Coordination
協調賽局

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Why is Coordination Important?

- Which Equilibrium to Select Among Many?
  - This requires Coordination!
- Examples of Coordination in Daily Life:
  - Language
  - Trading in Markets (Liquidity)
  - Industry Concentration

Why is Coordination Important?

- Equilibrium Selection in Game Theory
- Desirable Features:
  - Payoff-Dominance, Risk Dominance, etc.
- Convergence via Adaptation / Learning
  - Weibull (1995), Fudenberg and Levine (1998)
- Empirical: Infer "Selection Principles" by putting people in experiments and observe actual behavior/outcome

Why is Coordination Important?

- Possible "Selection Principles" :
  - Precedent, focal, culture understanding, etc.
- Why are observations useful?
- Schelling (1960, p.164):
  - One cannot, without empirical evidence, deduce what understandings can be perceived in a nonzero-sum game of maneuver any more than one can prove, by purely formal deduction, that a particular joke is bound to be funny."

Why is Coordination Important?

- Can't Communication Solve This?
- Not always... (See Battle of Sexes below)
- Sometimes communication is not feasible:
  - Avoiding Traffic Jams
  - Speed Limits (useful because they reduce speed "variance", and hence, enhance coordination!)
- Miscommunication can have big inefficiency!

Examples of Coordination Impact

- The standard width of US railroad tracks is 4 feet and 8.5 inch Because English wagons were about 5 feet (width of two horses)
  - Space Shuttle rockets are smaller than ideal since they need to be shipped back by train...
- Industries are concentrated in small areas
  - Silicon Valley, Hollywood, Hsinchu Science Park
- Urban Gentrification – I want to live where others (like me) live

Examples of Coordination Impact

- Drive on the Left (or Right) side of the road
  - Right: Asia, Europe (Same continent!)
  - Left: Japan, UK, Hong Kong (all islands!)
  - Sweden switched from left to right around 1900 (and at 12pm noon time!)
- What about America?
  - Right: to avoid hitting someone with the whip on your right hand
- Bolivians switch to Left in mountainous area

3 Types of Coordination Games

- Matching Games
  - Pure Coordination Game
- Games with Asymmetric Payoffs
  - Battle of Sexes, Market Entry Game
- Games with Asymmetric Equilibria
  - Stag Hunt, Weak-Link Game
- Applications: Market Adoption and Culture

Examples of Coordination Impact

- Categorizing Products
  - Where should you find Narnia? Family or Action?
  - Can you find your favorite grocery at a new store?
- Common Language: Internet promotes English
  - Some Koreans even get surgery to loosen their tongues, hoping to improve their pronunciation
- Key: Agreeing on something is better than not; but some coordinated choices are better.

Matching Game

- GAMES magazine (1989)
- Pick one celebrity for President, one for Vice-President
- One person is randomly awarded prize among those who picked most popular one
- 林書豪、陳偉殷、林飛帆、陳為廷、謝金燕、黃國昌、魏德聖、雞排妹、王炳忠、張安樂
- Prize?

Matching Game

- US Results:
- Bill Cosby (1489): successful TV show
- Lee Iacocca (1155): possible US candidate
- Pee-Wee Herman (656): successful TV show
- Oprah Winfrey (437): successful TV show
- ...
- Shirley MacLaine (196): self-proclaimed reincarnate

Pure Coordination Game

	A	B
A	1,1	0,0
B	0,0	1,1

- Both get 1 if pick the same; both get 0 if not
- Two pure NE, one mixed NE
- Which one will be played empirically?

Matching Game

- Mehta, Starmer and Sugden (AER 1994)
- Picking Condition (P): Just pick a strategy
- Coordinating Condition (C): Win \$1 if your partner picks the same as you do
- Difference between P and C = How focal
- Choices: Years, Flowers, Dates, Numbers, Colors, Boy's name, Gender, etc.

Matching Game

Category	Group P		Group C	
	Response	%	Response	%
Years	1971	8.0	1990	61.1
Flowers	Rose	35.2	Rose	66.7
Dates	Dec. 25	5.7	Dec. 25	44.4
Numbers	7	11.4	1	40.0
Colors	Blue	38.6	Red	58.9
Boy's Name	John	9.1	John	50.0
Gender	Him	53.4	Him	84.4

Asymmetric Players: Battle of Sexes

	1	2
1	0, 0	200, 600
2	600, 200	0, 0

- 100 lottery tickets = 10% chance to win \$1/\$2
- Pure NE: (1,2) and (2,1)
  - Players prefer equilibrium where they play strategy 2
- Mixed NE: (1/4, 3/4) each
- Which would you pick?

Asymmetric Players: Battle of Sexes

- Cooper, DeJong, Forsythe & Ross (AER 90')
- BOS: Baseline (MSE mismatch 62.5%)
- BOS-300: Row player has outside option 300
  - Forward induction predicts (2,1)
- BOS-100: Row player has outside option 100
  - Forward induction doesn't apply
- Compare BOS-100 and BOS-300 shows if "any outside option" works...

Battle of Sexes (Last 11 Periods)

Game	Outside	(1,2)	(2,1)	Other	Total Obs
BOS	-	37(22%)	31(19%)	97(59%)	165
BOS-300	33	0(0%)	119(90%)	13(10%)	165
BOS-100	3	5(3%)	102(63%)	55(34%)	165
BOS-1W					165
BOS-2W					165
BOS-SEQ					165

Asymmetric Players: Battle of Sexes

- Cooper, DeJong, Forsythe & Ross (AER 90')
- BOS-1W: 1 way communication by Row
- BOS-2W: 2 way communication by both
- BOS-SEQ: Both know that Row went first, but Column doesn't know what Row did
  - Information set same as simultaneous move
  - Would a sequential move act as an coordination device?

