

# Experimental Economics

## 實驗經濟學

Joseph Tao-yi Wang (王道一)

### 3 Cores of Economics 經濟學三大核心方法論

- Micro, Macro, Metrics (個體, 總體, 計量)?
  - Because of 1st year course (因為是博一必修)?
- Economic Theory (經濟理論/模型建構)
  - Mathematical/graphical/verbal models
    - (數學模型、圖形模型、嘴砲模型)
- Data Analysis (資料分析/計量方法)
  - Statistical methods, graphs (統計方法、製作圖表)
- Data Collection (資料取得)
  - Surveys, experimental methods, requesting data
    - (問卷調查、實驗方法、索取資料的管道)

# Experimental Economics, Behavioral Game Theory 實驗經濟學與行為賽局論

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Lecture 1, Spring 2015

# What is Experimental Econ? 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.**
  - 科學方法希望用可重複驗證的方式來解釋自然現象，並用此來做有用的預測。達成方式包含**觀察自然發生的現象**，以及**用實驗在控制條件下產生自然發生的現象**。

# What is Experimental Econ? 何謂實驗經濟學?

- Observation (觀察) vs. experimentation (實驗)
- Experimental Economics is a method of economics that seeks “experimentation that tries to simulate natural (economic) events under controlled conditions”
  - 實驗經濟學是經濟學的一種研究方法，目的是要「用實驗在控制條件下產生自然發生的現象」
- Other empirical work are “observation of natural (economic) phenomena”
  - 其他實證方法則是「觀察自然發生的經濟現象」

# Two Traditions of EE (實驗經濟學兩大傳統)

- Two Nobel Laureates of 2002 (兩位諾獎得主)
- **Vernon Smith** (臥龍·史密斯)
  - Market Experiments (市場實驗)
  - Experimental Economics = Economic Science
    - (實驗經濟學 = (唯一的)經濟科學)
- **Daniel Kahneman** (丹尼·卡尼曼)
  - “Psychology and Economics”
  - aka “Behavioral Economics” (see next slide)
    - 結合心理學與經濟學(又稱「行為經濟學」)
- The two traditions interacted and grew...
  - 兩大傳統互相影響、一起成長...

# What is Behavioral Econ? 何謂「行為經濟學」

- Isn't **Economics** by definition **Behavioral**?
  - 經濟學的目的不就是要解釋人類的行為嗎?
- What is “Non-behavioral Economics”?
  - (到底甚麼算是「非行為經濟學」嗎?)
  - “Bad” economics? 那應該叫「不好的經濟學」!
- **Non-behavioral Economics doesn't exist!**
  - (「非行為經濟學」有定義上的矛盾!)
  - Though **Experimental Economics** and **Behavioral Game Theory** are fine...
    - 「實驗經濟學」與「行為賽局論」沒問題?!



# Two Traditions of EE (實驗經濟學兩大傳統)

## 1. Market Experiments/Design (市場實驗/設計)

- How Adam Smith's **invisible hand** really works
  - (在實際市場中「看不見的手」如何運作)

## 2. Behavioral Game Theory (行為賽局論)

- What players actually do in games
  - (在賽局中真實的人如何做決定)

## Like the Two Traditions in Economic Theory

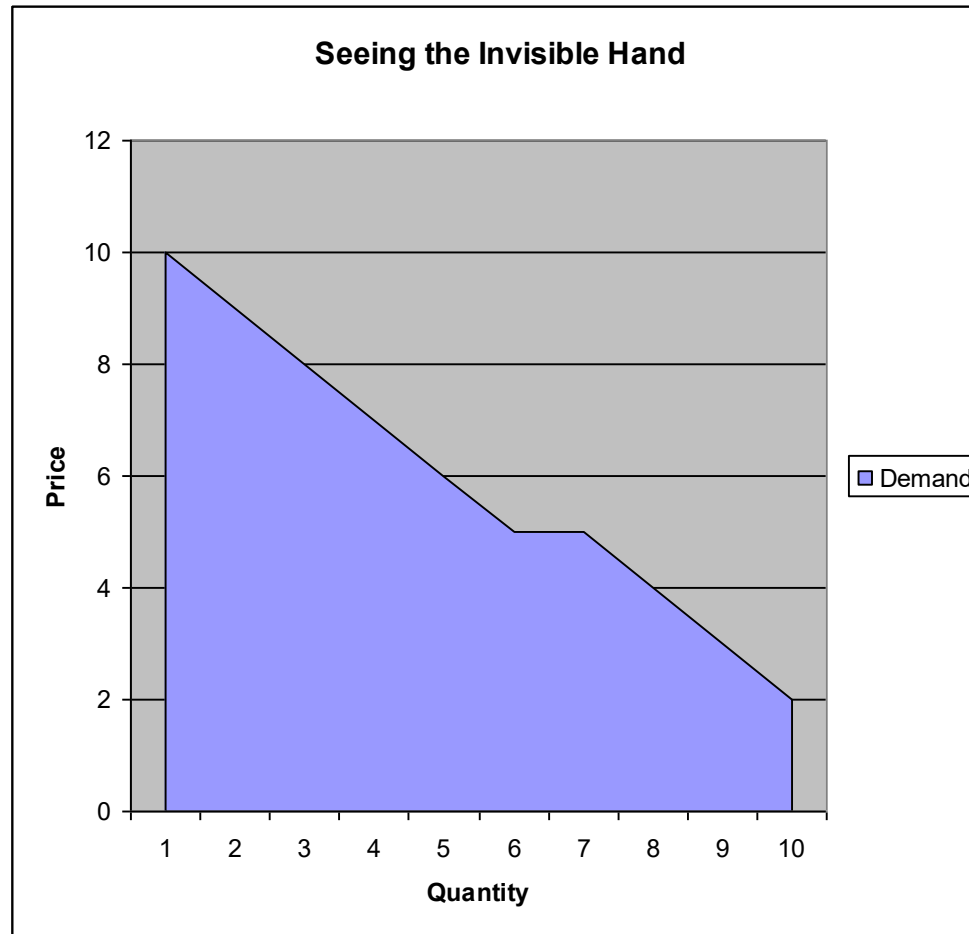
- (正如經濟理論兩大傳統):
  - General Equilibrium Theory (全面均衡理論)
  - Game Theory (賽局論)

