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

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Lecture 1, EE-BGT

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)?

1. Methods of 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)
2. Methods for Data Analysis (資料分析/計量方法)
   - Statistical methods, graphs (統計方法、製作圖表)
3. Methods for 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)

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.
  - 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 Economics?

□ 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」

Experimental Economics: Two Traditions

- 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?!

Experimental Economics: Two Traditions

- 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 strategic interactions
     - (在賽局中真實的人如何做決定)

Parallel to Two Traditions in Economic Theory:

- (正如經濟理論兩大傳統):

1. General Equilibrium Theory (一般均衡理論)
2. Game Theory (賽局論)

Market Experiments and Market Design

□ 市場實驗與市場設計

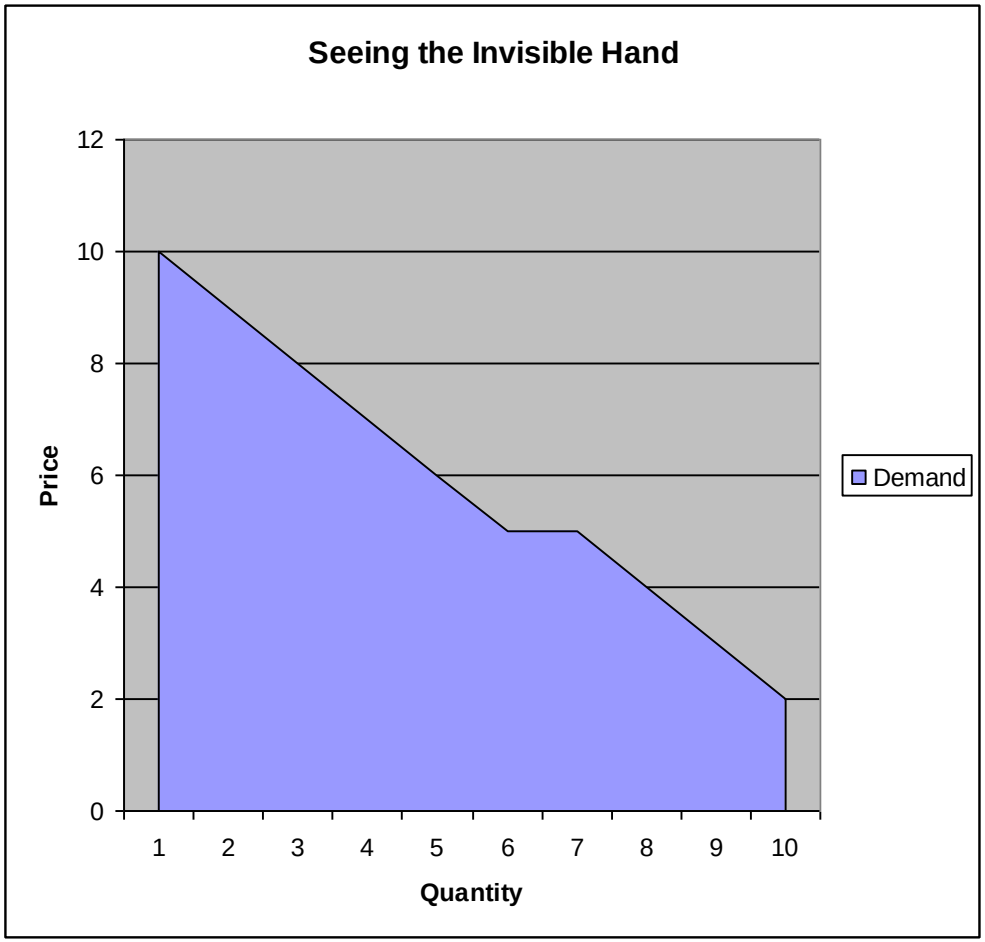
- The Pit Market (交易坑市場)
  - Chamberlin (JPE, 1948) 張伯倫
  - Smith (JPE, 1962) 臥龍・史密斯
- Experiment: Seeing the Invisible Hand
  - (課堂實驗：發現看不見的手)
  - Ran in Principles of Microeconomics Class
    - (在大一經濟學原理有做過)
  - See instructions (請見實驗說明)

Market Design: Nobel Prize of 2012

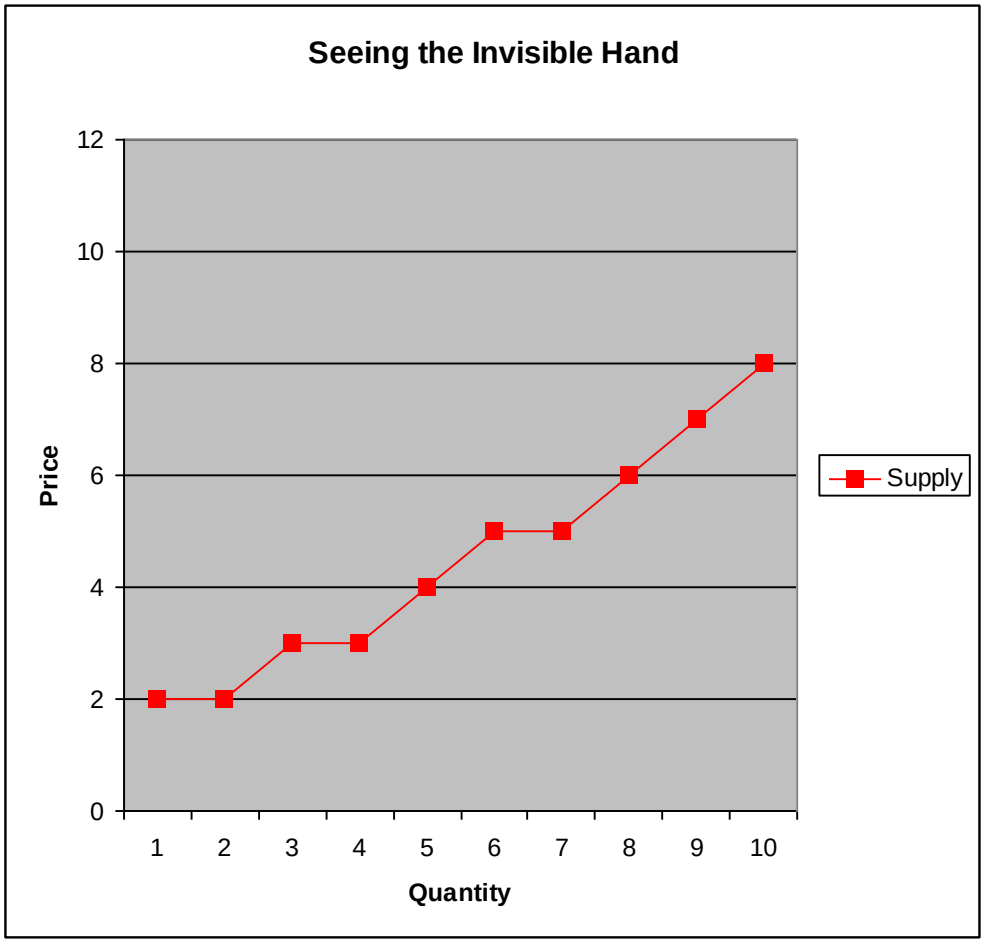
□ 市場設計：2012年瑞典央行紀念諾貝爾經濟科學獎得主

- 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)

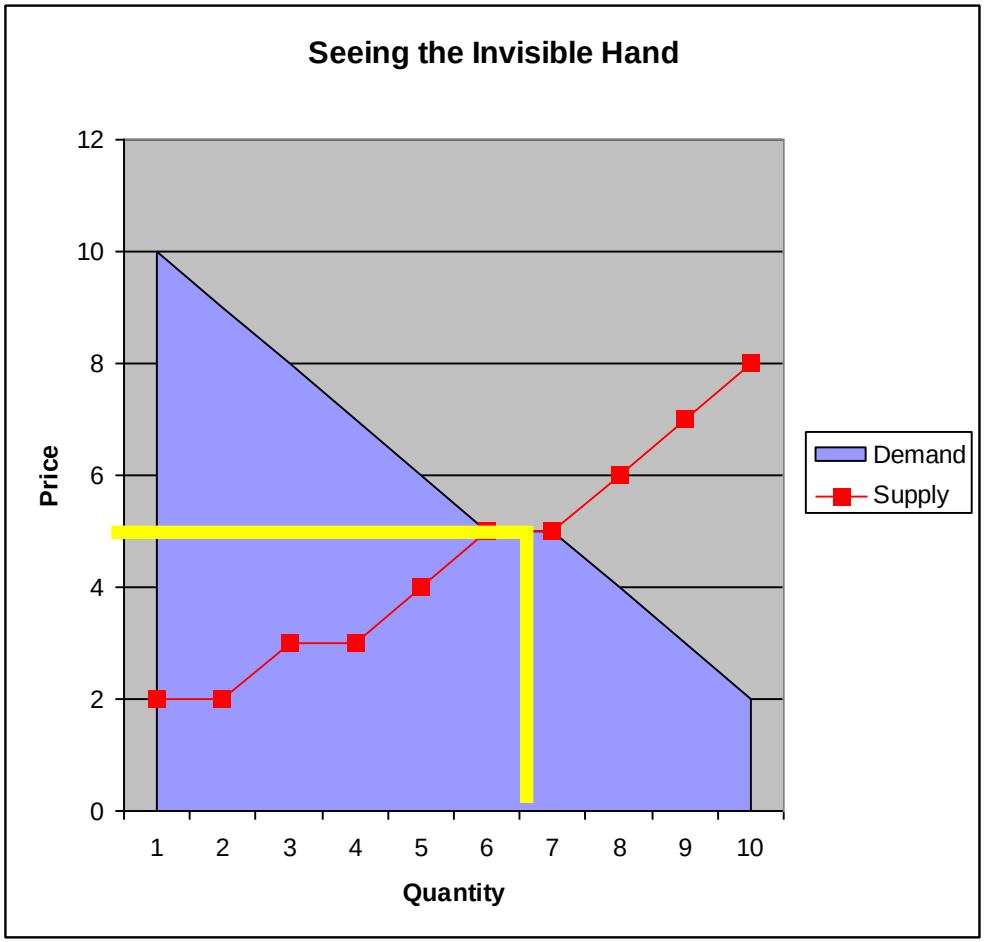
Seeing the Invisible Hand (發現看不見的手)



