

## Chapter 13

### Game Theory

### Gaming and Strategic Decisions

- Game theory tries to determine optimal strategy for each player
- ( ) is a rule or plan of action for playing the game
- ( ) strategy for a player is one that maximizes the expected payoff
- We consider players who are rational

### Noncooperative v. Cooperative Games

- ( ) Game
  - Players negotiate binding contracts that allow them to plan joint strategies
- Non-cooperative Game
  - Negotiation and enforcement of binding contracts between players is not possible

### Dominant Strategies

- ( ) Strategy is one that is optimal no matter what an opponent does.

### Payoff Matrix for Advertising Game

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

### Dominant Strategies

- Equilibrium in dominant strategies
  - Outcome of a game in which each firm is doing the best it can regardless of what its competitors are doing
- However, not every game has a dominant strategy for each player

## Dominant Strategies

- Game Without Dominant Strategy
  - The optimal decision of a player without a dominant strategy will depend on what the other player does.

Chapter 13

7

## Modified Advertising Game

		<i>Firm B</i>	
		Advertise	Don't Advertise
<i>Firm A</i>	Advertise	10, 5	15, 0
	Don't Advertise	6, 8	20, 2

Chapter 13

8

## The Nash Equilibrium Revisited

- A dominant strategy is stable, but in many games one or more party does not have a dominant strategy.
- A more general equilibrium concept is the **Nash Equilibrium**.
  - A set of strategies (or actions) such that **each player is doing the best it can given the actions of its opponents**

Chapter 13

9

## The Nash Equilibrium Revisited

- None of the players have incentive to deviate from its Nash strategy, therefore it is stable
  - In the Cournot model, each firm sets its own price assuming the other firms outputs are fixed. Cournot equilibrium is a Nash Equilibrium

Chapter 13

10

## The Nash Equilibrium Revisited

- Dominant Strategy
  - "I'm doing the best I can no matter what you do. You're doing the best you can no matter what I do."
- Nash Equilibrium
  - "I'm doing the best I can given what you are doing. You're doing the best you can given what I am doing."
- Dominant strategy is special case of Nash equilibrium

Chapter 13

11

## The Nash Equilibrium Revisited

- Two cereal companies face a market in which two new types of cereal can be successfully introduced
- Product Choice Problem
  - Market for one producer of crispy cereal
  - Market for one producer of sweet cereal
  - Noncooperative

Chapter 13

12

## Product Choice Problem

		Firm 2	
		Crispy	Sweet
Firm 1	Crispy	-5, -5	10, 10
	Sweet	10, 10	-5, -5

Chapter 13

13

## Beach Location Game

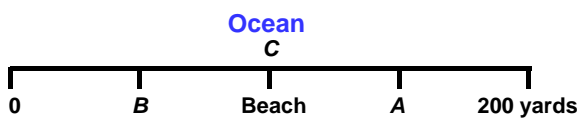
### Scenario

- Two competitors, Y and C, selling soft drinks
- Beach 200 yards long
- Sunbathers are spread evenly along the beach
- Price Y = Price C
- Customer will buy from the closest vendor

Chapter 13

14

## Beach Location Game



- Where will the competitors locate (i.e. where is the Nash equilibrium)?
- Will want to all locate in center of beach.
  - Similar to groups of gas stations, car dealerships, etc.

Chapter 13

15

## The Nash Equilibrium Revisited

### ( ) Strategies - Scenario

- Two firms compete selling file-encryption software
- They both use the same encryption standard (files encrypted by one software can be read by the other - advantage to consumers)
- Firm 1 has a much larger market share than Firm 2
- Both are considering investing in a new encryption standard

Chapter 13

16

## Maximin Strategy

		Firm 2	
		Don't invest	Invest
Firm 1	Don't invest	0, 0	-10, 10
	Invest	-100, 0	20, 10

Chapter 13

17

## Maximin Strategy

### Observations

- Dominant strategy  
Firm 2: Invest
- Firm 1 should expect firm 2 to invest
- Nash equilibrium
  - Firm 1: invest
  - Firm 2: Invest
- This assumes firm 2 understands the game and is rational

		Firm 2	
		Don't invest	Invest
Firm 1	Don't invest	0, 0	-10, 10
	Invest	-100, 0	20, 10

Chapter 13

18

## Maximin Strategy

- Observations
  - If *Firm 2* does not invest, *Firm 1* incurs significant losses
  - *Firm 1* might play don't invest
    - Minimize losses to 10 – maximin strategy

		Firm 2	
		Don't invest	Invest
Firm 1	Don't invest	0, 0	-10, 10
	Invest	-100, 0	20, 10

Chapter 13

19

## Maximin Strategy

- If both are rational and informed
  - Both firms invest
  - Nash equilibrium
- If Player 2 is not rational or completely informed
  - Firm 1's maximin strategy is not to invest
  - Firm 2's dominant strategy is to invest.