# Market Experiments and Market Design

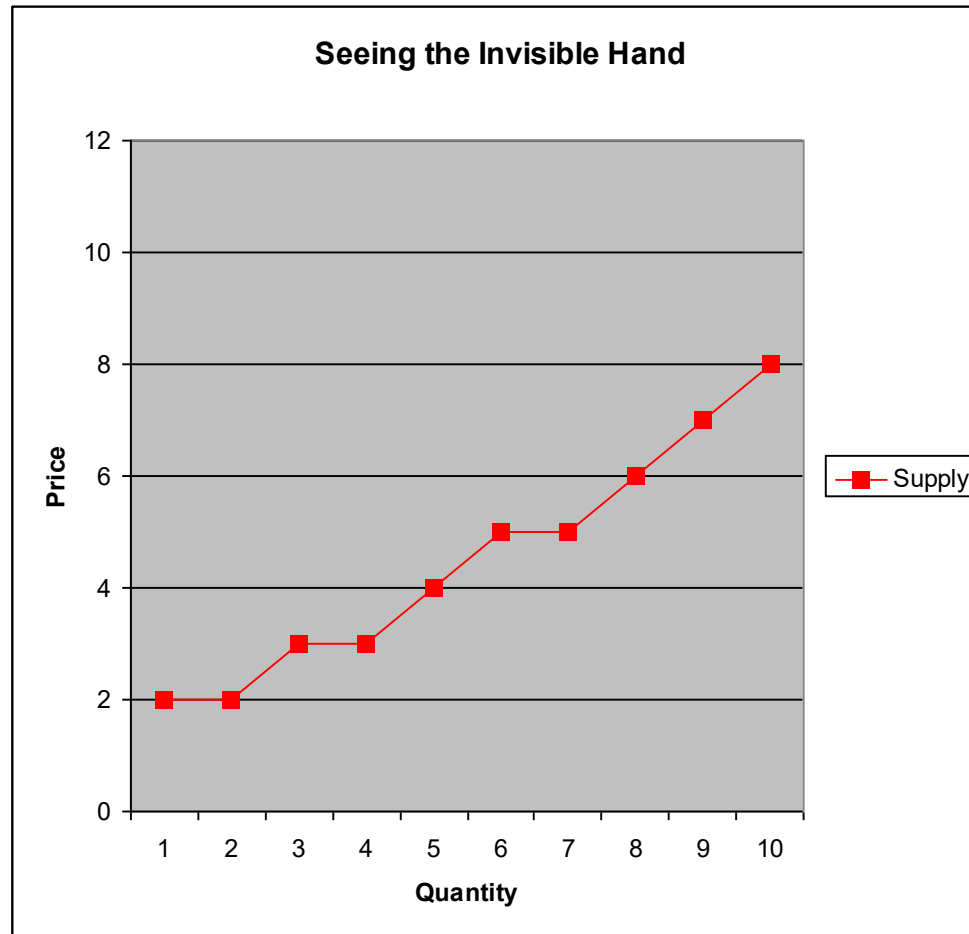
## – 市場實驗與市場設計

- **The Pit Market** (交易坑市場)
  - Chamberlin (JPE, 1948) 張伯倫
  - Smith (JPE, 1962) 臥龍·史密斯
- **Experiment: Seeing the Invisible Hand**
  - (課堂實驗：發現看不見的手)
  - Ran in Principles of Microeconomics Class
    - (在大一經濟學原理有做過)
  - See instructions (請見實驗說明)