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

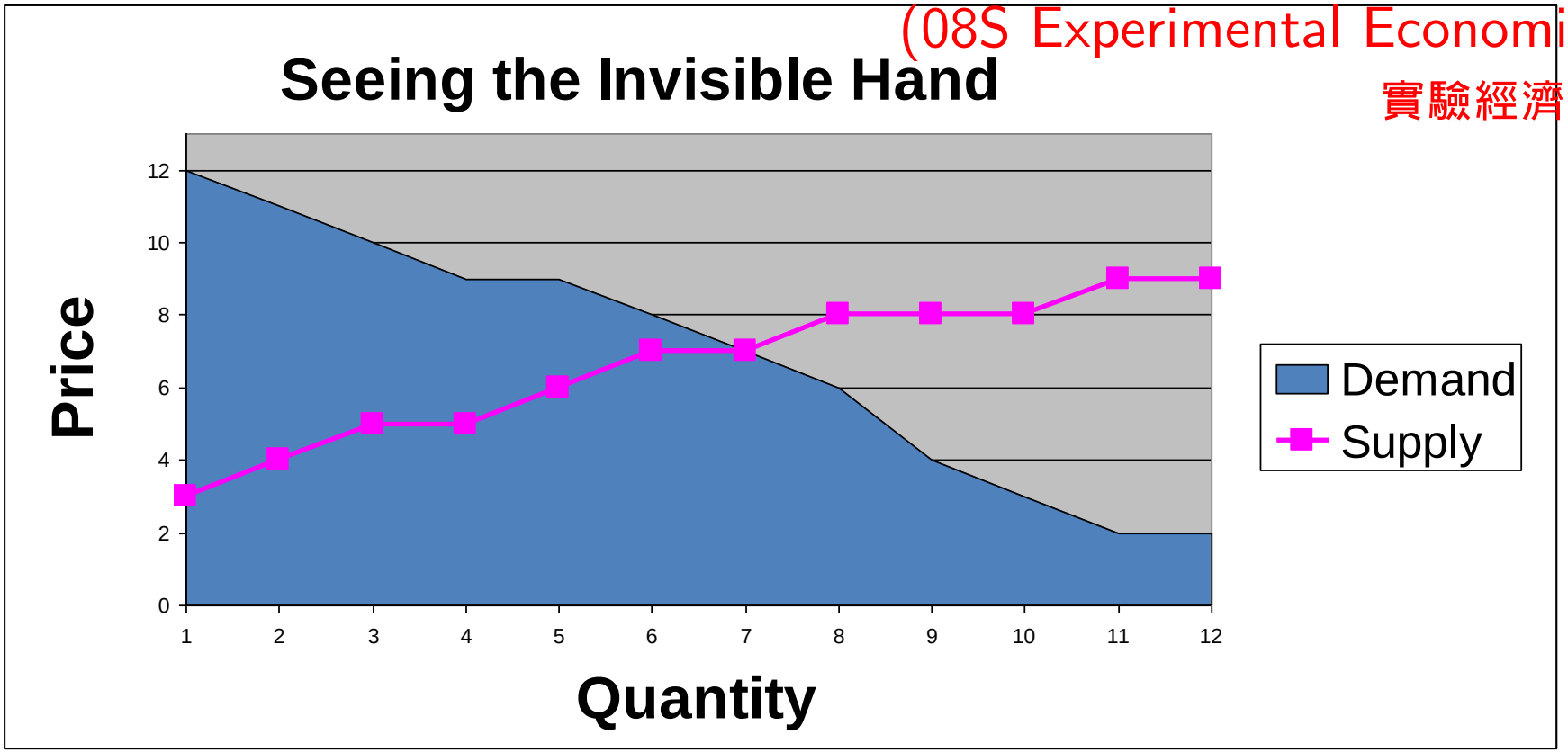
Seeing the Invisible Hand (發現看不見的手)

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

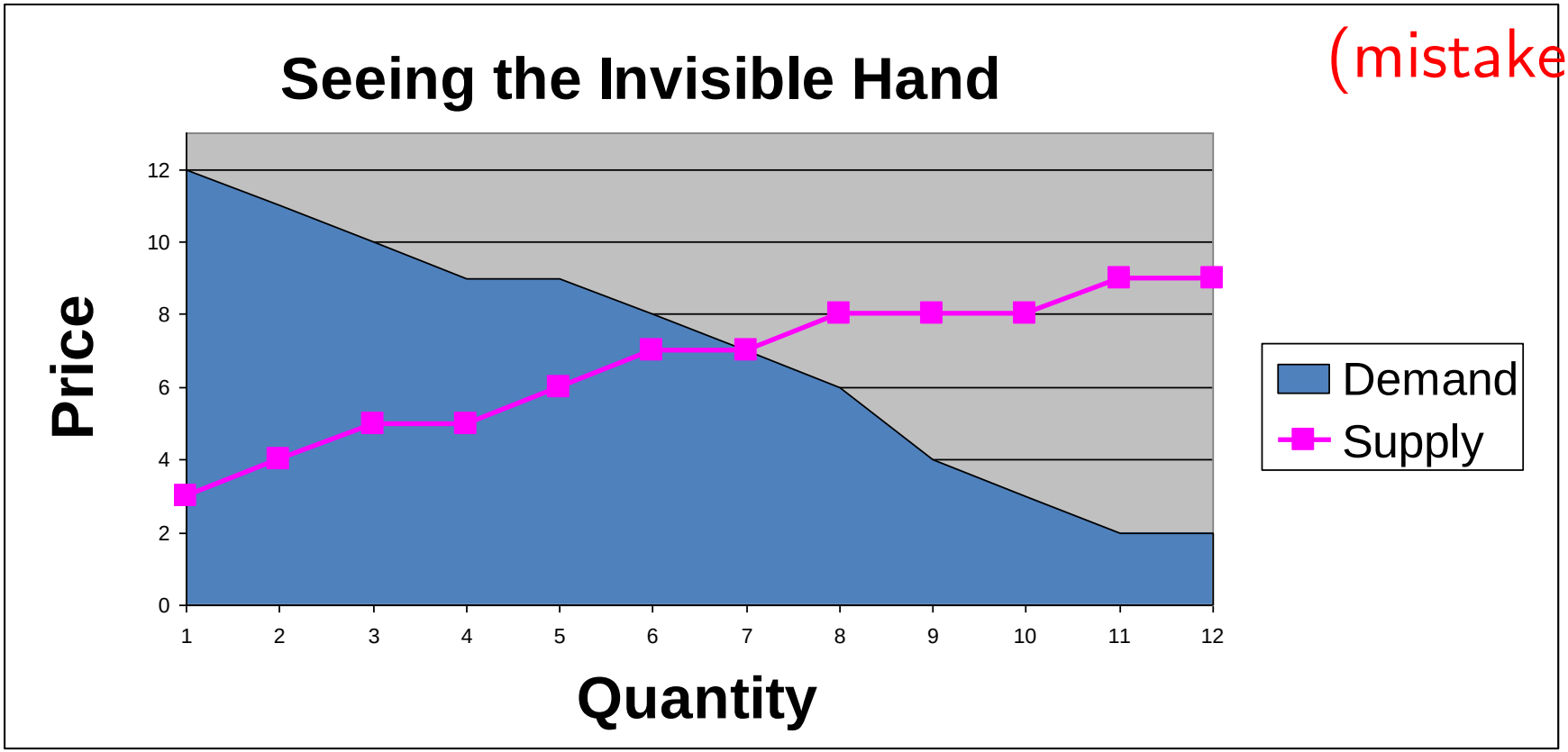
(08S Experimental Economics 實驗經濟學)



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

(mistake?)



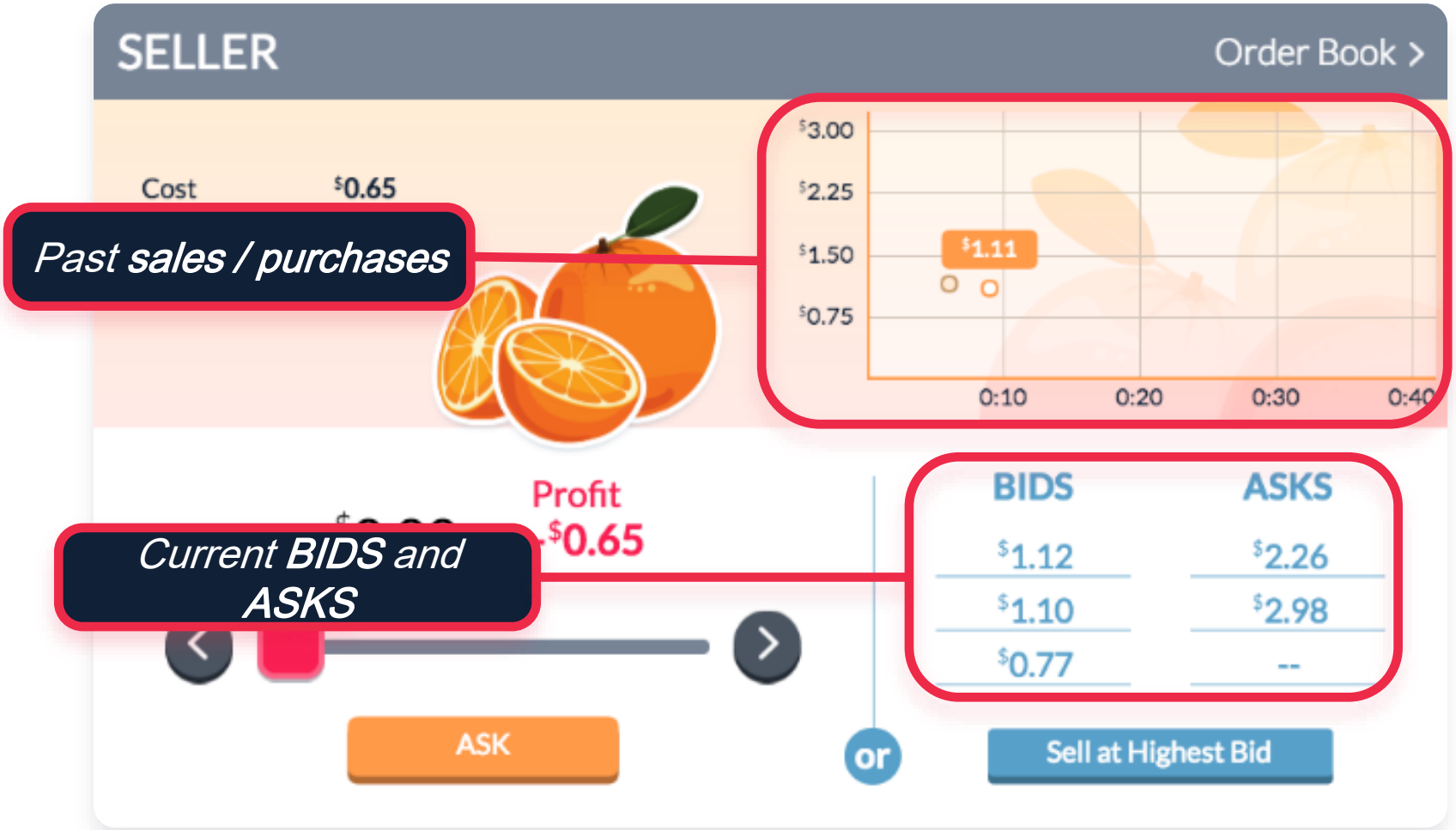
Game Instructions

Groups of 5 sellers and 5 buyers.
Trade to maximize your profits!