Chapter 13

20

## Prisoners' Dilemma

		Prisoner B	
		Confess	Don't Confess
Prisoner A	Confess	-6, -6	0, -10
	Don't Confess	-10, 0	-2, -2

Chapter 13

21

## Sequential Games

- Players move in turn, responding to each other's actions and reactions
  - Ex: Stackelberg model (ch. 12)
  - Responding to a competitor's ad campaign
  - Entry decisions

Chapter 13

22

## Sequential Games

- Going back to the product choice problem
  - Two new (sweet, crispy) cereals
  - Successful only if each firm produces one cereal
  - Sweet will sell better

Chapter 13

23

- If firms both announce their decision independently and simultaneously, they will both pick sweet cereal and both will lose money
- What if firm 1 sped up production and introduced new cereal first
  - Now there is a sequential game
  - Firm 1 thinks about what firm 2 will do

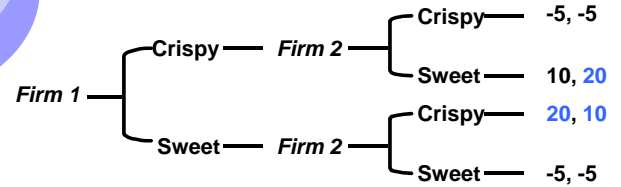
Chapter 13

24

## Extensive Form of a Game

- Extensive Form of a Game
  - Representation of possible moves in a game in the form of a decision tree

## Product Choice Game in Extensive Form



## Sequential Games

- The Advantage of Moving First
  - In this product-choice game, there is a clear advantage to moving first.
  - The first firm can choose a large level of output thereby forcing second firm to choose a small level.

## Threats, Commitments, and Credibility

- How To Make the First Move
  - Demonstrate Commitment
  - Firm 1 must do more than announcing that they will produce sweet cereal
    - Invest in expensive advertising campaign
    - Buy large order of sugar and send invoice to firm 2

## Threats, Commitments, and Credibility

- Empty Threats
  - If a firm will be worse off if it charges a low price, the threat of a low price is not credible in the eyes of the competitors.
  - When firms know the payoffs of each others actions, firms cannot make threats the other firm knows they will not follow.
  - In our example, firm 1 will always charge high price and firm 2 knows it

## Pricing of Computers (Firm 1) and Word Processors (Firm 2)

		Firm 2	
		High Price	Low Price
Firm 1	High Price	100, 80	80, 100
	Low Price	20, 0	10, 20

## Threats, Commitments, and Credibility

- Sometimes firms can make credible threats
- Scenario
  - Race Car Motors, Inc. (RCM) produces cars
  - Far Out Engines (FOE) produces specialty car engines and sells most of them to RCM
  - Sequential game with RCM as the leader
  - FOE has no power to threaten to build big cars since RCM controls output.

Chapter 13

31

## Production Choice Problem

		Race Car Motors	
		Small cars	Big cars
Far Out Engines	Small engines	3, 6	3, 0
	Big engines	1, 1	8, 3

Chapter 13

32

## Threats, Commitments, and Credibility

- RCM does best by producing small cars
- RCM knows that Far Out will then produce small engines
- Far Out prefers to make big engines
- Can Far Out induce Race Car to produce big cars instead?

Chapter 13

33

## Threats, Commitments, and Credibility

- Suppose Far Out threatens to produce big engines no matter what RCM does
  - Not credible since once RCM announces they are producing small cars, FO will not have incentive to carry out threat.
  - Can FOE make threat credible by altering pay off matrix by constraining its own choices?
    - Shutting down or destroying some small engine production capacity?

