

outcome, each **bilateral** deal becomes a game of strategy, even though the larger picture may have **thousands** of very similar deals going on.

To sum up, **when** each participant is significant in the interaction, either because each is a **large player** to start with or because commitments or private information narrow the scope of the relationship to a point where each is an important **player** *within* the relationship, we must think of the interaction as a strategic **game**. Such situations are the rule rather than the exception in business, in politics, and even in social interactions. Therefore the study of strategic games forms an important part of all fields that analyze these matters.

## 2 CLASSIFYING GAMES

Games of strategy arise in many different contexts and accordingly have many different features that require study. This task can be simplified by grouping these features into a few categories or dimensions, along each of which we can identify two pure types of games and then recognize any actual game as a mixture of the pure types. We develop this classification by asking a few questions that will be pertinent for thinking about the actual game that you are playing or studying.

### A. Are the Moves in the Game Sequential or Simultaneous?

Moves in chess are sequential: White moves first, then Black, then White again, and so on. In contrast, participants in an auction for an oil-drilling lease or a part of the airwave spectrum make their bids simultaneously, in ignorance of competitors' bids. Most actual games combine aspects of both. In a race to research and develop a new product, the firms act simultaneously, but each competitor has partial information about the others' progress and can respond. During one play in football, the opposing offensive and defensive coaches simultaneously send out teams with the expectation of carrying out certain plays but, after seeing how the defense has set up, the quarterback can change the play at the line of scrimmage or call a time-out so that the coach can change the play.

The distinction between **sequential** and **simultaneous moves** is important because the two types of games require different types of interactive thinking. In a sequential-move game, each player must think: if I do this, how will my opponent react? Your current move is governed by your calculation of its *future* consequences. With simultaneous moves, you have the trickier task of trying to figure out what your opponent is going to do *right now*. But you must recognize that, in making his own calculation, the opponent is also trying to figure out

your current move, while at the same time recognizing that you are doing the same with him. . . . Both of you have to think your way out of this circle.

In the next three chapters, we will study the two pure cases. In Chapter 3, we examine sequential-move games, where you must look ahead to act **now**; in Chapters 4 and 5, the subject is simultaneous-move games, where you **must** square the circle of “He thinks that I think that he thinks . . .” In each case, we will devise some simple tools for such thinking—trees and payoff tables—and obtain some simple rules to guide actions.

The study of sequential games also tells us when it is an advantage to move first and when second. Roughly speaking, this depends on the relative importance of commitment and flexibility in the game in question. For example, the game of economic competition among rival firms in a market has a first-mover advantage if one firm, by making a firm commitment to compete aggressively, can get its rivals to back off. But, in political competition, a candidate who has taken a firm stand on an issue may give his rivals a clear focus for their attack ads, and the game has a second-mover advantage.

Knowledge of the balance of these considerations can also help you devise ways to manipulate the order of moves to your own advantage. That in turn leads to the study of strategic moves, such as threats and promises, which we will take up in Chapter 10.

## **B. Are the Players’ Interests in Total Conflict or Is There Some Commonality?**

In simple games such as chess or football, there is a winner and a loser. One player’s gain is the other’s loss. Similarly, in gambling games, one player’s winnings are the others’ losses, so the total is zero. This motivates the name *zero-sum games* for such situations. More generally, the idea is that the players’ interests are in complete conflict. Such conflict arises when players are dividing up any fixed amount of possible gain, whether it be measured in yards, dollars, acres, or scoops of ice cream. Because the available gain need not always be exactly zero, the term *constant-sum game* is often substituted for zero-sum; we will use the two interchangeably.

Most economic and social games are not zero-sum. Trade, or economic activity more generally, offers scope for deals that benefit everyone. Joint ventures can combine the participants’ different skills and generate synergy to produce more than the sum of what they could have produced separately. But the interests are not completely aligned either; the partners can cooperate to create a larger total pie, but they will clash when it comes to deciding how to split this pie among them.

Even wars and strikes are not zero-sum games. A nuclear war is the most striking example of a situation where there can be only losers, but the concept is far older. Pyrrhus, the king of Epirus, defeated the Romans at Heraclea in

280 B.C. but at such great cost to his own army that he exclaimed: “Another such victory and we are lost.” Hence the phrase “Pyrrhic victory.” In the 1980s, at the height of the frenzy of business takeovers, the battles among rival bidders led to such costly escalation that the successful bidder’s victory was often similarly Pyrrhic.

