CHAPTER 3

Dominant Strategies and Social Dilemmas

To best understand this chapter, you need to have studied and understood the material from Chapters 1 and 2.

The first two chapters have focused mainly on concepts, pointing out that many problems of strategy can be studied as if they were games, and exploring the way the strategies and games are represented. But game theory is particularly interested in the interactions among the people involved in the game. From this point on, we will focus very strongly on the interactions.

We want to discover patterns of interaction that are stable and predictable. In economics, a stable and predictable pattern of interaction is usually called "an equilibrium." Game theorists follow this example so we can say that we are investigating "equilibrium" patterns of play in games.

As a first example, we will use a case from environmental policy and environmental economics. This is especially appropriate. Both of the words "economics" and "ecology" come from the Greek root word "oikos," which means a household. Here is the idea: within a household, the members of the household are in constant interaction, and their interaction is what makes the household work. When we use the words "economic" and "ecological" we are implying that in economic and ecological matters, the interaction is just as constant and crucially important as it is within a household.

1. THE DUMPING GAME

For this game, we will begin with a story, as we so often do. In this story, the characters are two property owners. Once again, we will call them Mr. Jones and Mr. Smith. Mr. Jones and Mr. Smith own weekend homes on side by side plots of land in a remote area that has no routine garbage collection. They can contract to have their garbage picked up by a trucking firm, but that is rather costly. It would cost either property owner $500 per year to arrange for the garbage pickup. Each one has another possible strategy to get rid of his garbage. Mr. Jones can dump his garbage near Mr. Smith's house, but far from his own; and similarly, Mr. Smith can dump his garbage near Mr. Jones's house. (Figure 3.1 shows a rough plot of their properties and these strategies.)

The two landowners will make their decisions simultaneously, so each will not know what strategy the other person is choosing. Therefore, we will want to represent this game in normal form. Each landowner chooses between two strategies: pay for a garbage pickup or dump the garbage. But what are the payoffs in this game?

The benefits the two landowners get from their weekend property are subjective benefits. They consist of the enjoyment the two get from spending their time in this remote and scenic location. But we need to express the benefits in money terms, if only in order to compare them with the dollar cost of the garbage pickup. We can

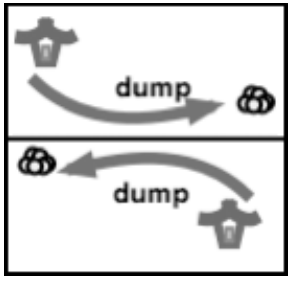

Figure 3.1. Mr. Smith and Mr. Jones's Dumping Strategies.

use an idea from economics to do this. We know that the property owners could benefit in other, monetary ways from their property. For example, each one could rent his property out for the season, rather than occupying it himself. We can estimate the money value of a person's subjective enjoyment of his property — it is the smallest amount of rent that he would accept in return for giving up his own occupation of the property.

Of course, the subjective benefits depend on whether someone is dumping his garbage on your property or not. Taking that into account, we will say that each person values his experience at his weekend home at $5,000 per year if there is no dumping, but at $4,000 per year if there is. In other words, if there were no dumping, neither Mr. Jones nor Mr. Smith would give up a year of occupancy for less rent than $5,000; but if there is dumping on the property, each of them would give up the year of occupancy for $4,000.

HEADS UP!

Here are some concepts we will develop as this chapter goes along:

Dominant Strategy: whenever one strategy yields a higher payoff than a second strategy, regardless which strategies the other players choose, the first strategy dominates the second. If one strategy dominates all other strategies (for a particular player in the game) it is said to be a dominant strategy (for that player).

Dominant Strategy Equilibrium: if, in a game, each player has a dominant strategy, then that combination of (dominant) strategies and the corresponding payoffs are said to constitute the dominant strategy equilibrium for that game.

Cooperative and Noncooperative Solutions: the cooperative solution of a game is the list of strategies and payoffs that the participants would choose if they could commit themselves to a coordinated choice of strategies: for example, by signing an enforceable contract. The strategies and payoffs they would choose if there are no enforceable agreements is the noncooperative solution.

Social Dilemma: a social dilemma is a game that has a dominant strategy equilibrium and the dominant strategy solution is different than the cooperative solution to the game.