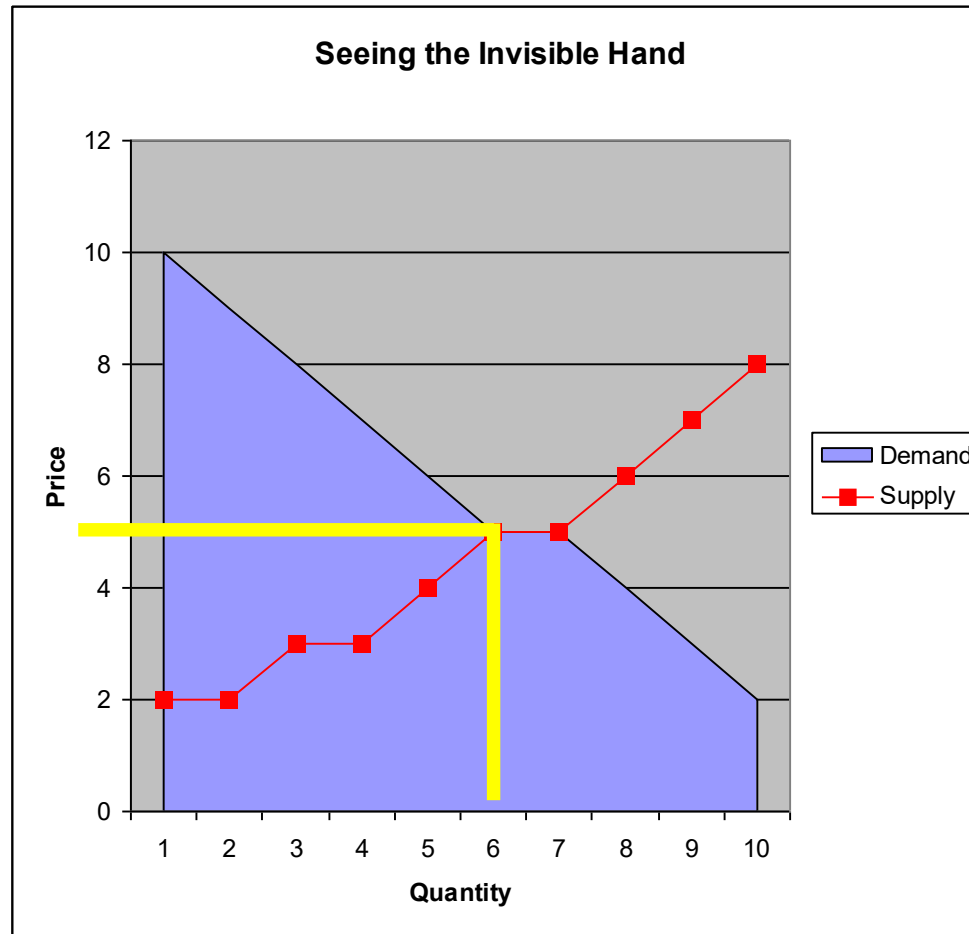
# Seeing the Invisible Hand (發現看不見的手)



# Seeing the Invisible Hand (發現看不見的手)



# Seeing the Invisible Hand (發現看不見的手)



# Seeing the Invisible Hand (發現看不見的手)

- Prices (成交價格)
  - 07F Economics I 經濟學一
- Pit Market (交易坑市場)
  - A: 6, 6, 6, 8, 5, 6, 6
  - B: 5, 5, 4, 6, 6, 6, 7
- Double Auction (雙邊喊價市場)
  - A: 5, 5, 5, 5, 5
  - B: 5, 5, 6, 6, 6
  - C: 4, 5, 5, 6, 5, 5

