

# Basic Principles of Experimental Design

## 經濟學實驗設計原理

Joseph Tao-yi Wang (王道一)  
Lecture 2c, EE-BGT

# Define Economic Experiment (定義經濟學實驗)

- ▶ **An Economic Experiment**
- ▶ Constructs a **controlled environment** to
- ▶ observe how **people make economic decisions** under **real incentives**, to answer
- ▶ questions raised by the researcher, testing a hypothesis or which theory matches reality
- ▶ 建構一個控制的環境，在有真實誘因的情況下，觀察人們如何做決定（經濟決策），為要回答研究者所提出的問題，檢驗哪個假說或理論比較符合現實。

# 4 Components of Controlled Environments

- ▶ 經濟學實驗：建構一個控制的環境，在有真實誘因的情況下，觀察人們如何做決定（經濟決策），為要回答研究者所提出的問題，檢驗哪個假說或理論比較符合現實。
- ▶ **4 Components:** (建構控制的環境有4個要素)
  1. Real Incentives:
    - ▶ Choices have real consequences (真實後果或誘因)
  2. A Good Control Group (對照組的設計)
  3. Random Assignment (隨機分組)
  4. No deception (完全不欺騙受試者)

# Principles of Experimental Design (實驗設計原理)

1. Control, Measure, or Assume (控制, 測量或假設)
2. Instructions (實驗說明)
3. Anonymity (匿名性)
4. Matching Protocols & Reputation Building (配對方式與受試者信譽)
5. Incentives (金錢誘因)
6. Order Effects (不同實驗的先後次序)
7. Controlling Risk Tastes (控制風險偏好)
8. Within-Subject and Between-Subject Design (同一 vs. 不同受試者)
9. Experimentetrics (實驗計量)
10. No Deception (不欺騙受試者)

▶ Reference: BGT, A1.2

# Control, Measure or Assume (控制/測量/假設)

- ▶ **Control** (控制)
  - ▶ Taking an action to affect a variable's value (主動賦予該變因的參數值)
  - ▶ "Induced" value theory (賦予參數理論)
- ▶ **Measurement** (測量)
  - ▶ Measure the value of a variable (測量該變因的參數值)
  - ▶ Via various methods (see below) (用下頁所列不同方法)
- ▶ **Assumption** (假設)
  - ▶ Pseudo-control (直接假設該變因的參數值)
  - ▶ Accept a maintain hypothesis about the value of a variable

# Control, Measure or Assume (控制/測量/假設)

- ▶ **Methods of Measurement:** (測量方法)
- ▶ Psychometric measures (surveys) (心理測驗/問卷)
- ▶ Risk-aversion measures (certainty equiv) (風險偏好)
- ▶ Probability judgments (scoring rules) (主觀機率判斷)
- ▶ Information acquisition (mouse/eye-tracking)
  - ▶ 資訊取得：滑鼠追蹤或眼球追蹤
- ▶ Psychophysiological measures (測量心理生理學上的反應)
  - ▶ fMRI(功能性磁振造影)/GSR(皮膚電阻反應)/PDR(瞳孔放大反應)/EEG(頭皮腦電波),...

# Experimental Instructions (實驗說明)

- ▶ Tell subjects what they need to know (告知所需資訊)
- ▶ **Public Knowledge: (公共知識)** (來自公開朗讀說明)
  - ▶ Established by reading instructions out loud
- ▶ How much to reveal? (要告訴受試者多少?)
  - ▶ Entire payoff structure (default) (完整告知報酬如何決定)
  - ▶ Not sure what subjects think about what they are not told (不知道他們會怎麼解讀未揭露的資訊)
- ▶ **Withhold some information:** (不告知某些資訊: 用以研究人們或市場如何在有有限資訊下學習探索)
  - ▶ Study how people/markets learn under limited information

# Anonymity (匿名性)

- ▶ Who's Who? Subject behavior can change knowing opponent's identity due to (見面三分情?受試者的行為會因為知道對方是誰而改變, 因為長相外貌、性別、害怕被報復等等)
  - ▶ Appearance, gender, Fear of retaliation, etc.
- ▶ Use the anonymity case as a benchmark
  - (因此, 我們通常用匿名實驗來當作基準實驗)
- ▶ Measure opponent characteristics (appearance) and compare to benchmark
  - ▶ 要研究這些變因時, 可以測量對方特質(例如長相多好看), 同時把它們顯示給受試者看, 然後把實驗結果和基準實驗作比較