Using this information, we can represent the Dumping Game in normal form as shown in Table 3.1.

Now remember, in game theory we focus on "rational" behavior, which means that each player chooses his "best response" to the strategy the other player has chosen or can be expected to choose. First, let us think of Mr. Smith's best response to the strategies that Mr. Jones might choose. These are shown in Table 3.2.

What we see in Table 3.2 is that "dump" is always the best response, regardless of which strategy Mr. Jones chooses. Now let us think through Mr. Jones's best responses to the strategies that Mr. Smith might choose. Since the game is symmetrical, it should come as no surprise that the best response is the same for Mr. Jones as it is for Mr. Smith. That is what we see in Table 3.3.

It seems that both players in the Dumping Game have rather easy decisions. That is because the strategy "dump" is an example of a "dominant strategy." A dominant strategy is a strategy that is the best response to any strategy that the other player or players might choose. In the Dumping Game, "dump" is a dominant strategy for both players. Since both players in the Dumping Game have dominant strategies, the Dumping Game also gives us a good example of a dominant strategy equilibrium. When each of the players in a game chooses his dominant strategy, the result is a "dominant strategy equilibrium." We can also say that the strategy "dump" dominates the strategy "hire a truck." Whenever one strategy yields a higher payoff than a second strategy,

Definition: *Dominated strategy* — Whenever one strategy yields a higher payoff than a second strategy, regardless of which strategies the other players choose, the first strategy dominates the second. In this case, the second strategy is said to be a dominated strategy.

Definition: *Dominant strategy* — If one strategy dominates all other strategies (for a particular player in the game), it is said to be a dominant strategy (for that player).

Table 3.1. The Dumping Game in Normal Form.

		Mr. Smith	
		Dump	Hire Truck
Mr. Jones	Dump	4,000, 4,000	5,000, 3,500
	Hire truck	3,500, 5,000	4,500, 4,500

Table 3.2. Best Responses For Mr. Smith.

If Mr. Jones's Strategy is	The Best Response for Mr. Smith is
Dump	Dump
Hire truck	Dump

Table 3.3. Best Responses for Mr. Jones.

If Mr. Smith's Strategy is	The Best Response for Mr. Jones is
Dump	Dump
Hire truck	Dump

regardless of which strategies the other players choose, the second strategy is dominated by the first, and is said to be a dominated strategy. In the Dumping Game, the strategy "hire a truck" is a dominated strategy.

2. DOMINANT STRATEGIES

When dominant strategies exist in a game, they provide a very powerful reason for choosing one strategy rather than another. You may have noticed that the Dumping Game is very much like the Prisoner's Dilemma. In the Prisoner's Dilemma, "confess" is a

Definition: *Dominant strategy equilibrium* — If, in a game, each player has a dominant strategy, then that combination of (dominant) strategies and the corresponding payoffs are said to constitute the dominant strategy equilibrium for that game.

dominant strategy both for Al and for Bob; and (confess, confess) is a dominant strategy equilibrium. Similarly, the Advertising Game, in Chapter 1 is an example of dominant strategy equilibria. All of these games — the Dumping Game and the other two — are examples of "social dilemmas." A social dilemma can be defined as a game with a dominant strategy equilibrium in which all players do worse than they would if they had all adopted nonequilibrium strategies.

3. SOCIAL DILEMMAS AND COOPERATIVE SOLUTIONS

From a mathematical point of view, the dominant strategy equilibrium is a "solution" to the game. That is, it tells us what strategies will be chosen and what the results will be if participants in the game make choices that are "rational" in a certain sense. But from the point of view of the participants in a social dilemma, the dominant strategy equilibrium is more the problem in itself. Let us return to the example of the dumping game. We can be pretty certain that both Mr. Smith and Mr. Jones would prefer the situation where each person chooses to hire a truck rather than the dominant strategy equilibrium. Since both are better off when both hire a truck, we can describe the (hire a truck,

Definition: *Cooperative solution* — the cooperative solution of a game is the list of strategies and payoffs that the participants would choose if they could commit themselves to a coordinated choice of strategies: for example, by signing an enforceable contract.

hire a truck) outcome as the "cooperative solution" to the Dumping Game.

