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Lecture 13

Game Theory – part II

microeconomics II
first module

Notes

- Last ***homework*** available soon
- Not yet available info for the ***exam***
- Don't miss ***Friday's lecture***

BMW vs. Benz: product choice problem

- ***BMW*** and ***Mercedes*** each wish to introduce a ***new type*** of vehicle in the market
  - Either a Compact Utility Vehicle (CUV) or
  - A Compact Cabriolet (Cabrio)
- Firms will be better off if they introduce a ***different type*** of vehicle
  - Because the demands in those markets are still small and ***cannot accommodate*** two competing sellers
  - Plus firms need to sell a high quantity to ***reach their MES***
- Decisions are ***non – cooperative***

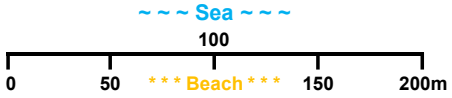
Product choice problem

BMW \ Mercedes	CUV	Cabrio
CUV	-6, -6	12, 10
Cabrio	10, 12	-5, -5

- If BMW ***hears*** that Mercedes is introducing a CUV, its best action is to produce a Cabrio
- Bottom left corner is ***Nash equilibrium***
- What is other Nash Equilibrium?

Beach location game

- Imagine a ***beach*** 200 meters wide
  - Sunbathers are spread ***evenly*** along the beach
  - Two ***vendors***, A and B, selling soft drinks
  - Both charge the ***same price***
  - Customer will buy from the ***closest vendor***
- ***Where*** will the competitors locate?
- Similar to groups of night clubs, car dealerships, etc.



Another scenario

- Two companies compete in the ***smartphone*** market
- They need to decide if they will ***drop the analog*** 3.5mm connector for a digital connector
- New connector does have ***advantages*** but also creates ***disutility*** to users
  - Wired headphones cannot be used as easily
  - Charging and listening is not possible
- Apple has ***more to gain*** by the change than Samsung
  - Samsung has the technology for its phones to be lighter, thinner and waterproof with the old jack, too

Payoffs

		Samsung: Analog (3.5mm)	Samsung: Digital (micro USB)
Apple	Analog (3.5mm)	0, 0	9, 2
	Digital (lightning)	-1, 9	10, 10

- Observations
  - ***Dominant strategy*** for Samsung is 'Digital'
  - ***Apple*** should expect Samsung to go 'digital' soon – so it goes 'digital'
  - ***Nash*** equilibrium: (Digital, Digital)
  - This ***assumes*** that Samsung's CEO has ***the same view*** for the game and is rational

What is the NE in this game?

		Zhanna: Left	Zhanna: Right
Alex	Up	0, 0	1, 1
	Down	1.000.000, 1.000.000	0, 0

- What is the ***outcome*** in this game?
- Outcome (Down, Left) is a ***Focal Point***

Rock – Scissors – Paper

		Player B: Rock	Player B: Scissors	Player B: Paper
Player A	Rock	0 , 0	1 , -1	-1 , 1
	Scissors	-1 , 1	0 , 0	1 , -1
	Paper	1 , -1	-1 , 1	0 , 0

- There is ***no NE*** in pure strategies

  no combination of strategies that some player does not want to ***deviate unilaterally*** from
- Then, what is the ***best strategy (equilibrium)*** for this game?

Mixed strategies

- Sometimes the best strategy is ***not a pure strategy***
- Players have to do ***randomization***

  assign a probability to each strategy and then chose the strategy ***randomly*** based on assigned probabilities
- Randomization results to a ***mixed strategy***

  player makes a ***random choice*** from strategy set based on the optimal combination of probabilities

Mixed strategies NE in R-S-P

- In the R-S-P game the ***NE is in mixed*** strategies

  randomize (or mix) all strategies with probability 1/3
- At the NE, both players will be doing ***the best*** they can ***given*** what their opponent is doing
- If you play any other strategy or mixture, your rival may realize it and ***play accordingly*** to ***take advantage*** of you
- What happens if you play ½ Rock and ½ Scissors?

  your opponent will ***keep playing Rock*** and you will never win!

Some useful facts

1. John Nash proved that ***every static game*** has ***at least one*** NE either in pure or in mixed strategies
2. A game might have ***both pure and mixed*** strategy NE
3. The calculation of the optimal probabilities for the randomization in a mixed strategy NE involves ***optimal response functions***
4. Mixed strategies are usual for games like ***poker*** but ***real firms*** might not find it reasonable to use mixed strategies

Repeated games

- Consider a ***static game*** which is ***repeated*** again and again
- ***Oligopolistic firms*** often play a repeated game
  - they compete for ***more than one periods***
- When games are repeated, ***two important things*** may happen:
  1. Players have a chance for ***retaliation***
  2. Players can develop ***reputations***