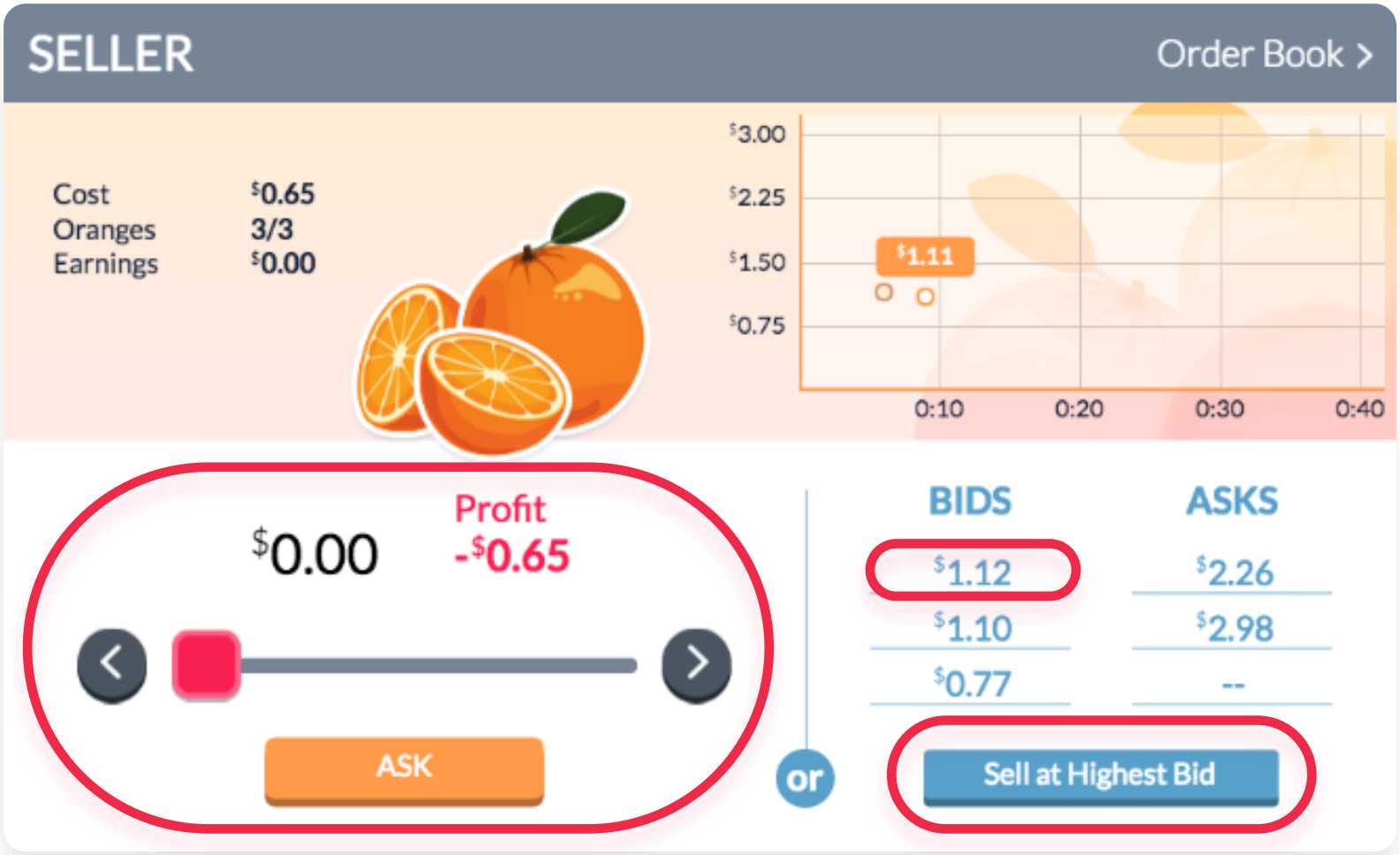
Orange producer, selling oranges

Hungry consumer, buying oranges

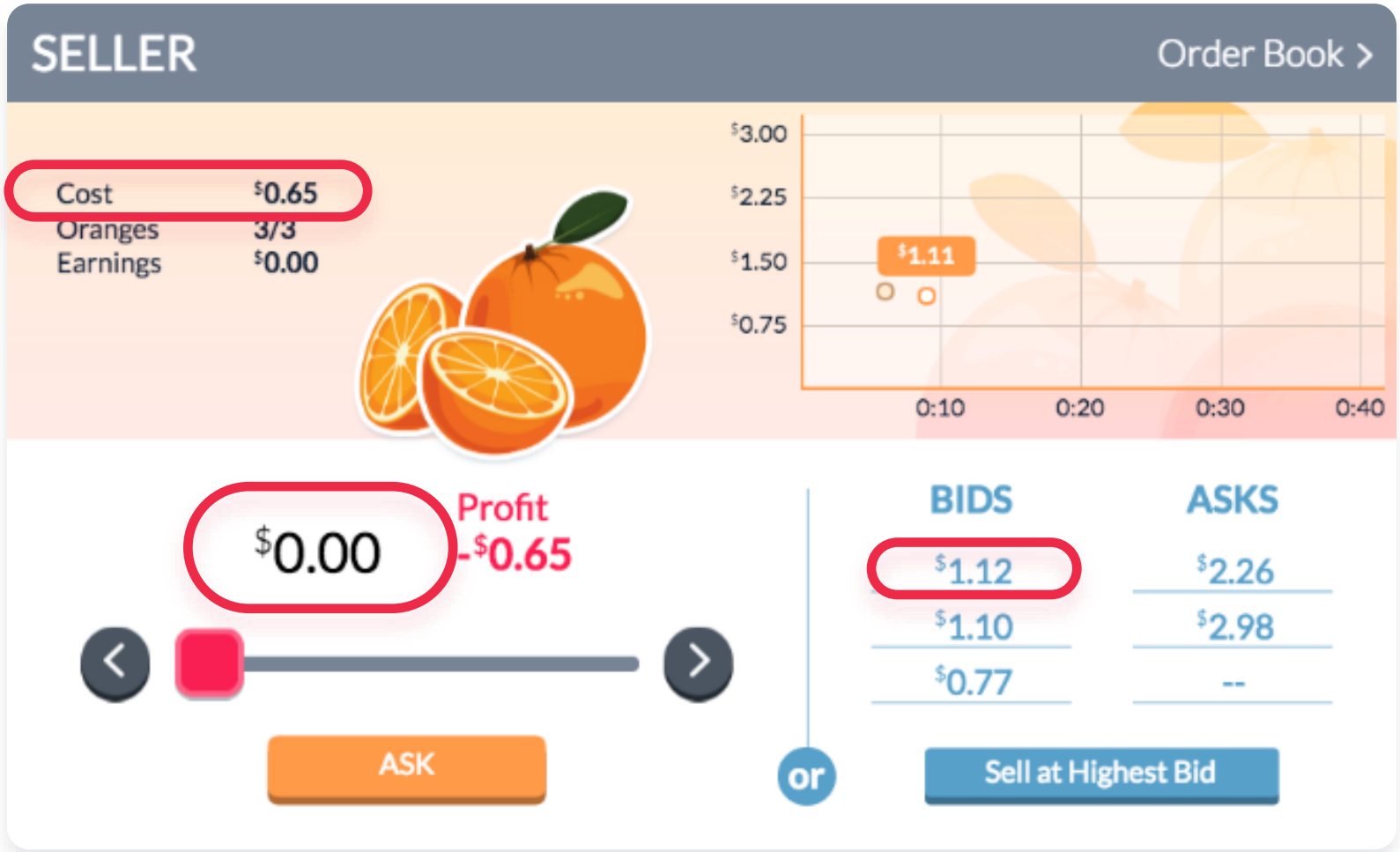
Bids are offers to buy



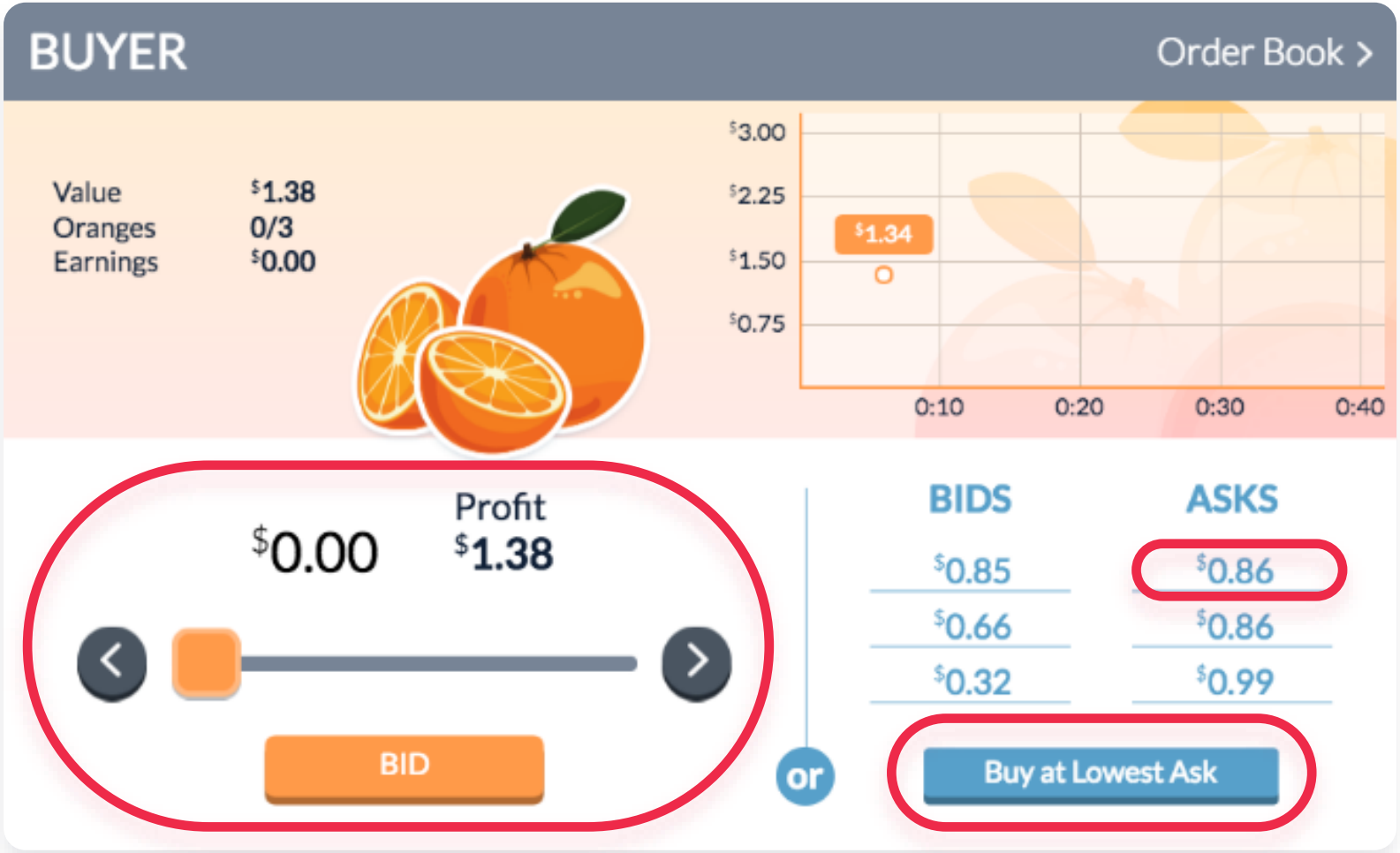
Submit an **ASK** using the slider, or **Sell at Highest Bid**