Suppose, to continue the example, that Mr. Smith and Mr. Jones come together and negotiate a contract. The contract states that each of them will hire a truck, and that there will be no dumping. After they have signed the contract, they are committed to the strategy of hiring a truck. If either of them should "cheat," the other player can file a lawsuit and force the cheater to comply with the contract. Thus, the institution of contracts provides a solution for social dilemmas in some cases. In this instance, it enables the two homeowners to arrive at the cooperative solution rather than the dominant strategy equilibrium.

Definition: *Noncooperative solution* — the noncooperative solution of a game is the list of strategies and payoffs that the participants would choose if there is no possibility to commit themselves to a coordinated joint strategy, so that each assumes the other will choose a best response strategy.

In fact, contracts of this kind among homeowners are quite common. They are called "covenants." Many suburban settlements have covenants against dumping and similar nuisances. Of course, legislation serves the same purpose in many incorporated settlements.

In general, we will define the cooperative solution of a game as the list of strategies and payoffs that the participants would choose if they could commit themselves to a coordinated choice of strategies, whether by means of a contract or by any other form of enforcement.

By contrast, the dominant strategy equilibrium we have been considering is a noncooperative solution. A noncooperative solution of a game is the list of strategies and payoffs that the participants would choose if there is no possibility of a binding agreement to coordinate strategies. In a noncooperative solution, each player chooses his best response to the strategies chosen by the others, and assumes that they do the same, so each player chooses a best

response to the best response strategies of the others. This is true in the Dumping Game, for example — each player assumes that the other player will choose "dump" and each player chooses the best response to "dump."

What defines a social dilemma is the fact that a dominant strategy equilibrium exists and is contrary to the cooperative solution. Thus, for example, in the Prisoner's Dilemma, the two prisoners would certainly prefer to coordinate their strategies, refuse to confess, then serve only one year in prison. The "third degree" treatment they receive is specifically designed to prevent them from coordinating their strategies. In the advertising game, again, not to advertise is the cooperative solution. When the government threatened to enforce a no advertising policy, the tobacco companies were in a position to profit by complying. They could profit because, with government enforcement, the choice of a no advertising strategy would be coordinated — both would adopt it simultaneously. However, the timing limitations that resulted from the reliance on heavy artillery and rail mobility made it impossible for the two sides to coordinate their strategies.

Definition: *Social dilemma* — A social dilemma is a game that has a dominant strategy equilibrium and the dominant strategy solution is different than the cooperative solution to the game.

Social dilemmas are a very important category of games, but dominant strategies and dominated strategies will be important in other kinds of games as well. Some games have dominant strategy equilibria and others do not. Also, some games that do have dominant strategy equilibria are not social dilemmas. But a dominant strategy equilibrium does not have to be inferior. Here is a business example that illustrates the possibility of a dominant strategy equilibrium that is not inferior to other strategy combinations.

4. COLLABORATIVE PRODUCT DEVELOPMENT

Omnisoft Corp. and Microquip, Ltd. are considering a collaborative project of research and product development. Each company has two strategies to choose between: to commit plenty of resources to the project, or to hold back, and only commit minimal resources to the project. A difficulty that can arise in this sort of game is that neither partner can monitor or enforce the commitment of effort and resources by the other. In this case, however, we are assuming that the project has "spinoff" technologies, that is, technologies that the two companies can put to use profitably even if the collaborative project does not work out, and that will make a difference. The payoffs (in billions) are shown in Table 3.4.

When we examine the game to determine whether or not there are dominant strategies, we find that there are. Suppose Omnisoft's strategy is to commit. Microquip can then earn 5 billion by choosing "commit" as its own strategy, but only three by choosing "hold back." If Omnisoft's strategy was to hold back, then Microquip can earn 2 billion by choosing "commit" and only 1 billion by choosing "hold back." Thus, "commit" is the dominant strategy for Microquip. By symmetrical reasoning, "commit" is the dominant strategy for Omnisoft as well. Since both players have dominant strategies, this game has a dominant strategy equilibrium. The dominant strategy equilibrium is for each of the two firms to choose "commit". This leads to the best possible outcome, with each firm earning 5 billion of profits.

Table 3.4. Collaborative Product Development.