Sustainability of non-Nash outcomes

- The firms can decide to ***collude***
  - implement an outcome ***better than the NE*** (but ***not a NE***)
- Collusion is ***not stable***
  - players have an ***incentive to deviate*** (cheat)
- If a player decides to cheat, he can get away with a higher profit ***for that period***
- BUT, starting ***from the next period***, the player who was cheated upon will retaliate by choosing his NE strategy

Pricing problem

		PlayStation	
		Low price	High price
Xbox	Low price	10, 10	100, -50
	High price	-50, 100	50, 50

- NE implies that they ***both set low prices***
- Collusion is ***better*** than NE but there is ***incentive*** for ***cheating***
  - it is ***even better*** for a firm to set a low price while the other firm sets a high price
- Collusion ***may be sustained*** if the game is repeated
  - firms might adopt a ***tit-for-tat strategy***

Tit-for-Tat strategy

- Retaliation is often called ***tit-for-tat*** strategy
  - *I trust you and play the collusive strategy but **if you cheat**, I will be playing my Nash strategy forever*
- The tit-for-tat strategy is a ***trigger strategy***
  - everyone trusts everyone else ***until*** someone… pushes the trigger
- Once the ***trigger is pushed***
  - The cheater loses from ***next period*** (collusion → NE)
  - The fair player loses too but ***does not trust*** the cheater anymore
  - For the fair player the NE is better than to be ***cheated upon***

Indefinite repetition

- What if the game is infinitely repeated?
- Competitors repeatedly set price ***every period***, forever
- ***Tit-for-tat*** strategy makes sense
- If a player ***cheats***:
  - The other player will be playing the ***Nash strategy***, forever
  - The cheater will get high profits ***for that period*** but from the ***next one*** will be getting much less
- The threat of retaliation is ***credible***

Finite repetition

- What if the game is repeated a ***known finite number*** of times?
- Lets take things ***from the end***
  - In the last period there is ***no possibility of retaliation***, thus, everyone will cheat
  - Yes, but if everyone cheats in the last period, there is ***no fear of retaliation*** to the second to last period
  - So, there is ***no possibility of retaliation*** for any period
- The ***threat*** of retaliation is ***not credible***
  - collusion is ***not sustainable***

Cooperation in repeated games

- Cooperation is ***at best difficult***
  - ***Conditions may change*** in the long-run
  - Need a ***small number*** of firms
  - Need ***stable demand*** and ***cost*** conditions
- Sometimes, a firm might have a ***legitimate reason*** to lower price and avoid to do it

  fear that such action may be ***misunderstood*** and push ***accidentally*** the trigger

Sequential games

- In sequential games players ***move in turns***, responding to each other's actions and reactions
  - Ex: ***Stackelberg*** model
  - Responding to a competitor's ***ad campaign***
  - ***Entry*** decisions

BMW vs. Benz – revisited

		Mercedes: CUV	Mercedes: Cabrio
BMW	CUV	-6, -6	12, 10
BMW	Cabrio	10, 12	-5, -5

- If both firms announce their decisions ***independently*** and ***simultaneously***, they may ***both lose money***
- What if Mercedes ***sped up*** production and introduced a new model ***first***?
  - Now there is a ***sequential game***
  - BMW will have to ***produce the opposite*** of what Mercedes produced

Extensive form

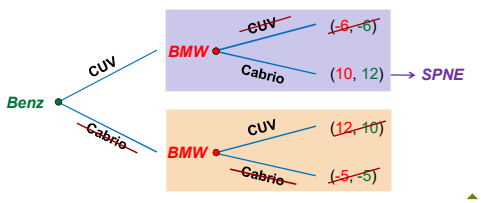
		Mercedes: CUV	Mercedes: Cabrio
BMW	CUV	-6, -6	12, 10
BMW	Cabrio	10, 12	-5, -5

- The above bi-matrix ***does not depict*** the game with clarity anymore
- We have to represent possible moves in the ***extensive form*** of a ***decision tree***

  we can ***work backward*** from the best outcome for BMW

Decision tree

		Mercedes: CUV	Mercedes: Cabrio
BMW	CUV	-6, -6	12, 10
BMW	Cabrio	10, 12	-5, -5



Sub-game Perfect NE

- In the previous product-choice game we ***split*** the game into sub-games
- Then we found the NE in ***every*** sub-game
- ***Sub-game Perfect NE*** (SPNE): A combination of strategies which is a NE ***in every subsequent sub-game*** that includes this combination
- We will use the SPNE as the ***basic*** equilibrium ***notion*** in dynamic games

The first-mover advantage

- In the previous product-choice game, there is a clear ***advantage to moving first***
- In ***quantity competing oligopoly*** there is the ***same*** advantage
  - The firm which goes first can choose a ***large level of output***, thereby ***forcing the second firm*** to choose a small level
  - ***Compare*** Cournot vs. Stackelberg

Thank you!

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WARNING!

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