Chapter 13

34

## Modified Production Choice Problem

		Race Car Motors	
		Small cars	Big cars
Far Out Engines	Small engines	0, 6	0, 0
	Big engines	1, 1	8, 3

Chapter 13

35

## Role of Reputation

- If Far Out gets the reputation of being irrational
  - They threaten to produce large engines no matter what Race Car does
- Threat might be credible because irrational people don't always make profit maximizing decisions
- A party thought to be crazy can lead to a significant advantage

Chapter 13

36

## Wal-Mart Stores' Preemptive Investment Strategy

- How did Wal-Mart become the largest retailer in the U.S. when many established retail chains were closing their doors?
  - Gained monopoly power by opening in small town with no threat of other discount competition
  - Preemptive game with Nash equilibrium

Chapter 13

37

## The Discount Store Preemption Game

		<i>Company X</i>	
		Enter	Don't enter
<i>Wal-Mart</i>	Enter	-10, -10	20, 0
	Don't enter	0, 20	0, 0

Chapter 13

38

## The Discount Store Preemption Game

- Two Nash equilibrium
  - Low left
  - Upper right
- Must be preemptive to win

		<i>Company X</i>	
		Enter	Don't enter
<i>Wal-Mart</i>	Enter	-10, -10	20, 0
	Don't enter	0, 20	0, 0

Chapter 13

39

## Entry Deterrence

- Barriers to entry is important for monopoly power
  - Economies of scale, patents and licenses, access to critical inputs
  - Firms can also deter entry
- To deter entry, the incumbent firm must convince any potential competitor that entry will be unprofitable.

Chapter 13

40

## Entry Possibilities

		<i>Potential Entrant</i> (\$80 fixed costs)	
		Enter	Stay out
<i>Incumbent</i>	High Price (accommodation)	100, 20	200, 0
	Low Price (warfare)	70, -10	130, 0

Chapter 13

41

## Entry Deterrence

- Scenario
  - If X does not enter I makes a profit of \$200 million.
  - If X enters and charges a high price I earns a profit of \$100 million and X earns \$20 million.
  - If X enters and charges a low price I earns a profit of \$70 million and X earns \$-10 million.

Chapter 13

42

## Entry Deterrence

- Could threaten X with warfare if X enters market?
  - Not credible because once X has entered, it is in your best interest to accommodate and maintain high price.

## Entry Deterrence

- What if I make an investment of 50 to increase capacity before X enters?
  - Irreversible commitment
- Gives new payoff matrix since profits will be reduced by investment
- Threat is completely credible
- Rational for firm X to stay out of market

## Entry Deterrence

		<i>Potential Entrant</i>	
		Enter	Stay out
<i>Incumbent</i>	High price (accommodation)	100-50, 20	200-50, 0
	Low Price (warfare)	70, -10	130, 0

## Entry Deterrence

- If incumbent has reputation of price cutting competitors even at loss, then threat will be credible.
- Short run losses may be offset by long run gains as monopolist

## Entry Deterrence

- Production of commercial airlines exhibit significant economies of scale
- Airbus and Boeing considering new aircraft
- Suppose not economical for both firms to produce the new aircraft

## Development of a New Aircraft

		<i>Airbus</i>	
		Produce	Don't produce
<i>Boeing</i>	Produce	-10, -10	100, 0
	Don't produce	0, 120	0, 0



## Development of a New Aircraft

- Boeing has head start
- Boeing will produce
- Airbus will not produce

		<i>Airbus</i>	
		Produce	Don't produce
<i>Boeing</i>	Produce	-10, -10	100, 0
	Don't produce	0, 120	0, 0

Chapter 13

49

## Development of a New Aircraft

- Governments can change outcome of game
- European government agrees to subsidize Airbus before Boeing decides to produce
- With Airbus being subsidized, the payoff matrix for the two firms would differ significantly.

Chapter 13

50

## Development of a Aircraft After European Subsidy

		<i>Airbus</i>	
		Produce	Don't produce
<i>Boeing</i>	Produce	-10, 10	100, 0
	Don't produce	0, 120	0, 0

Chapter 13

51

## Development of a Aircraft After European Subsidy

- Airbus will produce
- Boeing will not produce

		<i>Airbus</i>	
		Produce	Don't produce
<i>Boeing</i>	Produce	-10, 10	100, 0
	Don't produce	0, 120	0, 0

Chapter 13

52