		Omnisoft	
		Commit	Hold Back
Microquip	Commit	5,5	2,3
	Hold back	3,2	1,1

This example contrasts with some of the other ones in that the dominant strategy equilibrium is just the outcome that the two companies want. They could not improve on this outcome even if they merged. The equilibrium at (commit, commit) is not only the dominant strategy equilibrium in this game. It is also the "cooperative solution," that is, the outcome the players would choose if they could choose any pair of strategies at all. Games like this — in which the dominant strategy equilibrium is also the cooperative solution — do not play a large part in the literature of game theory. Most likely, that is because they do not present any problems for people and for society. Game theory is a pragmatic study, oriented toward finding and solving problems. But games in which the cooperative solution is a dominant strategy equilibrium are logically possible, and may even be fairly common in business, since, after all, noncooperative equilibria are barriers to increasing the profits, and (as economist George Stigler observed) "business" consists of all the methods we know for eliminating barriers to increased profits.

5. COOPERATIVE AND NONCOOPERATIVE GAMES YET AGAIN

As we have seen, a number of important applications of game theory rest on the contrast of cooperative and dominant strategy, noncooperative solutions, but not all games with dominant strategy equilibria are social dilemmas. Cooperative dominant games give no similar problems. Most game theorists would say that noncooperative solutions and equilibria are more fundamental, in that the participants in a cooperative agreement would choose whether to enter into the agreement or not in very much the way that they decide which strategy to choose in a noncooperative equilibrium.

Let us return to the social dilemma from the first section of the chapter, the Dumping Game. We have seen that one solution would be for the two landowners to sign a contract to have their garbage hauled. Once the contract has been drafted, each landowner must decide whether to accept the contract. If both accept the contract,

their payoffs are the cooperative solution payoffs: 4,500, 4,500. If either one refuses, they will both play noncooperatively and so are back to the social dilemma with its equilibrium payoff of 4,000, 4,000. Thus, they are playing a new game, the Acceptance Game, which is shown in Tables 3.5 and 3.6 below. In this case, the noncooperative solution is "accept, accept," and it is also the cooperative solution. The proposal of the contract has transformed the social dilemma into a cooperative-dominant game.[1]

In most of this book (except Part 5), we will focus on noncooperative games and solutions.

6. A POLITICAL GAME

Strategic choices have to be made not only in business, waste disposal, recreational games, and war — but also in routine, peace-time politics. Let us consider a political example.

Table 3.5. An Acceptance Game in Normal Form.

		Mr. Smith	
		Refuse	Accept
Mr. Jones	Refuse	4,000, 4,000	4,000, 4,000
	Accept	4,000, 4,000	4,500, 4,500

Table 3.6. Best Responses for Mr. Smith.

If Mr. Jones's Strategy is	The Best Response for Mr. Smith is
Accept	Accept
Reject	Doesn't Matter

[1]The "accept" strategy does not exactly fit the definition we have given for a dominant strategy, since "accept" and "reject" have the same payoff for Mr. Jones if Mr. Smith chooses "reject." This is a tricky point we will not deal with until Chapter 5. Nevertheless, Smith and Jones should have no difficulty arriving at "accept, accept" as their noncooperative solution to the Acceptance Game.

For this example, we have two candidates: Senator Blank and Governor Gray. Although the candidates have no personal preferences for one ideology over another, Senator Blank, as a Democrat, can take a position on the political left more credibly than Governor Gray, who is a Republican. Conversely, Governor Gray can take a position on the political right more credibly than Senator Blank. Adopting the left and right political positions are two of the strategies that they can choose. But they both have a third strategy available. Either or both of them can adopt a "middle of the road" political position.

In this case, therefore, we have a game in which each player has three strategies. We can express the game with three strategies in normal form very simply: the table will have three rows and three columns instead of two.

What are the payoffs in this game? We are assuming that the two candidates do not particularly care what positions they take. Their objective is not to advance a particular ideology, but just to get elected. Some German speaking political economists express this motivation as "Stimmungsmaximieren" — maximizing the vote. That is probably a little bit of an exaggeration. What the candidate needs is not the largest possible vote but a vote over 50%. On the other hand, a "landslide victory" by a large margin can be a big advantage to the winning candidate. In any case, we can express the payoffs as the percentage of the vote the candidate can expect to receive.