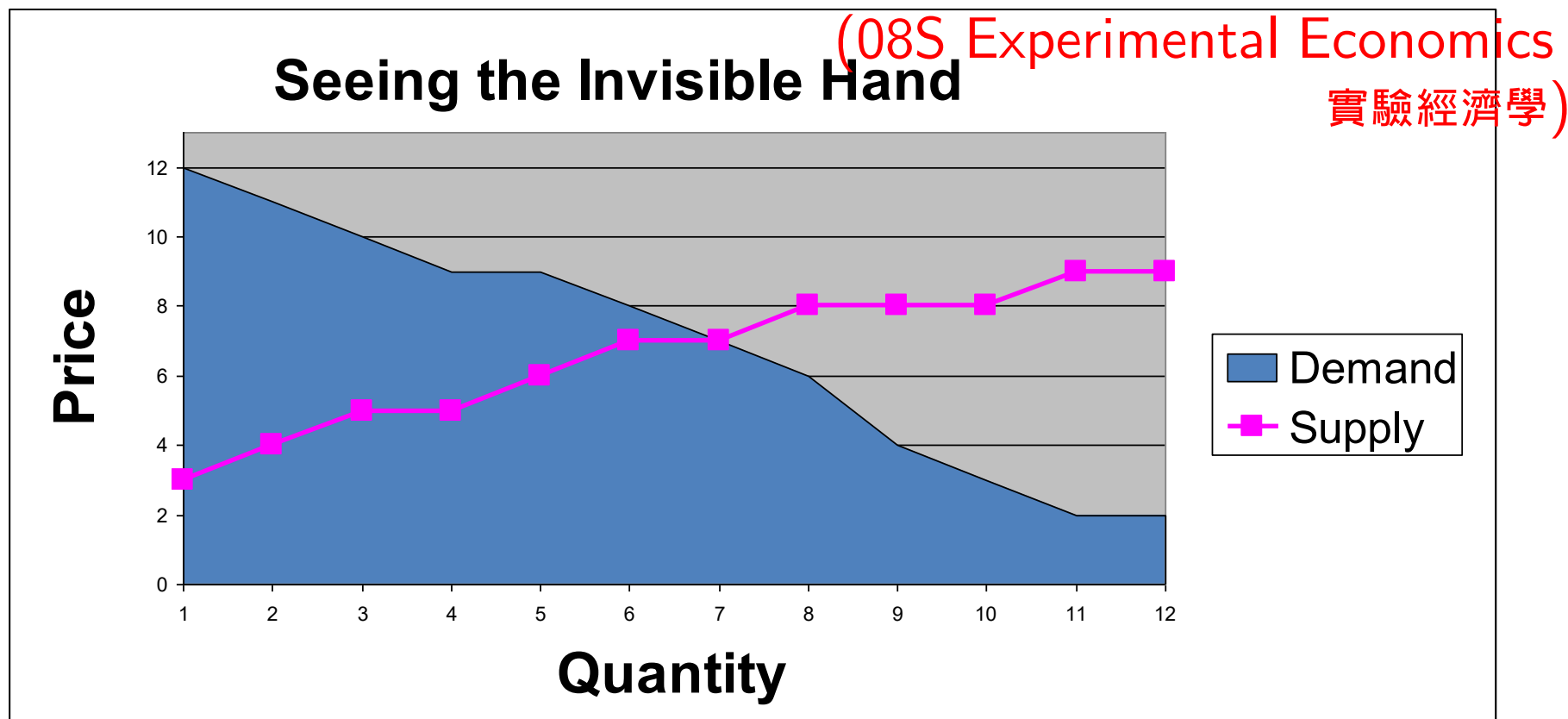


# Seeing the Invisible Hand (發現看不見的手)

回合		價 格	買方利潤	賣方利潤
交易坑1	平均值	6.1	1	2
	變異數	0.8	5.3	2.7
交易坑2	平均值	5.6	1.6	2.1
	變異數	1.0	1.3	1.5
雙邊 喊價1	平均值	5	3	2.2
	變異數	0	2.5	0.7
雙邊 喊價2	平均值	5.6	2.4	2.2
	變異數	0.3	2.8	1.2
雙邊 喊價3	平均值	5	2.5	1.8
	變異數	0.4	2.3	0.6

# Seeing the Invisible Hand (發現看不見的手)

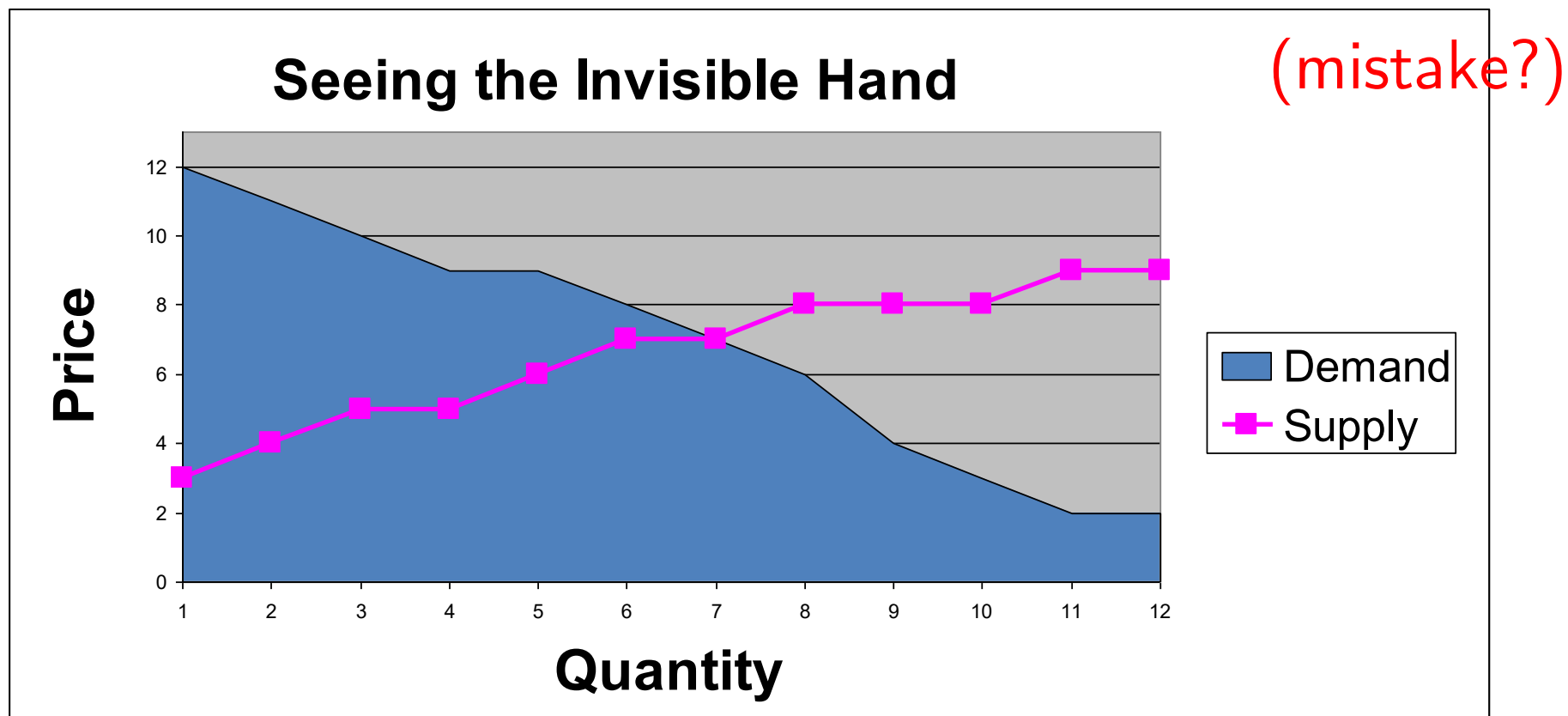
- Pit Market (交易坑市場) 1: 5, 6, 5, 3, 8, 8, 8
- Pit Market (交易坑市場) 2: 6, 4, 8, 4, 6, 7, 7, 7, 5





