Chapter 3 Notes: Game Theory

Essential Idea:
The payoff of an action often depends not only on the action itself, but also on how it relates to actions taken by others in the same environment.

The theory of games captures the potential for strategic interdependence between individuals, firms and governments. It recognizes that your satisfaction may depend on what others do. You, therefore, need to second guess others. Moreover, you need to recognize that others will try to second guess you.

Social Dilemmas
In chapter 1, we discussed the rule that an activity is worth doing if the benefit exceeds the cost.

When stating this rule, we implicitly focused on the benefit and cost that directly accrue to the person doing the activity.

For many activities, there are also external benefits and costs: these are benefits and costs that do not fall on the person doing the activity.

Example 1: Burn or Haul? (Two Dominant Strategies)

1. Two neighbors, Jack and Jill, have been independently cleaning up their garden. They now each face a choice of what to do with the dead leaves they have collected. They could haul them into the woods or burn them.
2. The labor cost to both Jack and Jill of hauling the leaves is $20, while the cost of burning them is only $1.
3. However, burning the leaves also entails a cost in terms of damage done by smoke from the fire. Their houses are close together, so if Jack burns his leaves it imposes an external cost on Jill. Similarly, if Jill burns her leaves it imposes an external cost on Jack. The external cost of each fire amounts to $15 for both Jack and Jill.
4. If Jack and Jill burn their leaves they each pay a cost of $31—the $1 labor cost and the $30 damage from two fires. If Jack burns his leaves while Jill hauls her, then Jack pays a cost of $16 (his $1 labor and $15 damage from one fire), while Jill pays $35. Similarly, if Jill burns her leaves while Jack hauls his, then Jill pays $16 and Jack pays $35. If both Jack and Jill haul leaves then they each pay a cost of $20. These payoffs can be summarized as follows:

Nash Equilibrium

Nash equilibrium: the combination of strategies in a game such that neither players has any incentive to change strategies given the strategy of his opponent

If every player has a dominant strategy, we would expect the player to play the dominant strategy. However, there are many games where not every player has a dominant strategy. Consider the following example.

Example 4: Burn or Haul? (One Dominant Strategy)
Consider again the scenario in example 1. But, suppose Jack now values the cost from the damage of one fire as equal to $15 and the cost of two fires equal to $40 (recall that in the previous example one fire caused damage of $15 but two damage of $30). What is predicted to happen?

		Jill	
		Burn	Haul
Jack	Burn	$31 Loss for Jill; $41 Loss for Jack	$35 loss for Jill; $16 Loss for Jack;
	Haul	$16 Loss for Jill; $35 Loss for Jack;	$20 Loss for Both

If Jill burns, Jack should haul. If Jill hauls, Jack should burn. **There is no dominant strategy for Jack—only for Jill (to burn).** If Jack predicts Jill will burn, he will haul.

A good rule for assessing whether a particular combination of strategies constitutes a Nash equilibrium is to ask whether either player has any incentive to choose a different strategy.

- When each player follows his or her dominant strategy in a social dilemma, the result is a Nash equilibrium.
- However, the example above shows that a Nash equilibrium does not require all players to have a dominant strategy.

Example 5: Burn or Haul? (No Dominant Strategy)
Consider again the scenario in example1. But, suppose that now both Jack and Jill value the cost from the damage of one fire as equal to $15 and that of two fires equal to $40. Can we predict what they should do?

		Jill	
		Burn	Haul
Jack	Burn	$41 Loss for Both	$35 loss for Jill; $16 Loss for Jack;

In this game, neither Jack nor Jill has a dominant strategy. If Jack burns then Jill should haul. But if Jack hauls then Jill should burn. The same logic applies to Jill.