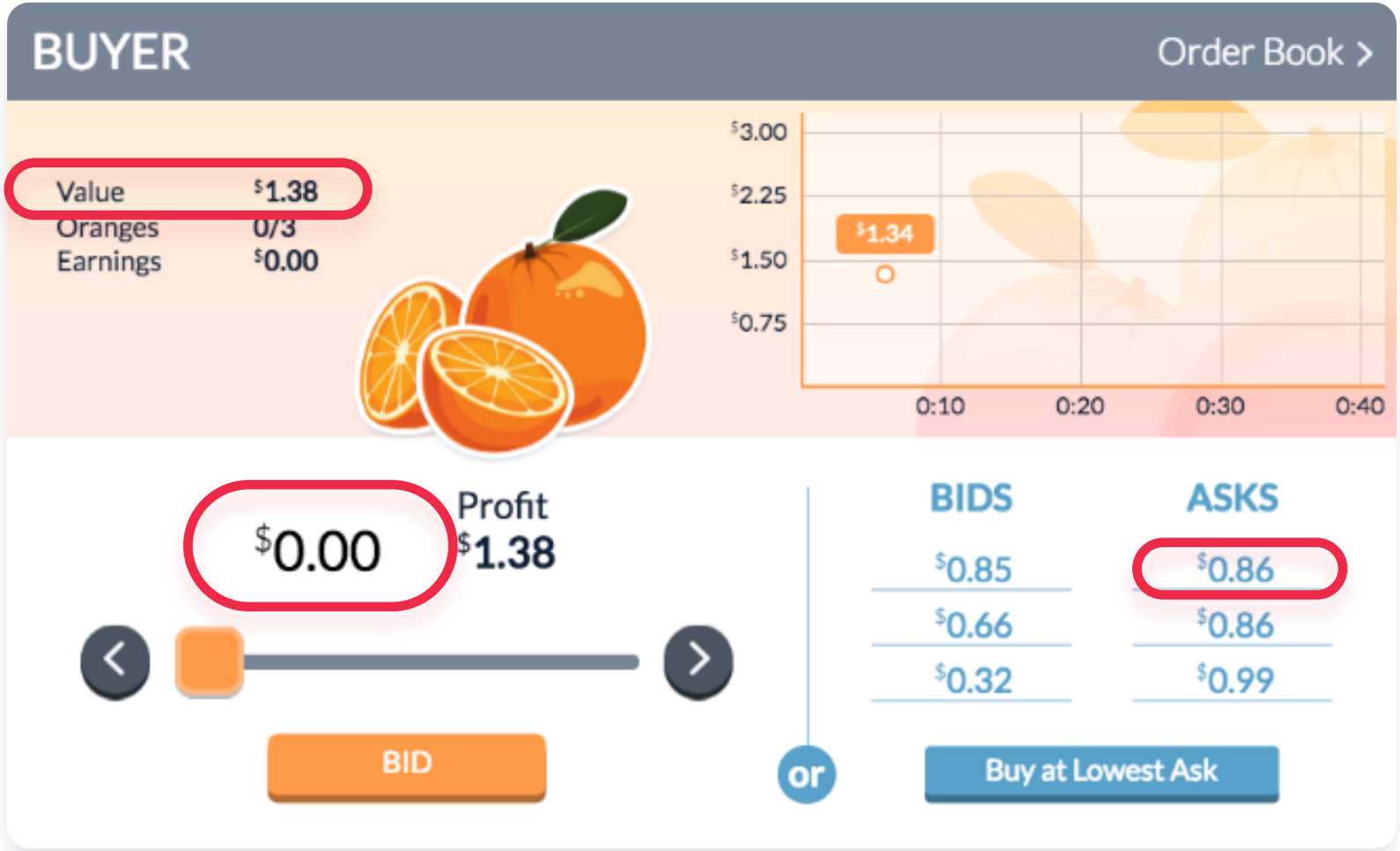
Seller's Profit = Sale Price – Cost of Production



Submit a **BID** using the slider, or **Buy at Lowest Ask**



Buyer's Profit = Value of consumption – Purchase Price



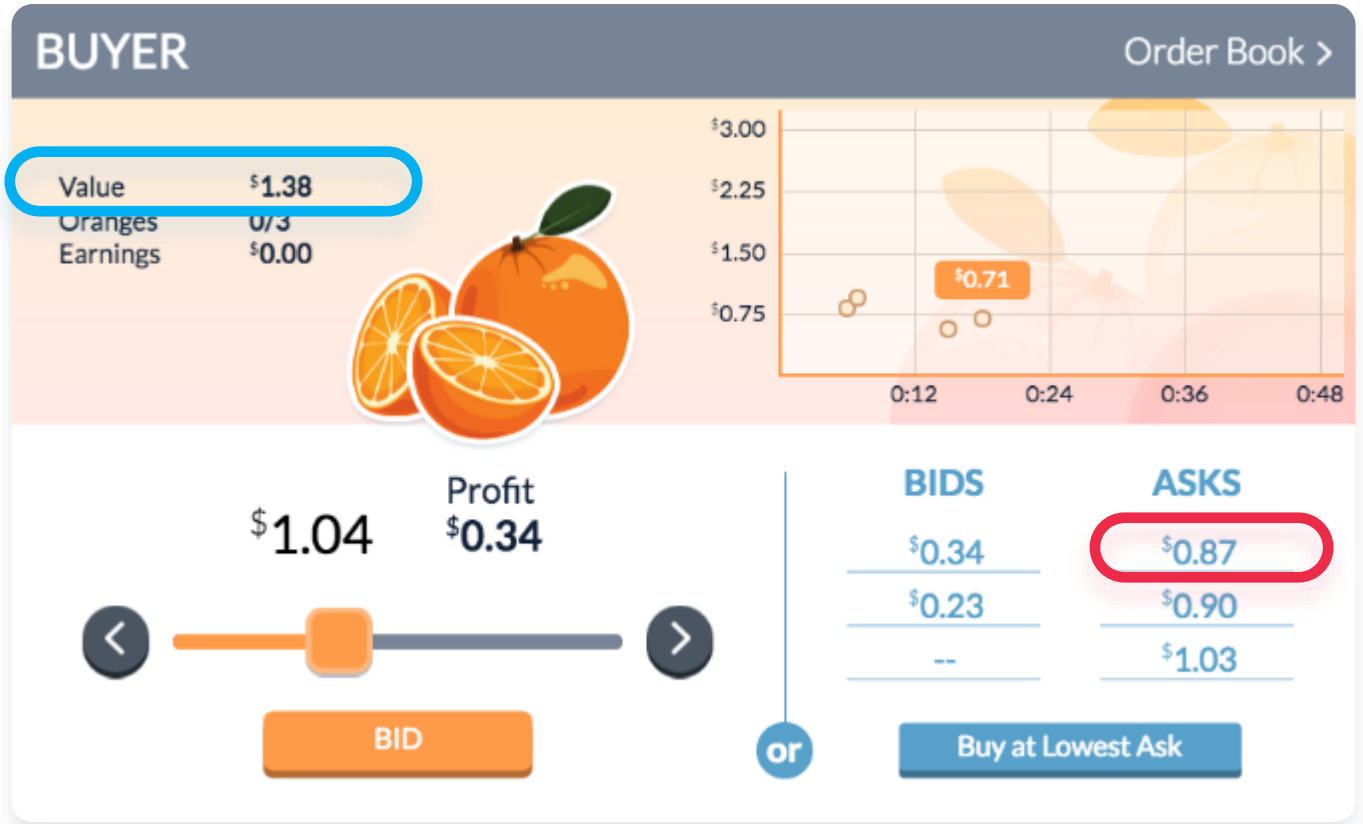
When does a transaction occur?

- Someone uses Buy at Lowest Ask Sell at Highest Bid
- A Buyer places a BID higher than the lowest outstanding Ask
- A Seller places an ASK lower than the highest outstanding Bid

As a **seller**, what is your profit if someone accepts your ask of $1.24?

Sale Price – Cost = $1.24 - $0.65 = $0.59

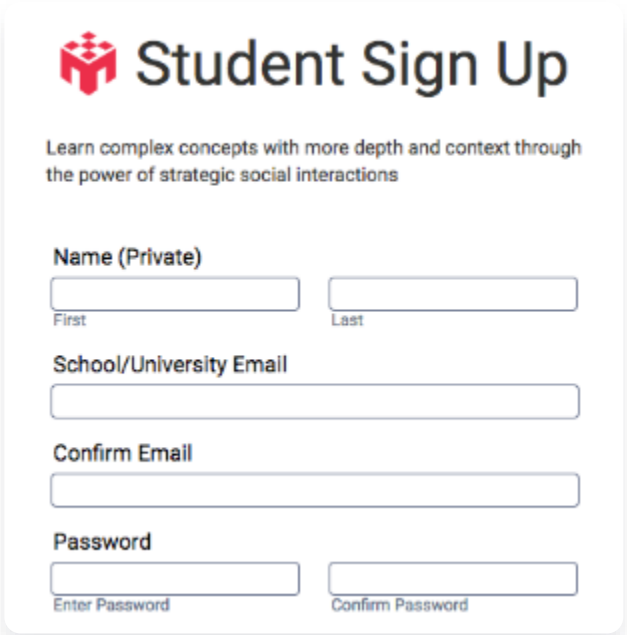
As a **buyer**, what is your profit if you "Buy at Lowest Ask"?



