theme 2: firms and market failure

game theory notes

introduction
dominant strategies, Nash equilibrium and Prisoner's Dilemma
repeated games
sequential games
entry deterrence
strategic trade
limitations of game theory

introduction

Game Theory
- von Newmann and Morgenstern (1944): Theory of Games and Economic Behavior
- refers to a set of tools that economists, political scientists, etc. use to analyze players' strategic decision making
- formally describes games and predicts their outcomes conditional on the rules of the game, the information that players have, and other factors

Game
- a game is any situation in which players make strategic decisions (decisions that take into account each others' actions and responses)

Payoffs
- players' valuations of the outcome of the game e.g. profits for firms, utility for individuals

Optimal Strategy
- a strategy (rule or plan of action for playing the game) that maximizes the expected payoff

Strategic Interdependence
- when a player's optimal strategy depends on the actions of others
- found in oligopolies

Static Game
- a game in which each player acts only once and the players act simultaneously
- firms have complete information about the payoff functions but imperfect information about rivals' moves

Dynamic Game
- a game in which players move either sequentially or repeatedly
- players have complete information about payoff functions and perfect information about previous moves by all players

Reading a Payoff Matrix

Payoff to Firm B if it does not advertise but A advertises

Payoff to Firm A if it advertises and B also advertises

		Firm B: Advertise	Firm B: Don't Advertise
Firm A	**Advertise**	4.1, 4.1	5.1, 3.8
	Don't Advertise	3.8, 5.1	4.6, 4.6

dominant strategies, Nash equilibrium & prisoners' dilemma

Dominant Strategy

- a strategy that produces a higher payoff than any other strategy the player can use for every possible combination of its rivals' strategies
- a strategy that is optimal no matter what an opponent does

		Firm B	
		Advertise	**Don't Advertise**
Firm A	**Advertise**	4.1, 4.1	5.1, 3.8
	Don't Advertise	3.8, 5.1	4.6, 4.6

- in this case, whether Firm B chooses to advertise or not advertise, the dominant strategy of Firm A is to advertise
- the dominant strategy for Firm B is also to advertise
- both will choose to advertise and end up with a payoff of 4.1 each, despite the fact that if they both do not advertise, they end up with a higher payoff of 4.6 each
- this is called the Prisoners' Dilemma
- when every player has a dominant strategy, this is called an equilibrium in dominant strategies

Prisoners' Dilemma

- a game in which all players have dominant strategies that result in payoffs that are inferior to what they could achieve if they used cooperative strategies
- however, one key limitation is that it assumes players cannot communicate - with communication, they can agree to cooperate and achieve the higher payoff

Nash Equilibrium

- however, not every game has a dominant strategy for each player
- see figure below

		Firm B	
		Advertise	**Don't Advertise**
Firm A	**Advertise**	10, 5	15, 0
	Don't Advertise	6, 8	20, 2

- in this case, Firm A has no dominant strategy - its optimal decision depends on what Firm B does
- however, Firm B has a dominant strategy - advertise
- hence, Firm A can conclude that Firm B will advertise, which means that the best response for Firm A is to advertise as well

sequential games

Commitment

- in the Stackleberg model, the firm that moved first had a first-mover's advantage by committing itself to a large output
- making a commitment is crucial, because if it's just an empty threat, its rival will know that the dominant strategy for the firm will be to accommodate once entry has occurred
- hence, Firm 1 constraints Firm 2's behavior by constraining its own behavior
- e.g. launch an expensive advertising campaign, thereby putting its reputation on the line
- e.g. sign a contract and make it public

Credible Threat

		Y Motors	
		Small cars	**Big cars**
X Engines	**Small engines**	3, 6	3, 0
	Big engines	1, 1	8, 3

- assume we have a sequential game in which Y Motors is the leader, and X engines produces engines for Y Motors
- the dominant strategy for Y Motors is to produce small cars, and it knows that in response to this decision, X Engines will produce small engines (3, 6 payoff)
- however, X Engines would prefer to produce big engines and for Y Motors to produce big cars (it can then make 8 instead of 3)
- X Engines can make its threat of producing only big engines credible by visibly and irreversibly reducing some of its own payoffs
- for example, it can shut down or destroy some of its small engine production capacity, which will result in this payoff matrix:

		Y Motors	
		Small cars	**Big cars**
X Engines	**Small engines**	0, 6	0, 0
	Big engines	1, 1	8, 3

- in this case, now Y Motors knows that whatever kind of car it produces, X Engines will produce big engines
- the best response for Y Motors is now to produce big cars
- evaluation:
    - such strategic commitments are risky and depend heavily on having accurate knowledge of the payoff matrix and the industry
- reputation is also important: if the managers of X Engines can develop a reputation for being irrational, they can threaten to produce big engines no matter what Y Motors produces
- irrational behavior could be advantageous in repeated games

Walmart's Preemptive Investment Strategy

- small towns can only hold one large discount shop at most

		Company X: Enter	Company X: Don't Enter
Walmart	**Enter**	-10, -10	20, 0
	Don't Enter	0, 20	0, 0

- Walmart found itself in a preemption game of sorts
- if Walmart enters but Company X does not, Walmart will make 20 and Company X will make 0, and vice versa
- two Nash equilibria: top right corner and bottom left corner
- which equilibrium results depends on who moves first
- if Walmart moves first, it can enter, knowing that the rational response of Company X will be not to enter
- the trick, therefore, is to preempt - to set up stores in other small towns quickly