Most games in reality have this tension between conflict and cooperation, and many of the most interesting analyses in game theory come from the need to handle it. The players’ attempts to resolve their conflict—distribution of territory or profit—are influenced by the knowledge that, if they fail to agree, the outcome will be bad for all of them. One side’s threat of a war or a strike is its attempt to frighten the other side into conceding its demands.

Even when a game is constant-sum for all players, when there are three (or more) players, we have the possibility that two of them will cooperate at the expense of the third; this leads to the study of alliances and coalitions. We will examine and illustrate these ideas later, especially in Chapter 17 on bargaining.

### C. Is the Game Played Once or Repeatedly, and with the Same or Changing Opponents?

A game played just once is in some respects simpler and in others more complicated than one with a longer interaction. You can think about a one-shot game without worrying about its repercussions on other games you might play in the future against the same person or against others who might hear of your actions in this one. Therefore actions in one-shot games are more likely to be unscrupulous or ruthless. For example, an automobile repair shop is much more likely to overcharge a passing motorist than a regular customer.

In one-shot encounters, each player doesn’t know much about the others; for example, what their capabilities and priorities are, whether they are good at calculating their best strategies or have any weaknesses that can be exploited, and so on. Therefore in one-shot games, secrecy or surprise are likely to be important components of good strategy.

Games with ongoing relationships require the opposite considerations. You have an opportunity to build a reputation (for toughness, fairness, honesty, reliability, and so forth, depending on the circumstances) and to find out more about your opponent. The players together can better exploit mutually beneficial prospects by arranging to divide the spoils over time (taking turns to “win”) or to punish a cheater in future plays (an eye-for-an-eye or tit-for-tat). We will consider these possibilities in Chapter 11 on the prisoners’ dilemma.

More generally, a game may be zero-sum in the short run but have scope for mutual benefit in the long run. For example, each football team likes to win, but they all recognize that close competition generates more spectator interest, which benefits all teams in the long run. That is why they agree to a drafting

scheme where teams get to pick players in reverse order of their **current** standing, thereby reducing the inequality of talent. In long-distance **races**, the runners or cyclists often develop a lot of cooperation; two or more of them **can help** one another by taking turns to follow in one another's slipstream. **Near the end** of the race, the cooperation collapses as all of them dash for the finish line.

Here is a useful rule of thumb for your own strategic actions in life. In a **game** that has some conflict and some scope for cooperation, you will often think up a great strategy for winning big and grinding a rival into dust but have a nagging worry at the back of your mind that you are behaving like the worst 1980s yuppie. In such a situation, the chances are that the game has a repeated or ongoing aspect that you have overlooked. Your aggressive strategy may gain you a short-run advantage, but its long-run side effects will cost you even more. Therefore you should dig deeper and recognize the cooperative element and then alter your strategy accordingly. You will be surprised how often niceness, integrity, and the golden rule of doing to others as you would have them do to you turn out to be not just old nostrums, but good strategies as well, when you consider the whole complex of games that you will be playing in the course of your life.

#### **D. Do the Players Have Full or Equal Information?**

In chess, each player knows exactly the current situation and all the moves that led to it, and each knows that the other aims to win. This situation is exceptional; in most other games, the players face some limitation of information. Such limitations come in two kinds. First, a player may not know all the information that is pertinent for the choice that he has to make at every point in the game. This includes uncertainty about relevant external circumstances—for example, the weather—as well as the prior and contemporaneous actions of other players. Such situations are said to have **imperfect information**. We will develop the theory of games with contemporaneous actions in Chapter 4 and methods for making choices under uncertainty in the appendix to Chapter 7 and in Chapter 9.

Trickier strategic situations arise when one player knows more than another does; they are called situations of **incomplete** or, better, **asymmetric information**. In such situations, the players' attempts to infer, conceal, or sometimes convey their private information become an important part of the game and the strategies. In bridge or poker, each player has only partial knowledge of the cards held by the others. Their actions (bidding and play in bridge, the number of cards taken and the betting behavior in poker) give information to opponents. Each player tries to manipulate his actions to mislead the opponents (and, in bridge, to inform his partner truthfully), but in doing so each must be aware that the opponents know this and that they will use strategic thinking to interpret that player's actions.