# Matching Protocol/Reputation (配對方式/信譽)

- ▶ **Random matching** (random switch) (隨機配對:每回合重新洗牌)
  - ▶ Empirically kills repeated game effects (實證上可除去重複賽局效果)
- ▶ **Mean-matching** (play with everyone once) (與所有人配對:跟其他每個人各配對一次)
  - ▶ More strict matching protocols: (更嚴格配對方式)
- ▶ **Non-repeat matching** (meet only once) (不重複配對: 整個實驗中只跟每個對手配對一次)
  - ▶  $2^n$  Subjects match  $2^n-1$  Rounds ( $2^n$ 人能做 $2^n-1$ 回合不重複配對)
- ▶ **Non-contagion matching** (no chain-of-influence)
  - ▶ No matching with “AB->BC->AC” (不污染配對: 整場沒有「我跟你配、你再跟他配, 最後我遇到他」的情形)

# Incentives (真實誘因)

- ▶ Hypothetical vs. Real Money Decisions (假設性問題 vs. 「玩真的」)
  - ▶ Difference between economic and psychological experiments (經濟學實驗和心理學實驗一大分野)
- ▶ Assumption behind money payments: (使用金錢報酬所需行為假設)  
"Everybody likes having more money and nobody gets tired of having more of it." (每個人都喜歡獲得更多金錢，而且多多益善/沒有人會覺得拿太多)
- ▶ Cost of deviation without real money is 0 (只是假設性問題的話，亂講亂選沒有成本)
- ▶ Paying money reduces variation & outliers (故金錢報酬會降低亂選的噪音，減少極端的特例)

# Incentives (真實誘因)

- ▶ Pay Less vs. Pay More (付得少/多是否影響結果?)
  - ▶ Comparison studies not done often enough (這種比較的實驗還不夠多)
  - ▶ Expensive to double/triple the payments (因為把報酬加倍很貴)
- ▶ Some experiments done in poor countries (不過仍有些實驗會特別到貧窮的國家去做)
  - ▶ Vietnam (越南：試字率高、人民卻很窮、鮮少遷徙)
  - ▶ Few results that disconfirm theory have been overturned by paying more money (這些少數重複實驗結果顯示：如果原本的實驗結果不支持理論預測，多付錢也大概不會讓實驗結果變得合乎理論的預測)

# Incentives (真實誘因)

- ▶ **Flat Maximum Critique** (值得想得更深入嗎? 還是作什麼都沒差?!)
  - ▶ Is it worthwhile (high stakes) to think hard? (重賞之下必有勇夫, 沒勇夫表示賞金不夠?)
  - ▶ EX: Costless to deviate from  $(1/3, 1/3, 1/3)$  in rock-paper-scissors (例如:「剪刀石頭布」不按照均衡策略 $(1/3, 1/3, 1/3)$ 來做沒有損失, 因為不管出什麼報酬都相同)
- ▶ **No ideal solution yet...** (尚未有很好的解決辦法, 不過...)
  - ▶ Design steep marginal incentives (可以設計得讓「邊際誘因」很高)
  - ▶ Modest effect on high stakes anyway (高獎金對結果的影響雖不是0, 但也沒那麼大)

# Order Effects (不同實驗的先後次序)

- ▶ AB: A came first; B came second (AB即「先做實驗A, 再做實驗B」)
  - ▶ Is this why we see different behavior?
    - ▶ 行為的改變是否只是因為先後次序不同?
- ▶ Try BA and include order dummies in analysis
  - ▶ 必須也做BA(次序反過來), 然後在資料分析的時候加上次序的虛擬變數來檢驗是否有影響
- ▶ What if ABC? (有ABC怎麼辦?)
- ▶ ACB/BAC/BCA/CBA/CAB or simplify design
  - ▶ 做ACB/BAC/BCA/CBA/CAB或簡化實驗設計

# Control Risk Preferences (控制風險偏好)

- ▶ **Binary Lottery Procedure:** (發樂透彩券當報酬)
  - ▶ Widely used to **control** risk preferences, but not much evidence that it works (控制風險偏好的常用辦法，但沒太多證據顯示有效，且需假設人們能把複合樂透簡化為簡單樂透)
  - ▶ Alternatives: (其他辦法)
- ▶ **Assume** risk neutrality (假設受試者是風險中立)
- ▶ **Measure** risk preferences (測量風險偏好)
  - ▶ Holt and Laury (2002) or Tanaka et al. (2010)
  - ▶ Choi et al. (2007); Andreoni and Sprenger (2012)
  - ▶ DOSE: Wang et al. (wp)

