Behavioral Game Theory
行為賽局論

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What is Experimental Economics? 何謂實驗經濟學？

- Science (科學的定義): (Merriam-Webster)
  - "knowledge or a system of knowledge covering general truths or the operation of general laws especially as obtained and tested through scientific method."
  - 用來描述普遍真理或普遍法則如何運行的系統性知識，特別是用科學方法獲得與檢驗的知識
- What is the "Scientific Method"?
- 何謂「科學方法」？

Scientific Methods (Wikipedia) (科學方法)

- "The scientific method seeks to explain the events of nature in a reproducible way, and to use these reproductions to make useful predictions. It is done through
- observation of natural phenomena, and/or through experimentation that tries to simulate natural events under controlled conditions."

What is Experimental Economics? 什麼是實驗經濟學？

- Experimental Economics is a method of economics that seeks "experimentation that tries to simulate natural (economic) events under controlled conditions"
- Other empirical work are "observation of natural (economic) phenomena"

Two Traditions of Experimental Economics 實驗經濟學的兩大傳統

- Two Nobel Laureates of 2002
- Vernon Smith (臥龍・史密斯)
  - Market Experiments
  - Experimental Economics = Economic Science
- Daniel Kahneman (丹尼・卡尼曼)
  - "Psychology and Economics"
  - aka "Behavioral Economics" (see next slide)
- The two traditions interacted and grew…

What is "Behavioral Economics"? 甚麼是「行為經濟學」？

- What does NOT count as "Behavioral" Economics?
  - Isn't "Economics" by definition "Behavioral"?
- What counts as "Non-behavioral Economics"?
  - "Bad" economics?
- Non-behavioral Economics doesn't exist!
  - Though terms like "Experimental Economics" and "Behavioral Game Theory" are fine…

Two Traditions of Experimental Economics 實驗經濟學的兩大傳統

1. Market Experiments/Design (市場實驗/設計)
   - How Adam Smith's "invisible hand" really works
2. Behavioral Game Theory (行為賽局論)
   - What players actually do in games

Like Two Traditions in Economic Theory:

- General Equilibrium Theory (全面均衡理論)
- Game Theory (賽局論)

Outline of Introduction to BGT 行為賽局論簡介大綱

1. What is Game Theory Good For?
2. Three Examples:
   1. Ultimatum Bargaining (最後通牒談判實驗)
   2. Beauty Contests (選美結果猜測實驗)
   3. Continental Divide (產業發展分水嶺實驗)
3. Experimental Regularity and Behavioral Game Theory
4. Conclusion

What is Game Theory? 何謂賽局論？

- Game Theory is about what happens when people---or genes, or nations---interact.
- Game: A taxonomy of strategic situations
  - Strategies (策略), Players (玩家), Payoffs (報酬)
- Important Milestones
  - GEB: Von Neumann & Morgenstern (1944)
  - Nash Equilibrium: Nash (PNAS, 1950)
  - Asymmetric information (資訊不透明) as Types: Harsanyi (MS, 1967-68)

What is Game Theory? 何謂賽局論？

- Power of game theory: generality/precision
- Analytical Game Theory (數學賽局「論」)
  - Mathematical derivations of what players with different cognitive capabilities are likely to do
- Possible Problems
  - Highly mathematical (High entry barrier)
- Bigger Problem
  - Based on introspection and guesses, not observations about how people actually play

What is Behavioral Game Theory? 何謂行為賽局論？

- Von Neumann and Morgenstern (1944):
  - "Our knowledge of the relevant facts of economics is incomparably smaller than that commanded in physics at the time when mathematization of that subject was achieved…"
- "It would have been absurd in physics to expect Kepler and Newton without Tycho Brahe---and there is no reason to hope for an easier development in economics."

What is Game Theory Good For? 賽局論有什麼用？

- Is Game Theory meant to
  - Predict what people do,
  - Explain why people act this ways,
  - Advise people what to do?
- Case: auction theory & real world auctions
  - Auction Theory vs. Experimental Evidence
  - Auction Theory vs. Real world auction design

Three Examples 三個例子

- BGT: *what players actually do*.
  - By utilizing results from hundreds of experiments
1. Ultimatum Bargaining (最後通牒談判實驗)
2. Beauty Contests (選美結果預測實驗)
3. Continental Divide (產業發展分水嶺實驗)

- Goal: Show how BGT can explain what people do more accurately by extending analytical game theory to include social preferences (fairness), limited strategic thinking, & learning.

Example 1: Ultimatum Bargaining 例一：最後通牒談判

- The Environment:
- Two players: Proposer and Respondent
- Action of Proposer: First makes a proposal regarding how to split NT$1000. (100-900, 200-800, 300-700, 400-600, 500-500, etc.)
- Act of Respondent: Accepts or Rejects the proposal.
- Outcome: Split accordingly if respondent accepts, both get nothing if rejects.