You may think that, if you have superior information, you should always conceal it from other players. But that is not true. For example, suppose you are the CEO of a pharmaceutical firm that is engaged in an R&D competition to develop a new drug. If your scientists make a discovery that is a big step forward, you may want to let your competitors know, in the hope that they will give up their own searches. In war, each side wants to keep its tactics and troop deployments secret; but, in diplomacy, if your intentions are peaceful, then you desperately want other countries to know and believe this fact.

The general principle here is that you want to release your information selectively. You want to reveal the good information (the kind that will draw responses from the other players that work to your advantage) and conceal the bad (the kind that may work to your disadvantage).

This raises a problem. Your opponents in a strategic game are purposive rational players and know that you are one, too. They will recognize your incentive to exaggerate or even to lie. Therefore they are not going to accept your unsupported declarations about your progress or capabilities. They can be convinced only by objective evidence or by actions that are credible proof of your information. Such actions on the part of the more-informed player are called **signals**, and strategies that use them are called **signaling**. Conversely, the less-informed party can create situations in which the more-informed player will have to take some action that credibly reveals his information; such strategies are called **screening**, and the methods they use are called **screening devices**. The word *screening* is used here in the sense of testing in order to sift or separate, not in the sense of concealing. Recall that, in the dating game in Section 2.F of Chapter 1, the woman was screening the man to test his commitment to their relationship, and her suggestion that the pair give up one of their two rent-controlled apartments was the screening device. If the man had been committed to the relationship, he might have acted first and volunteered to give up his apartment; this action would have been a signal of his commitment.

Now we see how, when different players have different information, the manipulation of information itself becomes a game, perhaps more important than the game that will be played after the information stage. Such information games are ubiquitous, and to play them well is essential for success in life. We will study more games of this kind in greater detail in Chapter 9.

### E. Are the Rules of the Game Fixed or Manipulable?

The rules of chess, card games, or sports are given, and every player must follow them, no matter how arbitrary or strange they seem. But, in games of business, politics, and ordinary life, the players can make their own rules to a greater or lesser extent. For example, in the home, parents constantly try to make the rules, and children constantly look for ways to manipulate or circumvent those

rules. In legislatures, rules for the progress of a bill (including the **order** in which amendments and main motions are voted on) are fixed, but the **game** that sets the agenda—which amendments are brought to vote first—can be **manipulated**; that is where political skill and power have the most scope, and **we** will address these matters in detail in Chapter 15.

In such situations, the real game is the “pregame” where rules are made, and your strategic skill must be deployed at that point. The actual playing out of the subsequent game can be more mechanical; you could even delegate it to someone else. However, if you “sleep” through the pregame, you might find that you have lost the game before it ever began. For many years, American firms ignored the rise of foreign competition in just this way and ultimately paid the price. Others, such as oil magnate John D. Rockefeller, Sr., adopted the strategy of limiting their participation to games in which they could also participate in making the rules.<sup>2</sup>

The distinction between changing rules and acting within the chosen rules will be most important for us in our study of strategic moves, such as threats and promises. Questions of how you can make your own threats and promises credible or how you can reduce the credibility of your opponent’s threats basically have to do with a pregame that entails manipulating the rules of the subsequent game in which the promises or threats may have to be carried out. More generally, the strategic moves that we will study in Chapter 10 are essentially ploys for such manipulation of rules.

But, if the pregame of rule manipulation is the real game, what fixes the rules of the pregame? Usually these pregame rules depend on some hard facts related to the players’ innate abilities. In business competition, one firm can take preemptive actions that alter subsequent games between it and its rivals; for example, it can expand its factory or advertise in a way that twists the results of subsequent price competition more favorably to itself. Which firm can do this best or most easily depends on which one has the managerial or organizational resources to make the investments or to launch the advertising campaigns.

Players may also be unsure of their rivals’ abilities. This often makes the pregame one of unequal information, requiring more subtle strategies and occasionally resulting in some big surprises. We will comment on all these matters in the appropriate places in the chapters that follow.