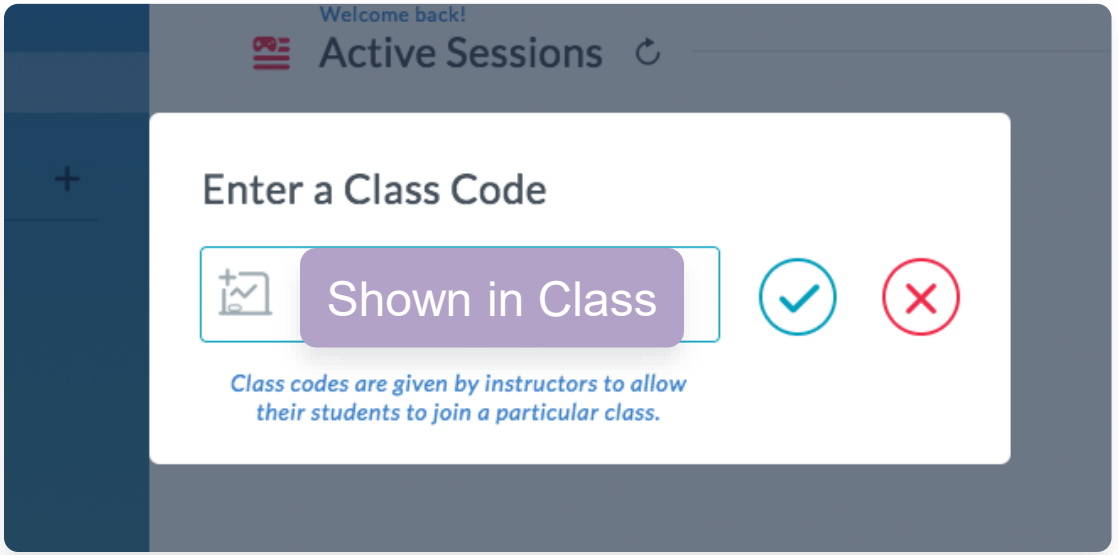
Value – Purchase Price = $1.38- $0.87= $0.51

Sign up www.moblab.com or download the app

1. Sign up as a student using your student Email



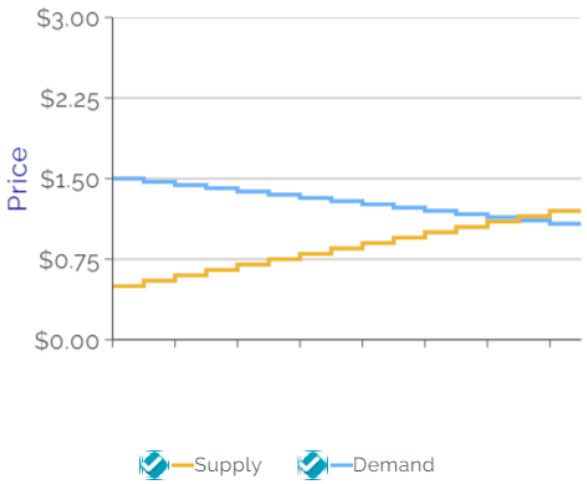
2. Join the class

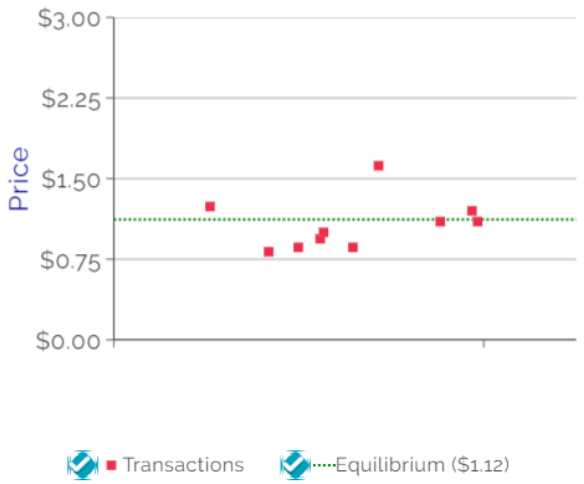


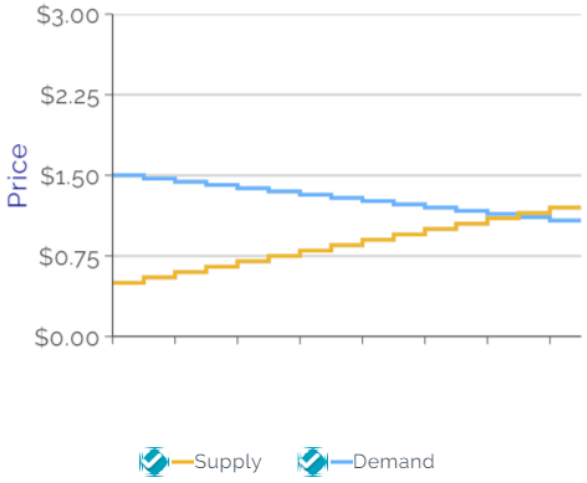
Sign up www.moblab.com or download the app