# Within-Subject vs. Between-Subject (比較同一/不同受試者的設計)

## ▶ **Within-Subject Design** (「比較同一受試者」的設計)

- ▶ Same subject observed in various treatments (觀察同一受試者在不同實驗環境中的反應)
- ▶ Pro: More statistically powerful (優點: 統計上解釋力強) (可做paired t-test)
- ▶ Con: Possible demand effect (缺點: 可能有「要求效果」)

## ▶ **Between-Subject Design** (「比較不同受試者」的設計)

- ▶ Different subjects observed in each treatment (觀察不同受試者在各自的實驗環境中的反應)
- ▶ Norm in experimental economics (實驗經濟學的「標準做法」)
- ▶ Con: “Impossible” for fMRI or eyetracking (很難做fMRI/眼動實驗)

# Experimetrics (實驗計量)

- ▶ Econometrics customized for experiments, just like
  - ▶ Econometrics is statistics customized for economics
    - ▶ 特別為實驗開發的計量方法，正如計量是為經濟學開發的統計方法
- ▶ **Bottom Line: Use all tool feasible to get the most out of your (experimental) data** (充分利用所有可能的計量工具來分析實驗資料)
- ▶ Experimental Design and Experimetrics sometimes look like substitutes, but they actually
- ▶ **Complement** each other in a good paper! (實驗設計和實驗計量有時可以互相替代，因為有好的設計，簡單敘述統計可能就夠了。但兩者相輔相成能產生最好的論文)



## List of Experiments (實驗計量方法列表)

- ▶ Mann-Whitney-Wilcoxon Test(s) vs. T-test
  - ▶ Non-parametric test similar to (un-)paired t-test
- ▶ Regression (with Random Effects)
- ▶ Maximum Likelihood Estimations (最大概似估計)
  - ▶ Level-k, Cognitive Hierarchy, Quantal Response Equilibrium
  - ▶ Learning (學習理論): EWA, Reinforcement (手滑反應均衡)
  - ▶ Simulate (模擬) and Estimate (估計)
- ▶ Out-of-sample Predictions (預測新的資料)
- ▶ Markov-switching (Eyetracking), SPM (fMRI)

# No Deception (不欺騙受試者)

- ▶ Economists do not deceive their subjects
  - ▶ (實驗經濟學家從不欺騙他們的受試者)
- ▶ Economists do not deceive their subjects
  - ▶ (實驗經濟學家從不欺騙他們的受試者)
- ▶ Economists do not deceive their subjects
  - ▶ (實驗經濟學家從不欺騙他們的受試者)
- ▶ This creates credibility (「徙木立信」)
  - ▶ Makes monetary payments “real” (因而相信真的有金錢報酬)

# No Deception (不欺騙受試者)

- ▶ And avoids anticipation/strategic responses
  - ▶ Differs from psychologists (who use debriefing)
    - ▶ 避免預期會被騙時的鬥智反應 (心理學家只要事後說明即可)
- ▶ Can achieve most goals with better design
  - ▶ Except to study the effect of deception (Really?)
    - ▶ 所謂「需要欺騙的實驗」大多能設計另一個「不需欺騙的實驗」來達到同樣目的 (除了研究人們被實驗者欺騙時的反應)
- ▶ Let subjects act as experimenters (to see...)
  - ▶ 真有人設計實驗讓受試者扮演實驗者的角色(來看被騙時...)

## Conclusion: The Gold Standards (設計十誡)

1. Control, Measure, or Assume (控制, 測量或假設)
2. Instructions (實驗說明)
3. Anonymity (匿名性)
4. Matching Protocols & Reputation Building (配對方式與受試者信譽)
5. Incentives (金錢誘因)
6. Order Effects (不同實驗的先後次序)
7. Controlling Risk Tastes (控制風險偏好)
8. Within-Subject and Between-Subject Design (同一 vs. 不同受試者)
9. Experimentetrics (實驗計量)
10. No Deception (不欺騙受試者)

▶ Reference: BGT, A1.2