## **F. Are Agreements to Cooperate Enforceable?**

We saw that most strategic interactions consist of a mixture of conflict and common interest. Then there is a case to be made that all participants should get together and reach an agreement about what everyone should do, balancing their

<sup>2</sup>For more on the methods used in Rockefeller’s rise to power, see Ron Chernow, *Titan* (New York: Random House, 1998).

mutual interest in maximizing the total benefit and their conflicting interests in the division of gains. Such negotiations can take several rounds, in which agreements are made on a tentative basis, better alternatives are explored, and the deal is finalized only when no group of players can find anything better. The concept of the core in Chapter 18 embodies such a process and its outcome. However, even after the completion of such a process, additional difficulties often arise in putting the final agreement into practice. For instance, all the players must perform, in the end, the actions that were stipulated for them in the agreement. When all others do what they are supposed to do, any one participant can typically get a better outcome for himself by doing something different. And, if each one suspects that the others may cheat in this way, he would be foolish to adhere to his stipulated cooperative action.

Agreements to cooperate can succeed if all players act immediately and in the presence of the whole group, but agreements with such immediate implementation are quite rare. More often the participants disperse after the agreement has been reached and then take their actions in private. Still, if these actions are observable to the others and a third party—for example, a court of law—can enforce compliance, then the agreement of joint action can prevail.

However, in many other instances individual actions are neither directly observable nor enforceable by external forces. Without enforceability, agreements will stand only if it is in all participants' individual interests to abide by them. Games among sovereign countries are of this kind, as are many games with private information or games where the actions are either outside the law or too trivial or too costly to enforce in a court of law. In fact, games where agreements for joint action are not enforceable constitute a vast majority of strategic interactions.

Game theory uses a special terminology to capture the distinction between situations in which agreements are enforceable and those in which they are not. Games in which joint-action agreements are enforceable are called **cooperative**, and those in which such enforcement is not possible, and individual participants must be allowed to act in their own interests, are called **noncooperative**. This has become standard terminology, but it is somewhat unfortunate because it gives the impression that the former will produce cooperative outcomes and the latter will not. In fact, individual action can be compatible with the achievement of a lot of mutual gain, especially in repeated interactions. The important distinction is that in so-called noncooperative games, cooperation will emerge only if it is in the participants' separate and individual interests to continue to take the prescribed actions. This emergence of cooperative outcomes from noncooperative behavior is one of the most interesting findings of game theory, and we will develop the idea in Chapters 11, 12, and 13.

We will adhere to the standard usage, but emphasize that the terms *cooperative* and *noncooperative* refer to the way in which actions are implemented or

enforced—collectively in the former mode and individually in the latter—and not to the nature of the outcomes.

As we said earlier, most games in practice do not have adequate mechanisms for external enforcement of joint-action agreements. Therefore most of our analytical development will proceed in the noncooperative mode. The few exceptions include the discussion of bargaining in Chapter 17 and a brief treatment of markets and competition in Chapter 18.

### 3 SOME TERMINOLOGY AND BACKGROUND ASSUMPTIONS

When one thinks about a strategic game, the logical place to begin is by specifying its structure. This includes all the strategies available to all the players, their information, and their objectives. The first two aspects will differ from one game to another along the dimensions discussed in the preceding section, and one must locate one's particular game within that framework. The objectives raise some new and interesting considerations. Here, we consider aspects of all these matters.

#### A. Strategies

**Strategies** are simply the choices available to the players, but even this basic notion requires some further study and elaboration. If a game has purely simultaneous moves made only once, then each player's strategy is just the action taken on that single occasion. But, if a game has sequential moves, then the actions of a player who moves later in the game can respond to what other players (or he himself) have done at earlier points. Therefore each such player must make a complete plan of action, for example: "If the other does A, then I will do X but, if the other does B, then I will do Y." This complete plan of action constitutes the strategy in such a game.

There is a very simple test to determine whether your strategy is complete. It should specify how you would play the game in such full detail—describing your action in every contingency—that, if you were to write it all down, hand it to someone else, and go on vacation, this other person acting as your representative could play the game just as you would have played it. He would know what to do on each occasion that could conceivably arise in the course of play, without ever needing to disturb your vacation for instructions on how to deal with some situation that you had not foreseen.

This test will become clearer in Chapter 3, when we develop and apply it in some specific contexts. For now, you should simply remember that a strategy is a complete plan of action.