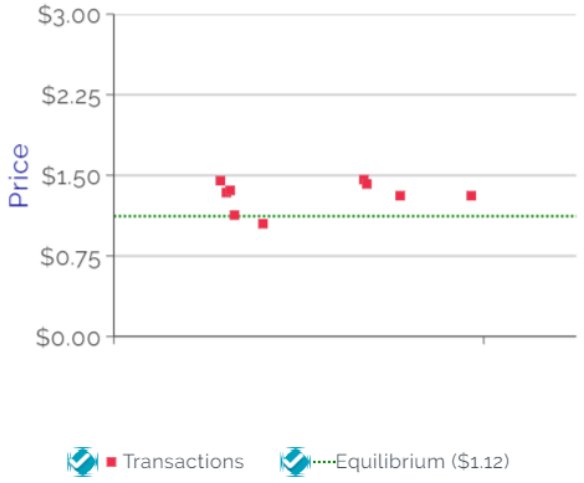
Enter the Activity

MobLab Double Auction:
EE-BGT 21S Results: Round 1

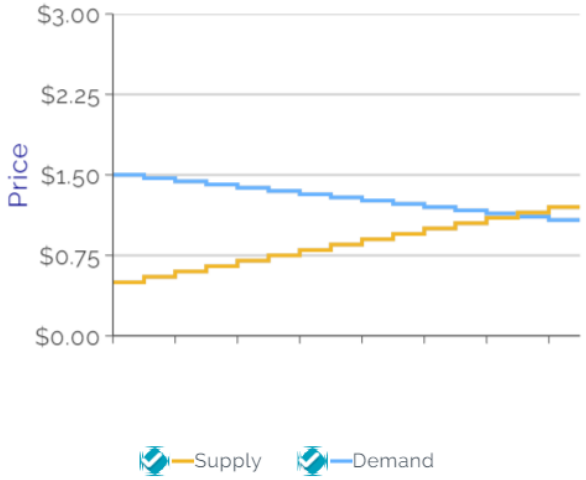


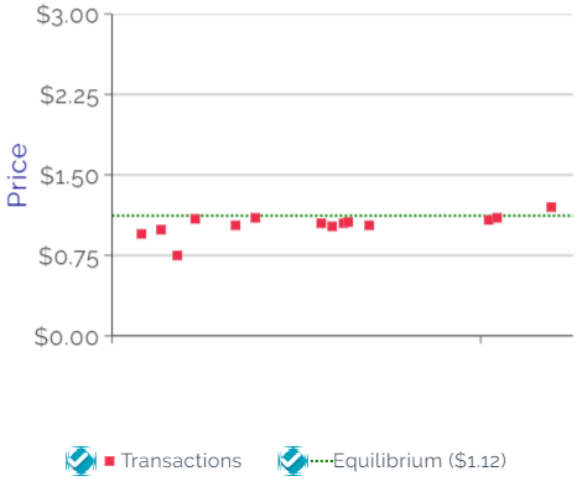


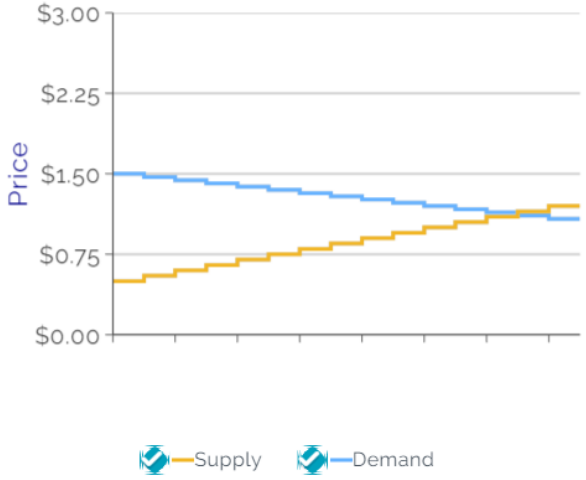


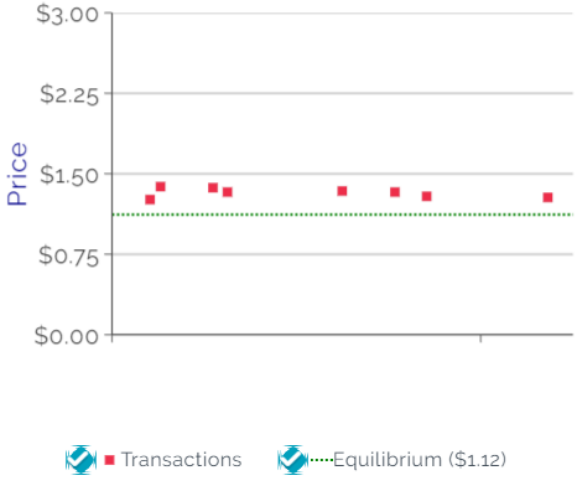


MobLab Double Auction:
EE-BGT 21S Results: Round 2

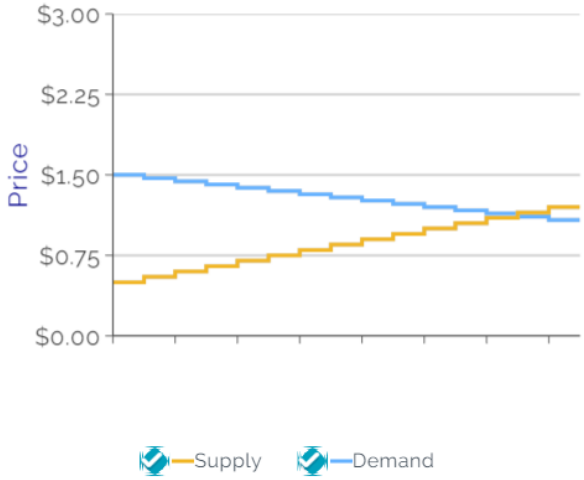


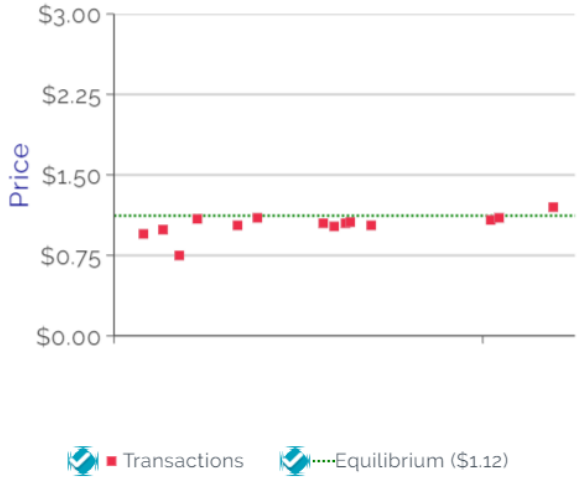


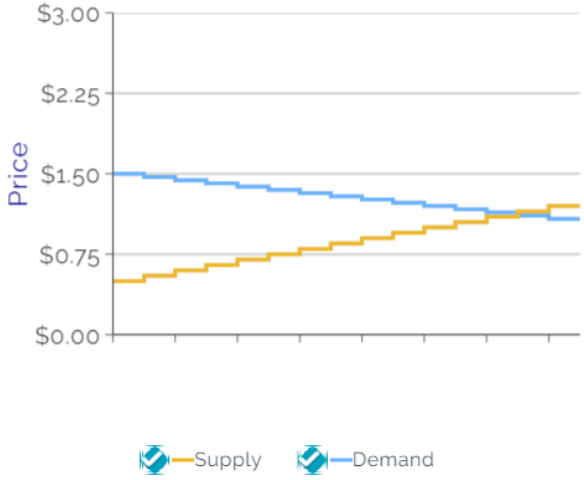


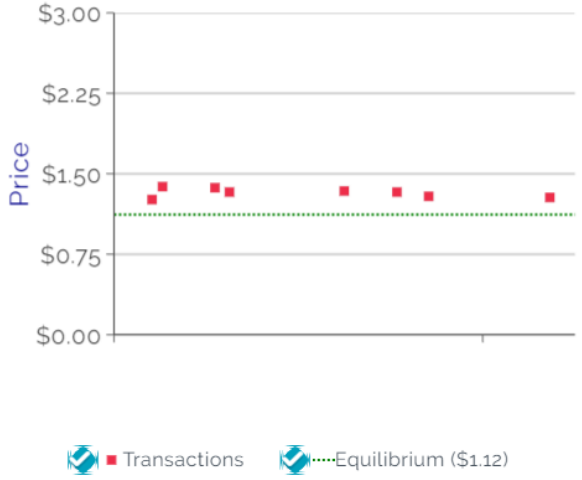


MobLab Double Auction:
EE-BGT 21S Results: Round 3

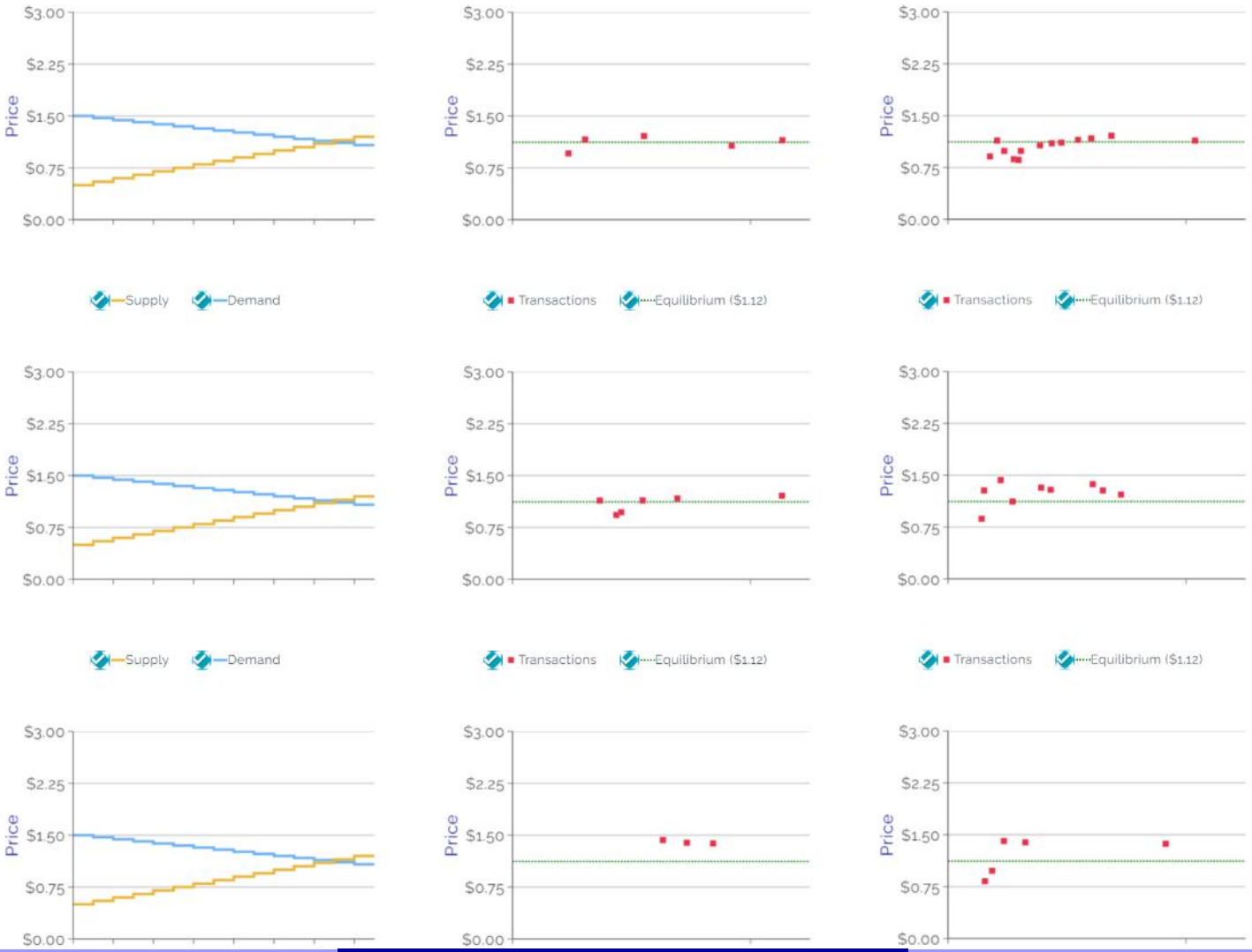




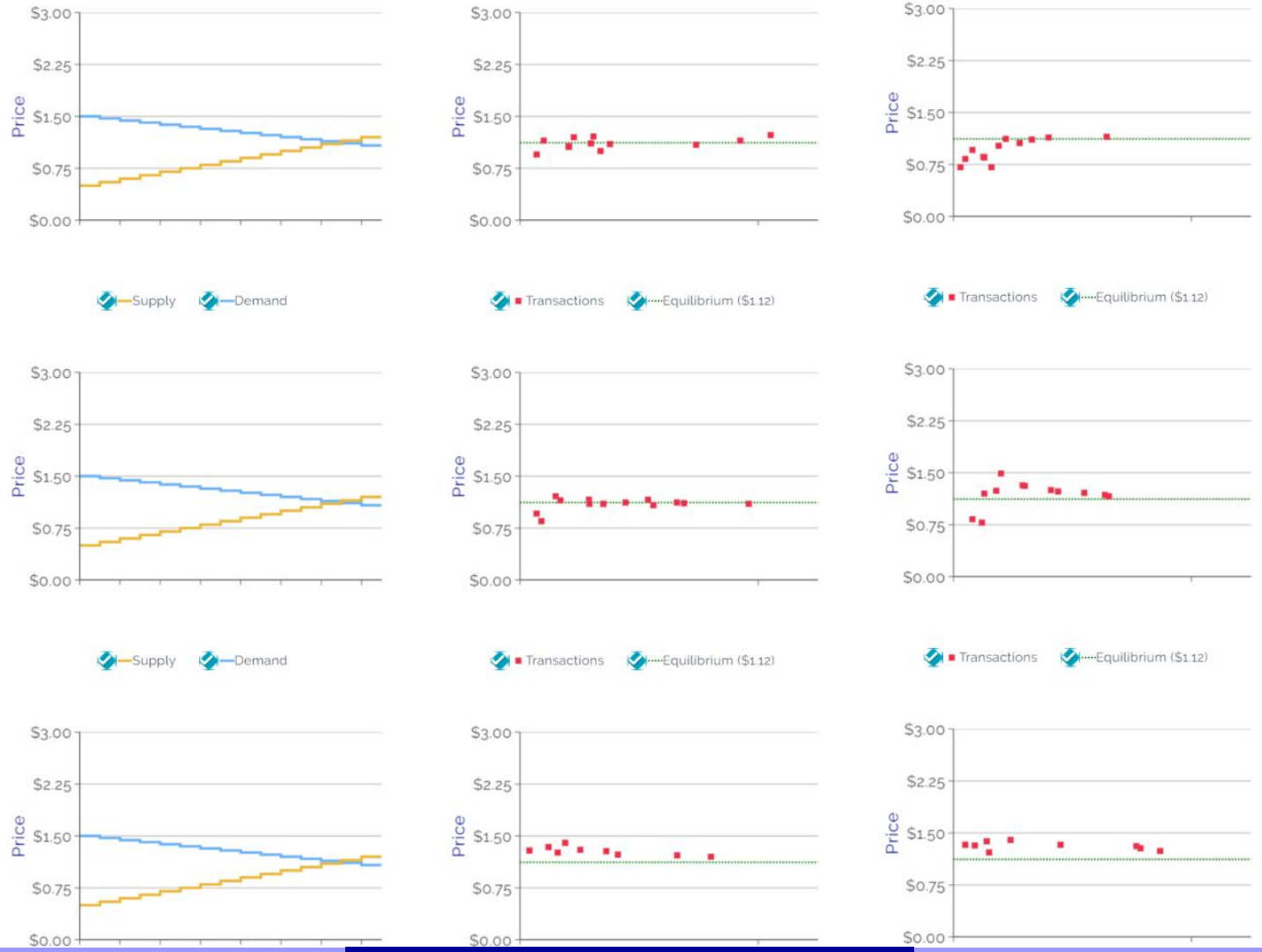




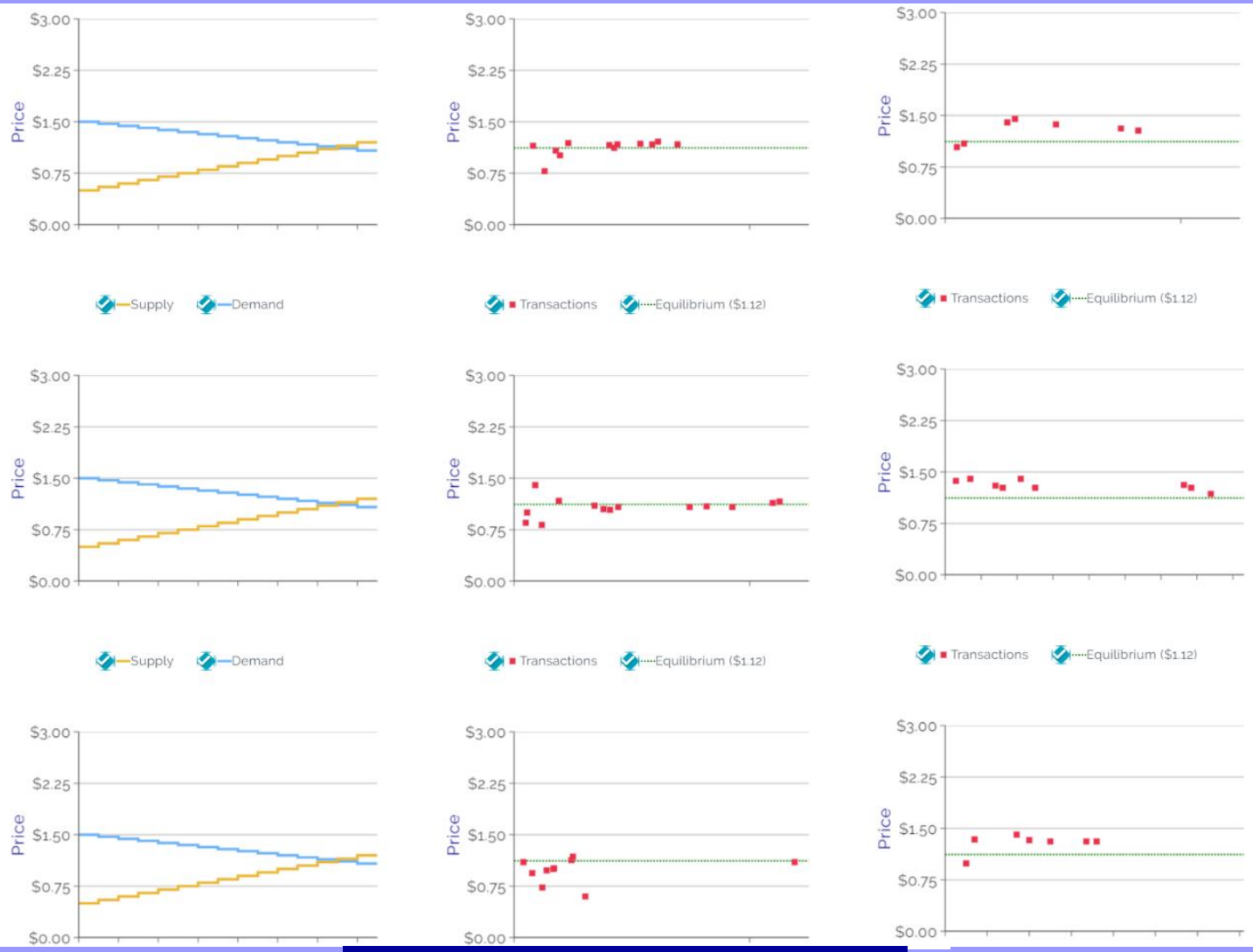