Example 1: Ultimatum Bargaining 例一：最後通牒談判

- Photographer vs. Tourist
- AGT Predictions
  - Responders accept any low offer
  - Proposers offer "unfairly"
- Experimental Results
  - Responders reject "unfair" offers
  - Proposers often offer "fairly" (50-50)
- BGT Explanation:
  - Negative Reciprocity (你對我不仁，我就對你不義)

Example 1: Ultimatum Bargaining 例一：最後通牒談判

- Responders don't maximize own earnings
  - Still think strategically (but w/ social preferences)
- Further Investigation:
- Primitive societies under different culture of "fairness" (Ch.2)
- Knoch, …, Fehr, Science 2006
  - TMS someone's DLPFC, and s/he will accept "unfair" offers

Example 2: Beauty Contest 例二：選美結果預測

- Keynes (1936, p. 156), "It is not a case of choosing those which, to the best of one's judgment, are really the prettiest,
- nor even those which average opinion genuinely thinks the prettiest.
- We have reached the third degree, where we devote our intelligences to anticipating what average opinion expects the average opinion to be. And there are some, I believe, who practice the fourth, fifth, and higher degrees."

Example 2: Beauty Contest 例二：選美結果預測

- p-Beauty Contest Game (aka Guessing Game)

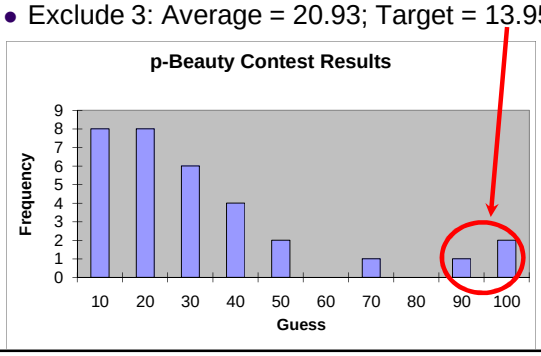
- The Environment: N players
- Action of Player: Each player guesses a number from 0~100
- Outcome: The person whose number is closest to p=2/3 of the average of all guesses wins

Example 2: Beauty Contest
例二：選美結果預測

- Each pick 0-100 to predict 2/3 of the average
- AGT Predictions
  - Unique Nash: Choose 0 (dominant solvable)
- Experimental Results
  - First-round choices around 21-40
  - Converge to 0 within 10 rounds
- BGT Explanations
  - Limited iterated reasoning (level-k; 多層次思考)
  - Learning: Towards equilibrium (學習「到」均衡)

Results from 2008
課堂實驗結果

- Average = 27.75; Target = 18.5
- Exclude 3: Average = 20.93; Target = 13.95



Example 3: Continental Divide
例三：產業發展分水嶺

- Location Problem: Silicon Valley or Hollywood?
- Seven people a group, each choose 1~14
- Payoff dep. on your choice & group median
  - Main part of the payoff matrix in the next slide
- Key Feature:
  - Should pick low if others pick low
  - Should pick high if others pick high
- When everyone is going to China, Hsinchu Science Park, etc. will you follow this trend?

Example 3: Continental Divide
例三：產業發展分水嶺

	3	4	5	6	7	8	9	10	11	12
3	60	66	70	74	72	1	-20	-32	-41	-48
4	58	65	71	77	80	26	8	-2	-9	-14
5	52	60	69	77	83	46	32	25	19	15
6	42	52	62	72	82	62	53	47	43	41
7	28	40	51	64	78	75	69	66	64	63
8	11	23	37	51	69	83	81	80	80	80
9	-11	3	18	35	57	88	89	91	92	94
10	-37	-21	-4	15	40	89	94	98	101	104
11	-66	-49	-31	-9	20	85	94	100	105	110
12	-100	-82	-61	-37	-5	78	91	99	106	112

Example 3: Continental Divide
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7	28	40	51	64	78	75	69	66	64	63
8	11	23	37	51	69	83	81	80	80	80
9	-11	3	18	35	57	88	89	91	92	94
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Example 3: Continental Divide
例三：產業發展分水嶺

- AGT Predictions
  - Multiple Equilibrium: 3 or 12
- Experimental Results
  - Don't always gravitate toward Good Eq.
  - Small history accidents have big LR impact
- BGT Explanation
  - Learning in the "basin of attraction"
  - Initial Conditions: Lucky 7 vs. 8 (一路發)?

Experimental Regularity & BGT
一致的實驗結果vs.行為賽局論

- Goal: *Improve* game theory by establishing regularity and inspiring new theory
- Why has empirical observation played a small role in game theory until recently?
- How others react to data?

1. People are confused, not motivated
2. Experimental designs are all bad
3. People were playing a different game
4. Non-rational behavior can't be modeled

Conclusion 結論

- AGT → Experimental Regularities → BGT
- Three Examples
- Want to see more?
  - Camerer (2003), Behavioral Game Theory…
- HW0:
  - Read BGT, Ch.1 and Lecture notes on Experimental Economics and BGT (both online)
  - Solve the equilibrium of the three examples above (consult an intermediate micro textbook if needed)