Of course, that will depend on where the voters are. We shall assume that the voters are distributed symmetrically, with 30% favoring the political right, 30% favoring the political left, and 40% preferring to vote for a candidate with a middle-of-the-road position. The payoffs are shown in Table 3.7. We are assuming that if both candidates adopt the same "middle-of-the-road" position, they split the vote 50-50, and the winner is determined by random errors in counting the vote. In that case, each has an equal chance of victory. If the two candidates take different positions, the voters will vote for the one nearest their position, with two exceptions. First, not all of the voters on the left will choose the Republican candidate even if

Table 3.7. Vote Payoffs for Two Candidates.

		Governor Gray		
		Left	Middle	Right
Senator Blank	Left	55,45	30,70	50,50
	Middle	75,25	50,50	70,30
	Right	50,50	25,75	45,55

Table 3.8. Best Responses for Senator Blank.

If Gray's Strategy is	The Best Response for Blank is
Left	Middle
Middle	Middle
Right	Middle

he/she takes the left position; and similarly, not all of the voters on the right will choose the Democrat even if he/she takes the right position. Second, if nobody takes the middle position, the middle vote divides equally.

The best responses for Senator Blank are shown in Table 3.8. As we see, the "middle-of-the-road" strategy is a dominant strategy for Senator Blank. And even though the game is not perfectly symmetrical, we can reason symmetrically, and see that the "middle-of-the-road" strategy is also a dominant strategy for Governor Gray. Since both candidates have dominant strategies, we have a dominant strategy equilibrium.

This is not a social dilemma. Since the total vote is the same, 100%, regardless of which strategies the two candidates choose, there is no conflict between the dominant strategy equilibrium and the cooperative solution in this game. But that is looking at it from the point of view of the candidates, and not from the point of view of the voters. This dominant strategy solution might not be a very good one from the point of view of the voters. Only one political

point of view, the "middle-of-the-road" viewpoint, is ever expressed. For those on the left or the right — who together are 60% of the voters in this case — it may seem that they have been left out entirely. In the real world American politics, we do hear this complaint expressed. Many Americans on the right and on the left seem to perceive that the deck is stacked against them. Perhaps this is a symptom that middle strategies are often dominant strategies in American politics.

7. GAMES WITH MORE THAN TWO STRATEGIES

Most of our examples so far in this textbook have been "two-by-two games," that is, games with just two participants, each of whom must choose between just two strategies. Like the political game, though, most real world interactions involve more than two participants or more than two strategies or both, and sometimes the number of participants or strategies or both is very large indeed. In future chapters, we will consider games with more than two participants. As we have seen, games with more than two strategies are only a little more complicated than two-by-two games, when they are represented in normal form. Only the table has to have more than two rows and columns.

For another example, let us go back to the Dumping Game. We will change it by adding a third strategy: burning the garbage. So now each of the two homeowners will have to choose among three strategies: hire a truck, dump, or burn. Burning will have the same effect on the value of both tracts of land. If one landowner burns, it will reduce the value of both pieces of land by $250, and if both burn, by $350, from what it would be otherwise. The payoff table is shown in Table 3.9. It differs from our previous examples only in that it has one more row and one more column.

As usual, we want to investigate the best responses of each player to the strategies that might be chosen by the other player. The best responses for each are shown in Table 3.10. Once again, we see that "dump" is a dominant strategy for Mr. Smith. By symmetrical reasoning, it is also a dominant strategy for Mr. Jones.

Table 3.9. The Dumping Game with Three Strategies.

		Mr. Smith		
		Dump	Hire Truck	Burn
Mr. Jones	Dump	4,000, 4,000	5,000, 3,500	4,750, 3,750
	Hire truck	3,500, 5,000	4,500, 4,500	4,250, 4,750
	Burn	3,750, 4,750	4,750, 4,250	4,650, 4,650

Table 3.10. Best Responses for Mr. Smith.

If Mr. Jones's Strategy is	The Best Response for Mr. Smith is
Dump	Dump
Hire truck	Dump
Burn	Dump

So we will again have a dominant strategy equilibrium and a social dilemma.

8. A TEXTBOOK-WRITING GAME

The concept of a dominant strategy equilibrium is a powerful one, but we will find that not all games have dominant strategy equilibria. Here is an example of a game of three strategies in which there is no dominant strategy equilibrium.