MobLab Double Auction:
CCU Results: Round 1



MobLab Double Auction:
CCU Results: Round 2

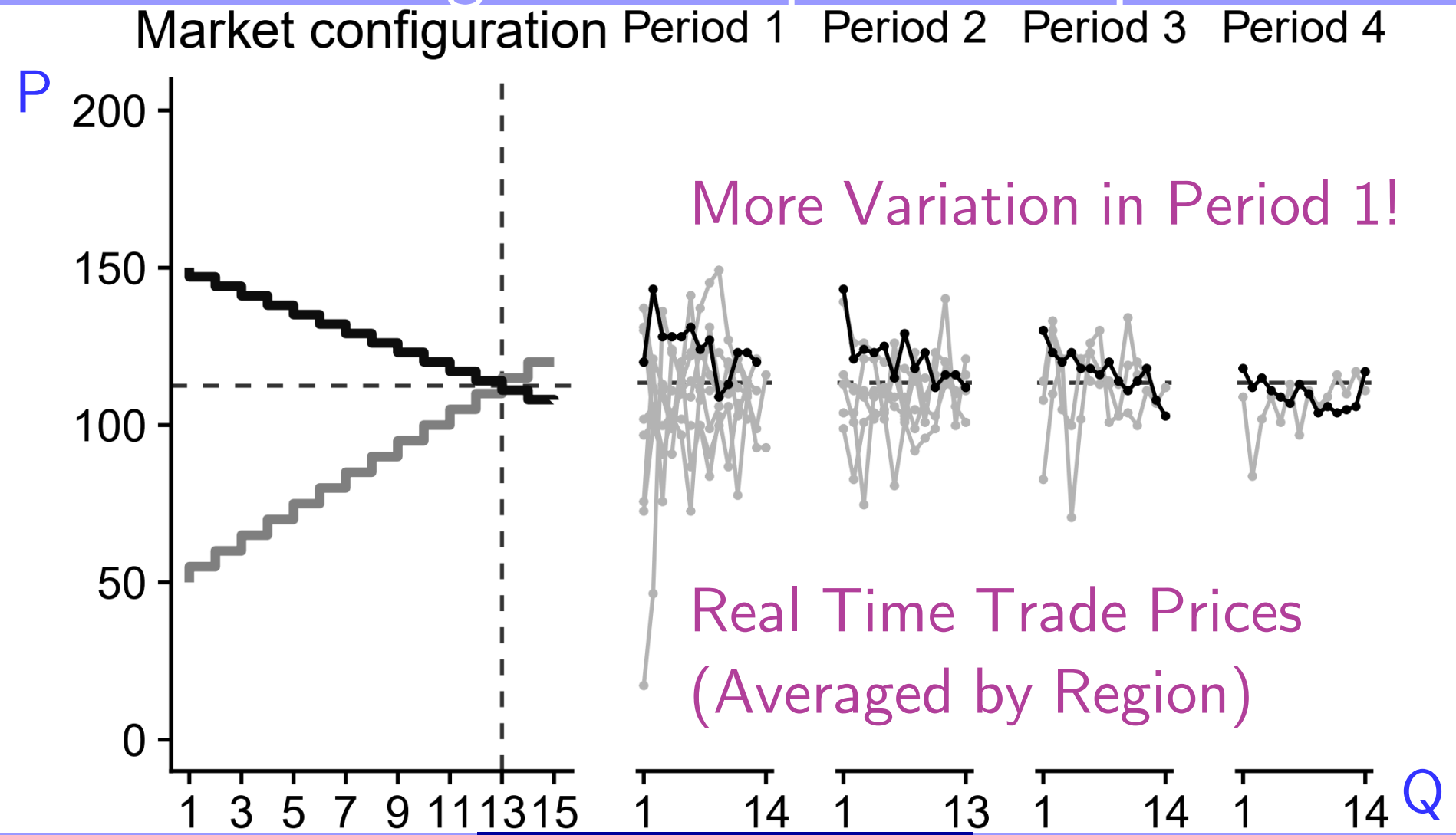


MobLab Double Auction:
CCU Results: Round 3



MobLab Double Auction: Lin et al. (2020)

Prices Converge to Competitive Equilibrium



MobLab Double Auction:

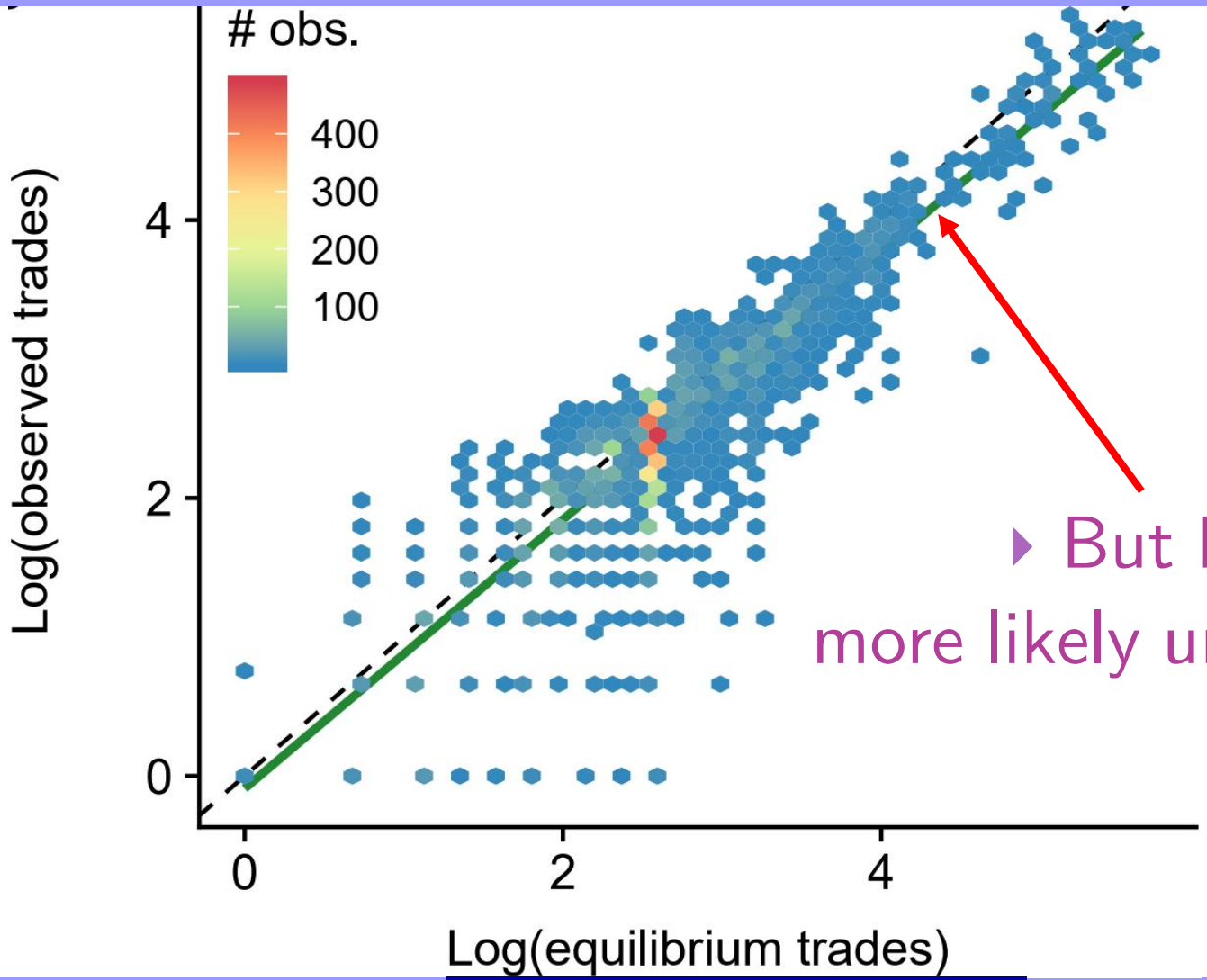
Summary Statistics

	Mean	(s. d.)
Double Auction	(5,809 Markets)	
MED δ - Accuracy	0.070	(0.280)
Smith's α - Fluctuation	0.279	(0.294)
Efficiency	81.5%	(25.8%)

Mean Error Deviation (MED): $\delta = \frac{1}{Q} \sum_{q=1}^{Q} \frac{P_q - P_{CE}}{P_{CE}}$

Smith's Alpha: $\alpha = \frac{\sqrt{\frac{1}{Q} \sum_{q=1}^{Q} (P_q - P_{CE})^2}}{P_{CE}}$