# Seeing the Invisible Hand (發現看不見的手)

- Double Auction (雙邊喊價市場) 1: 6, 10, 7, 7, 7, 8, 8, 7
- Double Auction (雙邊喊價市場) 2: 7, 6, 6, 6, 6, 7, 7, 7



# Market Design: Nobel Prize of 2012

– 市場設計：2012年瑞典央行紀念諾貝爾經濟科學獎得主

- **Lloyd S. Shapley** (夏普利)
  - Gale-Shapley algorithm finds stable matching in matching markets (提出演算法求配對分發市場的穩定解)
- **Alvin E. Roth** (AER!) (艾文·羅斯)
  - Test this in the lab (在「實驗室」中驗證夏普利的理論)
  - Take this to the field (在「現場」設計穩定配對分發制度)
  - Medical Residents, School Choice, Kidney Exchange... (實習醫生、學校分發、器官交換市場等等)

# Behavioral Game Theory 行為賽局論(大綱)

## 1. What is Game Theory Good for?

– (賽局論有甚麼用?)

## 2. Three Examples (三個例子):

1. Ultimatum Bargaining (最後通牒談判實驗)
2. Continental Divide (產業發展分水嶺實驗)
3. Beauty Contests (選美結果猜測實驗)

## 3. Experimental Regularity and Behavioral Game Theory (一致的實驗結果與行為賽局論)

## 4. Conclusion (結論)

# What is Game Theory? 何謂賽局論?

- Game Theory: What happens if people or nations interact. (賽局論研究「人們」互動的結果)
- Game (賽局): Taxonomy of strategic situations
  - 需要籌思對策的各種情境
  - Strategies (策略), Players (參與者), Payoffs (報酬)
- Important Milestones (重要里程碑)
  - **GEB**: Von Neumann & Morgenstern (1944)
  - **Nash Equilibrium** (奈許均衡): Nash (PNAS, 1950)
  - **Asymmetric information as Types** (把資訊不透明看作每個人有不同類型): Harsanyi (MS, 1967-68)

# What is Game Theory? 何謂賽局論?

- Power of game theory: Generality/precision
  - 賽局論能廣泛應用在不同的領域，也能做精確的預測
- Analytical Game Theory (數學賽局「論」)
  - Mathematical derivations of what players with different cognitive capabilities are likely to do
    - 用數學分析不同聰明程度的玩家在不同的賽局採取何種對策
- Possible Barrier: Highly mathematical
- Bigger Problem (可能的問題是需要很多數學，但更大的問題是)
  - Based on introspection and guesses, not observations about how people actually play
    - 根據數學家的自我想像與猜測，而非人們實際上怎麼做

# What is Behavioral Game Theory?

- 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...”
  - 「跟物理學(在三百年前)數理化的時候相比，目前我們對於跟經濟學相關的事實和實證結果真的知道太少了！ .....

# What is Behavioral Game Theory?

- Von Neumann and Morgenstern (1944):
- “It would have been absurd in physics to expect Kepler and Newton without Tycho Brahe---and...
  - 「在物理學上，要是沒有泰谷的天文觀測紀錄，刻卜勒和牛頓不可能寫出行星運動定律。.....
- “...there is no reason to hope for an easier development in economics.”
  - 「.....同樣地，如果沒有足夠資料，經濟學如何有同樣的發展？當然不可能！」

# What is Game Theory Good For? 賽局有啥用?

- Is Game Theory meant to 賽局論可以
  - **Predict** what people do, (預測人們的行為)
  - **Explain** why people act this ways, (解釋人們的行為)
  - **Advise** people what to do? (建議人們該怎麼做)
- Case (實例): auction theory & real world auctions
  - Auction Theory (拍賣理論)  
vs. Experimental Evidence (實驗結果)
  - Auction Theory (拍賣理論)  
vs. Real World Auction Design (拍賣制度設計)



# Three Examples 三個例子

- BGT: what players actually do
  - (行為賽局論：人們實際怎麼做)
  - By utilizing results from hundreds of experiments 根據上百個「爾虞我詐」的實驗結果
    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)