Prof. Heffalump and Dr. Boingboing are the authors of rival textbooks of game theory. Their books are of equal quality in every way except length.[2] Both authors know that professors will usually

[2]This is an unrealistic simplifying assumption, since, of course, this book is far better than any other game theory textbook, page for page, in every way. By now you have probably noticed that we do not hesitate to make unrealistic simplifying assumptions in order to get the point across. Of course, textbooks vary in many ways, including the quality of the writing, the production, and whether or not the author has a sense of humor.

choose the longer book if one is longer than the other. Each would like to get the larger audience, but writing a longer book is a bigger effort, so neither author wants to write a book longer than it needs to be to capture the bigger audience. Each of the two authors can choose among the following three strategies: write a book of 400 pages, 600 pages, or 800 pages. The payoffs are shown in Table 3.11. The payoffs might be royalties, in thousands of dollars per year, or might also reflect some subjective benefits from being in first place — whatever it is that the authors want to get out of their writing.

Table 3.12 shows the best responses for Dr. Boingboing, depending on Prof. Heffalump's strategy choice. What we see is that Dr. Boingboing will want to choose a different strategy when Dr. Heffalump chooses a 400 page text than he will want to choose if Prof. Heffalump chooses a 600 or 800 page text. Dr. Boingboing's idea is to write a text just one step longer than Dr. Heffalump's text, if he can. It follows that there is no one strategy that is Dr. Boingboing's best response to each of the different strategies Prof. Heffalump

Table 3.11. Writing a Game Theory Textbook.

		Prof. Heffalump		
		400 p.	600 p.	800 p.
Dr. Boingboing	400 p.	45,45	15,50	10,40
	600 p.	50,15	40,40	15,45
	800 p.	40,10	45,15	35,35

Table 3.12. Best Responses for Dr. Boingboing.

If Prof. Heffalump's Strategy is	The Best Response for Dr. Boingboing is
400	600
600	800
800	800

might choose. In other words, there is no dominant strategy for Dr. Boingboing. And since the game is symmetrical, we can reason in just the same way and find that there is no dominant strategy for Prof. Heffalump either.

So the textbook writing game gives us an example of a game in which there is no dominant strategy. If we are to find a "solution" for a game like this one, it will have to be a different kind of solution. We will go on to investigate that in the next chapter. So we set this example aside for now, and will return to it in Chapter 4.

9. SUMMARY

One objective of game theoretic analysis is to discover stable and predictable patterns of interactions among the players. Following the example of economics, we call these patterns "equilibria."

Since we assume that players are rational, their choices of strategies will only be stable if they are best response strategies — the player's best response to the other players' strategies. If there is one strategy that is the best response to every strategy the other player or players might choose, we call that a dominant strategy. If every player in the game has a dominant strategy, then we have a dominant strategy equilibrium.

A dominant strategy equilibrium is a noncooperative equilibrium, which means that each player acts independently, not coordinating the choice of strategies. If the players in the game are able to commit themselves to a coordinated choice of strategy, the strategies they choose are called a cooperative equilibrium. It is possible that the cooperative equilibrium may be the same as a dominant strategy equilibrium, but then again it may not be.

One important class of games with dominant strategy equilibria are the social dilemmas. The familiar Prisoner's Dilemma is a typical example of this class. What the Prisoner's Dilemma has in common with every other social dilemma is that it has a dominant strategy equilibrium that conflicts with its cooperative equilibrium.

We have seen applications to environmental management, advertising, military mobilization, business, partnership, and politics.

It seems clear that dominant strategy equilibrium has a wide range of application. Nevertheless, we have also seen that not all games have dominant strategies or dominant strategy equilibria.

10. EXERCISES AND DISCUSSION QUESTIONS

10.1. Solving the Game

Explain the advantages and disadvantages of the dominant strategy equilibrium as a solution concept for noncooperative games.