Battle of Sexes (Last 11 Periods)

Game	Outside	(1,2)	(2,1)	Other	Total Obs
BOS	-	37(22%)	31(19%)	97(59%)	165
BOS-300	33	0(0%)	119(90%)	13(10%)	165
BOS-100	3	5(3%)	102(63%)	55(34%)	165
BOS-1W	-	1(1%)	158(96%)	6(4%)	165
BOS-2W	-	49(30%)	47(28%)	69(42%)	165
BOS-SEQ	-	6(4%)	103(62%)	56(34%)	165

Where Does Meaning Come From?

- Communication can help us coordinate
- But how did the common language for communication emerge in the first place?
- Put people in a situation of no meaning and see how they create it!
- Blume, DeJong, Kim & Sprinkle (AER 98')
  - See also BDKS (GEB 2001) which is better!

Evolution of Meaning

	A	B
T1	0,0	7,7
T2	7,7	0,0

- Blume et al. (AER 98')
- Sender has private type T1 or T2
- Sends message "*" or "#" to receiver
- Receiver chooses A or B (to coordinate type)

Evolution of Meaning

- Blume et al. (AER 1998)
- Game 1: Baseline as above
- Game 1NH: See only history of own match

- Game 2: Receiver can choose C (safe action) that gives (4,4) regardless of T1/T2
- Theory: Pooling or Separating Equilibrium

Percentage Consistent with Separating

Game \ Period	1	5	10	15	20
1st Session					
Game 1	48	65	74	89	95
2nd Session					
Game 1	49	72	61	89	100
Game 1NH	55	55	28	55	72
Game 2					
Separating	44	88	88	88	94
Pooling	39	05	00	05	05

Evolution of Meaning

- Blume et al. (AER 1998)
- Game 2: Receiver can choose C (safe action) that gives (4,4) regardless of T1/T2
- Game 3: Coordinate payoffs become (2,7) so sender wants to disguise types to force receiver to choose C (safe action)
- Allowed to send 2 or 3 messages…

Results of Game 3: 2 vs. 3 messages

# of Messages	1-10	11-20	21-30	31-40	41-50	51-60
2-Separating	43	53	38	39		
2-Pooling	33	34	41	43	2nd Session	
3-Separating	43	38	33	24		
3-Pooling	33	37	42	60		
2-Separating	39	27	23	24	24	23
2-Pooling	39	48	51	60	63	61
3-Separating	23	22	23	25	22	24
3-Pooling	55	61	58	56	57	61

1st Session

Example of Asymmetric Payoffs

- Market Entry Game
- n players decide to enter a market with capacity c
- Payoffs declines as number of entrants increase; <0 if number $> c$
- Kahneman (1988): Number close to equil.
  - "To a psychologist, it looks like magic."
- See BI-SAW paper by Chen et al. (2012)...

Market Entry Game Results (Sundali et al. 95')

Market capacity	1	3	5	7	9	11	13	15	17	19
MSE	0	2.1	4.2	6.3	8.4	10.5	12.6	14.7	16.8	18.9
1^{st} block	1.3	5.7	9.7	6.7	3.7	14.0	11.3	11.3	16.0	18.0
all data	1.0	3.7	5.1	7.4	8.7	11.2	12.1	14.1	16.5	18.2

Games with Asymmetric Equilibria

	1	2
1	800, 800	800, 0
2	0, 800	1000, 1000

- Cooper et al. (AER 1990): Stag Hunt
- 100 lottery tickets = 10% chance to win \$1 or \$2
- Pure NE: (1,1) & (2,2)
- Which would you pick?

Games with Asymmetric Equilibria

- Cooper et al. (AER 1990)
- CG: Baseline Stag Hunt
- CG-900: Row has outside option 900 each
  - Forward induction predicts (2,2)
- CG-700: Row has outside option 700 each
  - Forward induction won't work
- CG-1W: 1 way communication by Row
- CG-2W: 2 way communication by both

Stage Hunt (Last 11 Periods)

Game	Outside	(1,1)	(2,2)	Other	Total Obs
CG	-	160(97%)	0(0%)	5(3%)	165
CG-900	65	2(2%)	77(77%)	21(21%)	165
CG-700	20	119(82%)	0(0%)	26(18%)	165
CG-1W	-	26(16%)	88(53%)	51(31%)	165
CG-2W	-	0(0%)	150(91%)	15(9%)	165

Weak-link Game: Team Production Example

- Van Huyck, Battalio and Beil (AER 1990)
- Each of you belong to a team
- Each of you can choose effort X=1-4
  - Spade = 4, Heart = 3, Diamond = 2, Club = 1
- Earnings depend on your own effort and the smallest effort of your team
  - Each person has to do his/her job for the whole team project to fly
- Have you every had such a project team?

Weak-link Game: Team Production Example

- Payoff $= 60 + 10 * \min\{X_j\} - 10 * (X_i - \min\{X_j\})$

Team Project Payoff

Cost of Effort X

Your X	Smallest X in the team			
	4	3	2	1
4	100	80	60	40
3	-	90	70	50
2	-	-	80	60
1	-	-	-	70

Weak-link Game: Team Production Example

- What is your choice when...
- Group size = 2?
- Group size = 3?
- Group size = 20?

- Can some kind of communication help coordinate everyone's effort?