# Three Examples 三個例子

- Goal: Show how BGT can
- explain what people do more accurately
- by **extending** game theory to include:
  - **social preferences (fairness)**,
  - **limited strategic thinking**, and
  - **learning**.
    - 目的：說明行為賽局論如何更準確預測人們的行為，把**社會(公平)偏好**、**有限理性思考**和**學習過程**引入數學賽局論。

# 例一：最後通牒談判(Ultimatum Bargaining)

- **2 players (參與者):** Proposer (下通牒的提議者) and Respondent (回應者)
- **Action of Proposer (提議如何瓜分新台幣100元):**  
First makes a proposal on how to split \$100: 10-90, 20-80, 30-70, 40-60, 50-50,...
- **Act of Respondent (回應接受或拒絕):**  
Accepts or Rejects the proposal.
- **Outcome (結果):** Split accordingly if accept, both get nothing if reject.
  - (接受則按該提議瓜分100元; 拒絕則兩人什麼都沒有)

# 例一：最後通牒談判(Ultimatum Bargaining)

- Photographer vs. Tourist (觀光景點攝影師兜售照片)
- **AGT Predictions** (數學賽局論的預測)
  - Responders accept any low offer (回應者通通接受)
  - Proposers offer **unfairly** (提議者提出極不公平方案)
- **Experimental Results** (實驗結果)
  - Responders reject **unfair** offers (回應者拒絕不公平方案)
  - Proposers often offer **fairly** (50-50) (提議合理方案)
- **BGT Explanation:** (行為賽局論的解釋)
  - Negative Reciprocity (你對我不仁，我就對你不義)

# 例一：最後通牒談判(Ultimatum Bargaining)

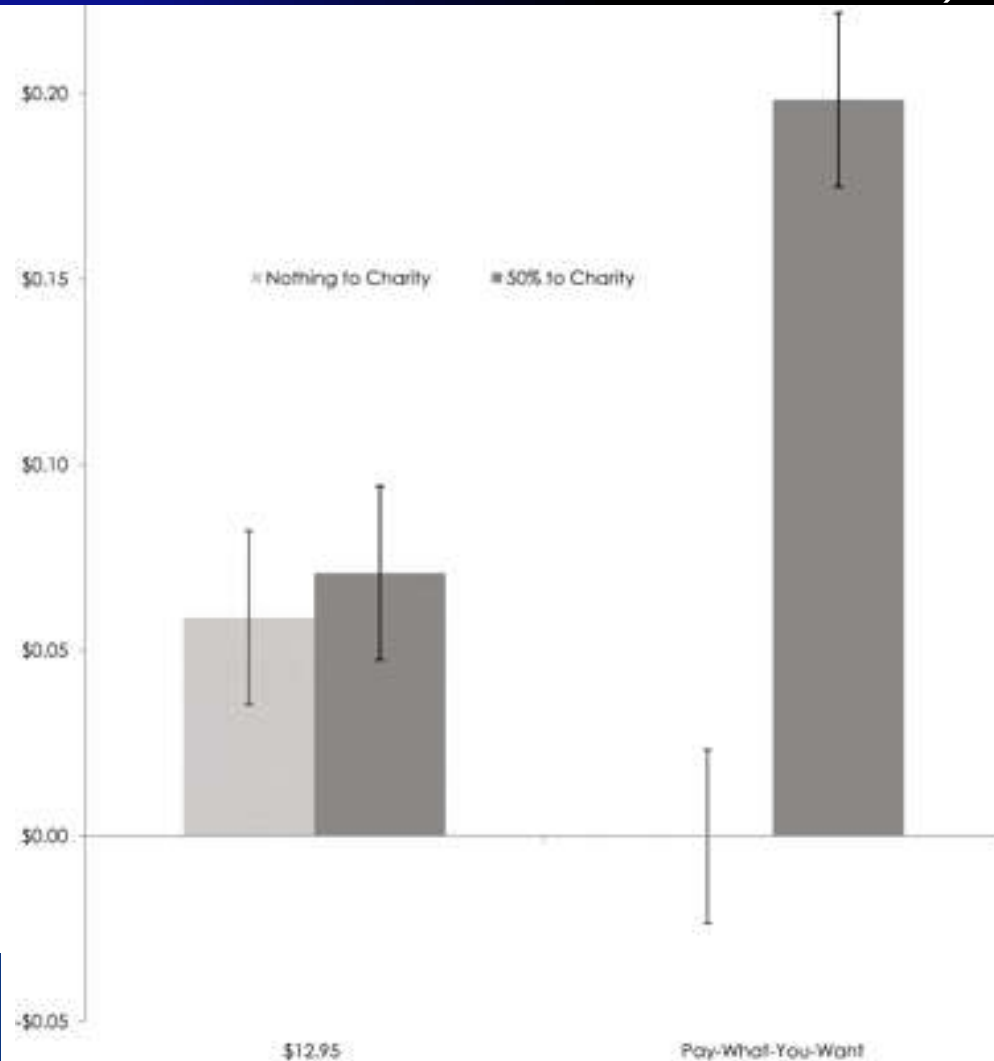
- Responders do not maximize own earnings
  - (回應者並非追求自己「物質上」的報酬最大)
  - Still think strategically (w/ social preferences)
    - 但仍是理性思考，只是有社會偏好、厭惡不公平
- Further Investigation (延伸研究): BGT, Ch.2
- Primitive societies under different culture of **fairness** (不同原始部落有不同的公平文化)
- Knoch, ..., Fehr, Science 2006
  - TMS your DLPFC to accept **unfair** offers
    - 用穿顱刺激DLPFC腦區能讓人接受不公平方案