10.2. Effort Dilemmas

One family of "social dilemmas" arises where a group of people are involved in some task that depends on the efforts of each of them. The strategy choices are "work" and "shirk." In an effort dilemma, one person's shirking places the burden of increased effort on the other(s). Then the payoff table could be something like Table 3.13a.

a. Are there any dominant strategies in this game? What?
b. Has this game a dominant strategy equilibrium?
c. What would be the cooperative solution in this game?
d. In the Pacific Northwest of the United States, in the middle of the 20th century, between two and three dozen plywood companies were worker owned. The worker-owners controlled the companies by majority rule and hired and fired the managers.

Table 3.13a. An Effort Dilemma.

		Mr. Jones	
		Work	Shirk
Mr. Smith	Work	10,10	2,14
	Shirk	14,2	5,5

However, the managers typically had discretion to assign and discipline work, and were, if anything, more powerful than managers in similar profit-seeking companies. Does the example suggest an explanation of this?

10.3. Public Goods

In economics, a "public good" is defined as a good or service with two characteristics: (1) It is not practically possible to charge the agents who benefit from the good and make their payment a condition for them to get the benefit of the good (the good is "nonexclusive") (2) The cost of providing the good is the same regardless of the number of beneficiaries there are (the good is "nonrivalrous"). Here is an example in the form of a two-person game. Joe and Irving each can choose between the strategy of producing one unit of a public good or no units of a public good. If the public good is not produced, each gets a payoff of 5. If either Joe or Irving produces a unit of the public good, both players' payoffs are increased by 2, but the agent who produces the good pays a cost that reduces his payoffs by 3. Thus, for example, if Joe produces and Irving does not, Joe's payoff is $5 + 2 - 3 = 4$ and Irving's payoff is $5 + 2 = 7$.

a. Express this as a payoff table.
b. Analyze the game in terms of dominant strategies.
c. Is it a social dilemma? Why or why not?

10.4. Poison Gas

Allemand and Angleterre are rival nations, often at war, and both can produce and deploy poison gas on the battlefield. In any battle, the payoffs to using gas are as in Table 3.13b.

a. Are there any dominant strategies in this game? What?
b. Has this game a dominant strategy equilibrium?
c. What would be the cooperative solution in this game?

Table 3.13b. Gas.

		Angleterre	
		Gas	No
Allemand	Gas	–8,–8	3,–10
	No	–10,3	0,0

d. Is this game a social dilemma? Why?
e. Historically, poison gas was used in World War I, but not in World War II, although Germany opposed France and Britain in the second war as it had in the first. The consensus explanation was that if one side were to use gas in a battle, the other side would retaliate with gas in subsequent battles, with the result that the first user would nevertheless be worse off as a result. Discuss the limitations of the Dominant Strategy Equilibrium in the analysis of social dilemmas in the light of this contrast.

10.5. Running for Office

Richard Nixon, a highly successful Republican politician, said that the way for a Republican to be elected to public office was to "run to the right in the primary election, but run to the center in the general election." The political example in this chapter gives an explanation for the advice to "run to the center in the general election." How would you explain "run to the right in the primary?" *Note*: in the political systems of many American states, including California (Nixon's home state), primary elections are held to determine the nominees of the major parties, and are limited to voters registered as members of those respective parties. The nominees selected then compete in a general election. *Hint*: it may be that registered members of the Republican Party are not distributed over the political spectrum as the general population is.

Table 3.13c. Training.

Proportion Trained	Net Productivity
0	5
50%	7.5
100%	10

10.6. Happy Hour

Refer to problem 4 in Chapter 1.

a. Are there any dominant strategies in this game? What?
b. Has this game a dominant strategy equilibrium?
c. What would be the cooperative solution in this game?
d. Is this game a social dilemma? Why?

10.7. The Training Game

Two firms hire labor from the same unskilled pool. Each firm can either train its labor force or not. Training increases productivity but there are spillovers in that the rival can hire the trained workers away. Thus, both firms always face the same productivity net of pay, although the net productivity is higher if more workers are trained. The relation between the proportion trained and net productivity is shown in Table 3.13c.

(Each firm either trains all of its workers or none, so 0, 50%, and 100% trained are the only possibilities.) Each firm's profit is the net productivity shown in the table minus training cost. Training cost is three if the firm chooses to train its employees and zero otherwise.

a. Who are the "players" in this game?
b. What are their strategies?
c. Express this as a game in normal form.
d. Are there dominant strategies in this game? What?
e. Is there a dominant strategy equilibrium? What?