 to avoid getting into an argument with you. (That is, the benefit of parking is €10, and the cost of an argument is €30.) At the same time the other driver guesses, accurately, that you too would be willing to pay up to €30 to avoid a confrontation and up to €10 to park in the vacant spot.

a. Model this situation as a two-stage decision tree in which the other driver's bid to take the space is the opening move and your strategies are (1) to protest and (2) not to protest. If you protest (initiate an argument), the rules of the game specify that the other driver has to let you take the space. Show the payoffs at the end of each branch of the tree.

b. What is the equilibrium outcome?

c. What would be the advantage of being able to communicate credibly to the other driver that your failure to protest would be a significant psychological cost to you?

6. Newfoundland's fishing industry has declined sharply due to overfishing, even though fishing companies were supposedly bound by a quota agreement. If all fishing companies had abided by the agreement, yields could have been maintained at high levels.

a. Model this situation as a prisoner's dilemma in which the players are Company *A* and Company *B*, and the strategies are to keep the quota and break the quota. Include appropriate payoffs in the matrix. Explain why overfishing is inevitable in the absence of effective enforcement of the quota agreement.

b. Provide another environmental example of a prisoner's dilemma.

c. In many potential prisoner's dilemmas, a way out for a would-be cooperator is to make reliable character judgements about the trustworthiness of potential partners. Explain why this solution is not available in many situations involving degradation of the environment.

7. Consider the following game, called 'matching pennies', which you are playing with a friend. Each of you has a penny hidden in your hand, facing either heads up or tails up (you know which way the one in your hand is facing). On the count of 'three' you simultaneously show your pennies to each other. If the face-up side of your coin matches the face-up side of your friend's coin, you get to keep the two pennies. If the faces do not match, your friend gets to keep the pennies.

a. Who are the players in this game? What are each player's strategies? Construct a payoff matrix for the game.

b. Is there a dominant strategy? If so, what?

c. Is there an equilibrium? If so, what?

8. Consider the following game. Harry has four 20-pence pieces. He can offer Sally from one to four of them. If she accepts his offer, she keeps the coins Harry offered her and Harry keeps the others. If Sally declines Harry's offer, they both get nothing. They play the game only once, and each cares only about the amount of money he or she ends up with.

a. Who are the players? What are each player's strategies? Construct a decision tree for this ultimatum bargaining game.

b. Given their goal, what is the optimal choice for each player?

9.* Jill and Jack both have two pails that can be used to carry water down from a hill. Each makes only one trip down the hill, and each pail of water can be sold for €5. Carrying the pails of water down requires considerable effort. Both the children would be willing to pay €2 each to avoid carrying one bucket down the hill and an additional €3 to avoid carrying a second bucket down the hill.

a. Given market prices, how many pails of water will each child fetch from the top of the hill?

b. Jill and Jack's parents are worried that the two children don't cooperate enough with one another. Suppose they make Jill and Jack share their revenues from selling the water equally. Given that both are self-interested, construct the pay-off matrix for the decisions Jill and Jack face regarding the number of pails of water each should carry. What is the equilibrium outcome?

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