# Disneyland Photo Field Experiment 還真的有!

- Gneezy et al. (2010), “Shared Social Responsibility: A Field Experiment in **Pay-What-You-Want** Pricing and **Charitable Giving**,” *Science* 329 (5989): 325–327.
  - Change pricing scheme of photo taken at a Disneyland ride (on different days)
- Fixed US\$12.95 vs. Pay-What-You-Want
- Nothing to Charity vs. 50% to Charity\*

# Fig.1 Profit per rider (amount paid minus production costs)

- Problem: This is profit only because Disney did not really donate more money to charity!
- Instead reduced regular donations by the same amount!
- Likely to change results if disclosed...



## 例二：選美結果預測賽局(p-Beauty Contest)

- Newspaper shows 6 pictures
- Choose one picture and win a prize if
  - you chose the **most chosen** picture
  - 凱因斯認為股票市場就像報紙預測選美結果：
- “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**.
  - 「這不是要挑每個人 **各自認為最漂亮的**[臉蛋],
  - 更不是要挑 **大家公認最漂亮的**。



## 例二：選美結果預測賽局(p-Beauty Contest)

- We have reached the third degree, where we devote our intelligences to
- anticipating what average opinion expects the average opinion to be.
  - 我們已經想到第三層去，
  - 努力預測一般人心目中認為大家公認最漂亮的會是誰。
- And there are some, I believe, who practice the fourth, fifth, and higher degrees.”
  - 而且我相信有些人還可以想到第四層、第五層或更高。」
- Keynes (1936, p.156)

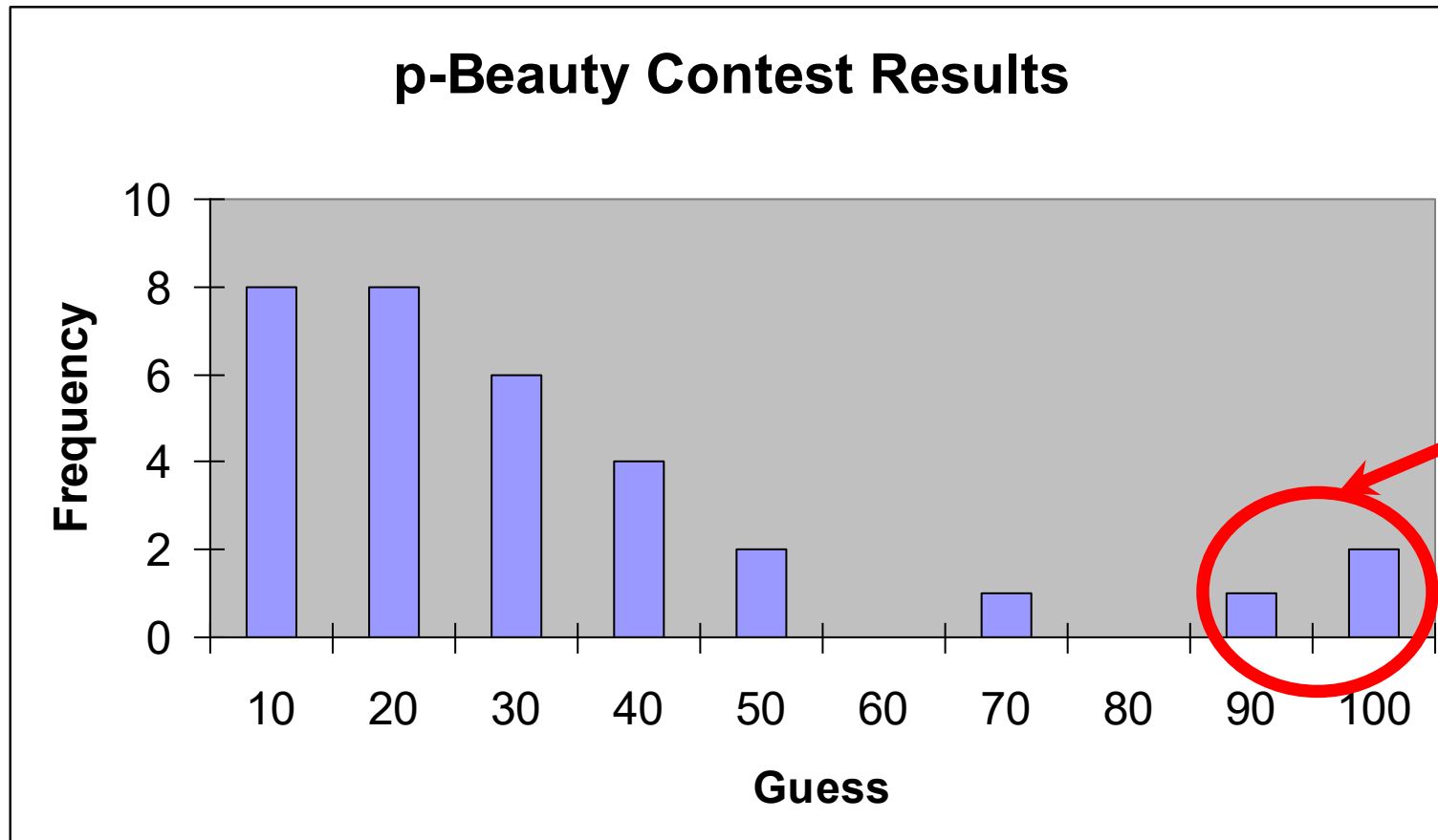
## 例二：選美結果預測賽局(p-Beauty Contest)

- p-Beauty Contest (Guessing Game)
  - 選美結果預測賽局，又稱「猜測(平均的三分之二)賽局」
- **Environment (遊戲規則):** N players (參與者)
- **Action of Player (參與者的策略):** Each player guess a number from 0-100
  - 每一位參與者都猜一個0-100數字
- **Outcome (結果):** Number closest to  $p=2/3$  of the average wins
  - 所猜數字最接近所有猜測數字的平均乘 $p=2/3$ 的人就是贏家

## 例二：選美結果預測賽局(p-Beauty Contest)

- Each pick 0-100 to predict  $\frac{2}{3}$  of the average
- **AGT Predictions** (數學賽局論的預測)
  - Unique Nash: Choose 0 (dominant solvable)
    - 不斷地刪除劣勢策略可解出唯一的Nash均衡(大家都選0)
- **Experimental Results** (實驗結果)
  - First-round choices (首次平均) around 21-40
  - Converge to 0 within 10 rounds (十回合內到均衡)
- **BGT Explanation:** (行為賽局論的解釋)
  - 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 obs.  
Average  
= 20.93  
Target  
= 13.95

## 例三：產業發展分水嶺 (Continental Divide)

- Location Problem: Silicon Valley or Hollywood?
- 7 a group, each choose 1-14 (一組七人, 各選1-14)
- Payoff based on **your choice & group median**
  - 你的報酬取決於**你的數字**和**所有人的中位數**(報酬矩陣見下表)
- Key Feature: (別人選小你也該選小、別人選大你也該選大)
  - 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 the trend?
  - 當大家都在竹科(或東莞?)設廠, 你會獨排眾議, 還是隨波逐流?

# 例三：產業發展分水嶺 (Continental Divide)

	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

# 例三：產業發展分水嶺 (Continental Divide)

	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	90	106	112

## 例三：產業發展分水嶺 (Continental Divide)

- **AGT Predictions** (數學賽局論的預測)
  - Multiple Equilibrium (兩個均衡): 3 or 12
- **Experimental Results** (實驗結果)
  - Don't always gravitate toward Good Eq.
  - Small history accidents have big LR impact
  - 重複多次不見得會到較好的均衡、歷史的偶然對長期發展有重大影響
- **BGT Explanation** (行為賽局論的解釋)
  - Learning in the **basin of attraction**
  - Initial Conditions: Lucky 7 vs. 8 (一路發)?
  - 在「引力範圍」內被牽引, 初始條件: Lucky 7 vs. 8 (一路發)



# Experimental Regularity 有一致的結果，然後？

- **Goal:** Improve game theory by establishing regularity and inspiring new theory
  - **目的:** 改進賽局論(而非推翻), 用一致的結果激發新理論
- **Why has empirical observation played a small role in game theory until recently?**
  - **為何實證觀察直到最近才對賽局論有影響?**
- John Nash did experiments at RAND
  - 奈許本人其實有嘗試跟蘭德智庫一起做賽局實驗, 但是...
- “Unbelievable” PD results?!
  - 沒有進一步發展是因為囚犯兩難的實驗結果「難以置信」?

# Experimental Regularity 有一致的結果，然後？

- How others react to (experimental) data?
  - 關於實驗方法的反對意見：
    1. People are confused, not motivated
      - 人們搞錯了、沒誘因？好的實驗設計可克服、讓決策有真實後果
    2. Experimental designs are all bad
      - 實驗設計都很糟？民主政治是最糟的政治制度，但其他更不可行
    3. People were playing a different game
      - 人們其實在做別的？也許是「美麗人生」，但as-if 模型都如此
    4. Non-rational behavior cannot be modeled
      - 非理性就是亂選？但非理性行為仍可預測(Predictably Irrational)

# Conclusion 結論

- AGT → Experimental Regularities → BGT
  - 數學賽局論 → 看到一致的實驗結果 → 行為賽局論
- Three Examples (三個例子)
- Want to see more? (更多請見)
  - Camerer (2003), Behavioral Game Theory
- Homework:
  - Read BGT, Ch.1 and Lecture notes (both online)
  - Solve the equilibrium of the 3 examples above
  - 你能解出上述三個例子的均衡嗎？翻翻大二個經課本吧！