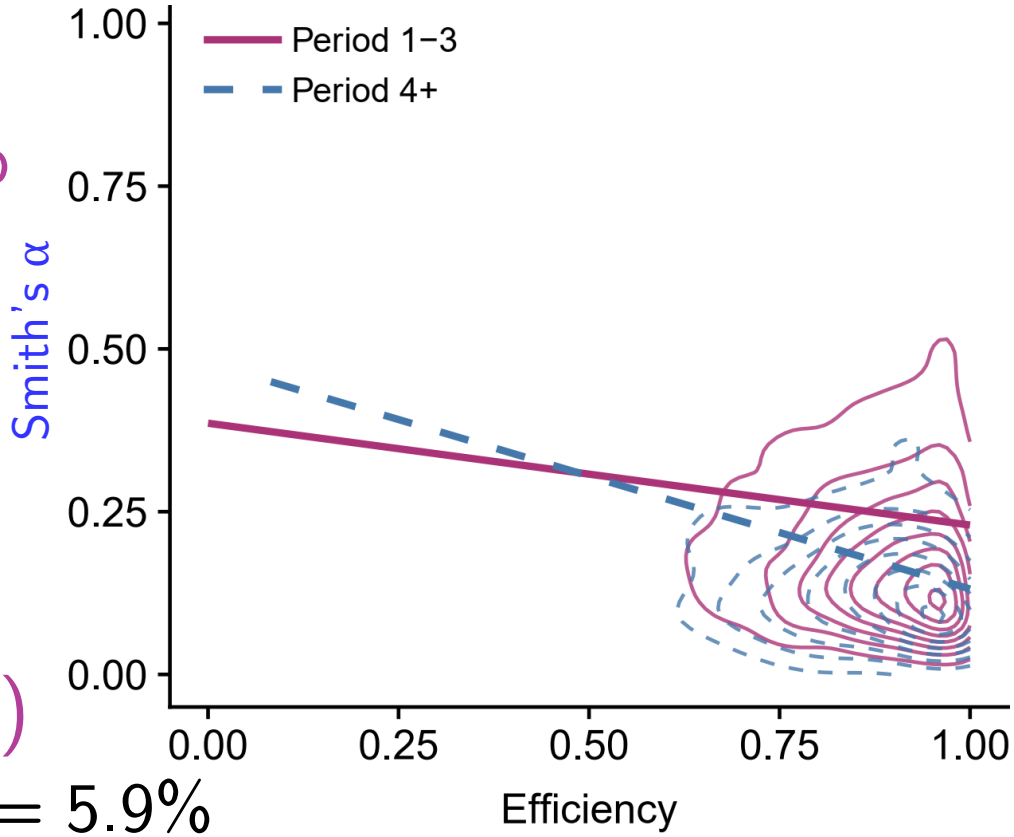
MobLab Double Auction:
Trade Volume Close to CE!



- But Deviations more likely under-trade

MobLab Double Auction:
Between-Period Price Convergence to CE

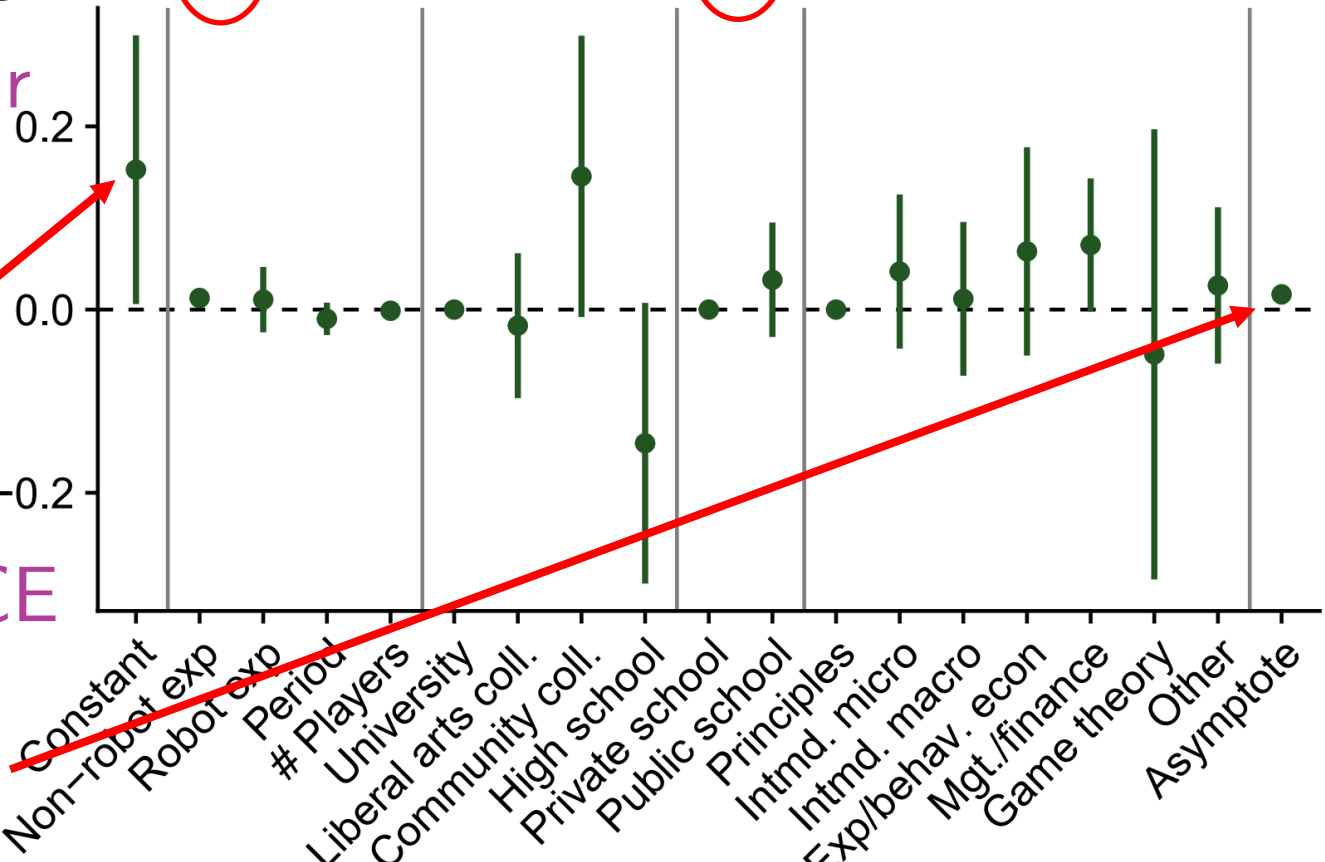
- Negative Relation Between:
- Smith's α
  - Converge from 20.6% to 8.6% (in 25 rounds)
- Efficiency
  - Stable at 92%
- Benchmark:
  - Ketcham et al. (1984)
    - Asymptotic Smith's $\alpha = 5.9\%$
    - Efficiency: around 95.89%



MobLab Double Auction:
Within-Period Price Convergence to CE

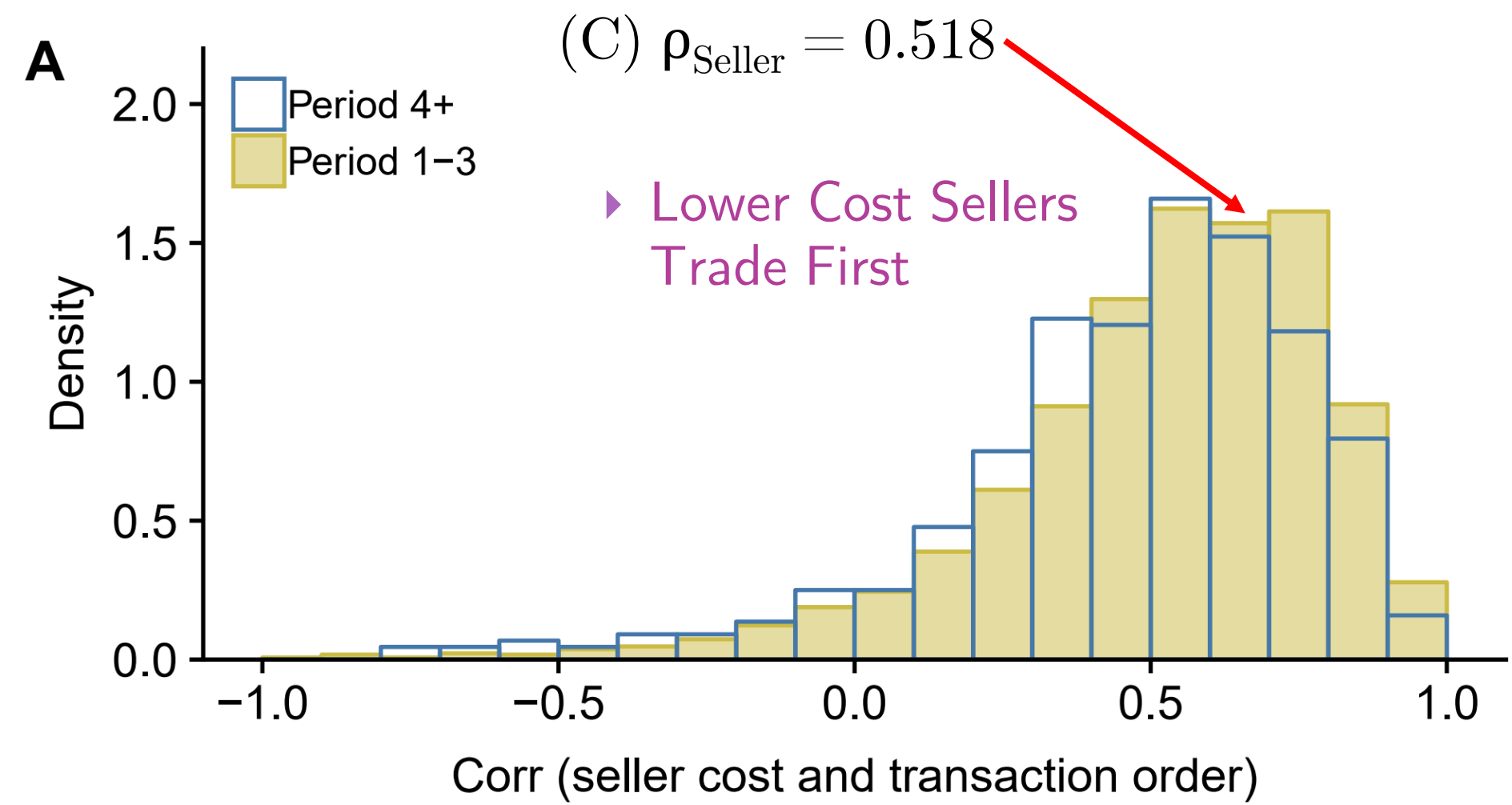
$$y_{it} = (1/t)\mathbb{X}_i \cdot \beta_1 + (1 - 1/t)\beta_2 + \epsilon_{it},$$

- as in Noussair et al. (1995)

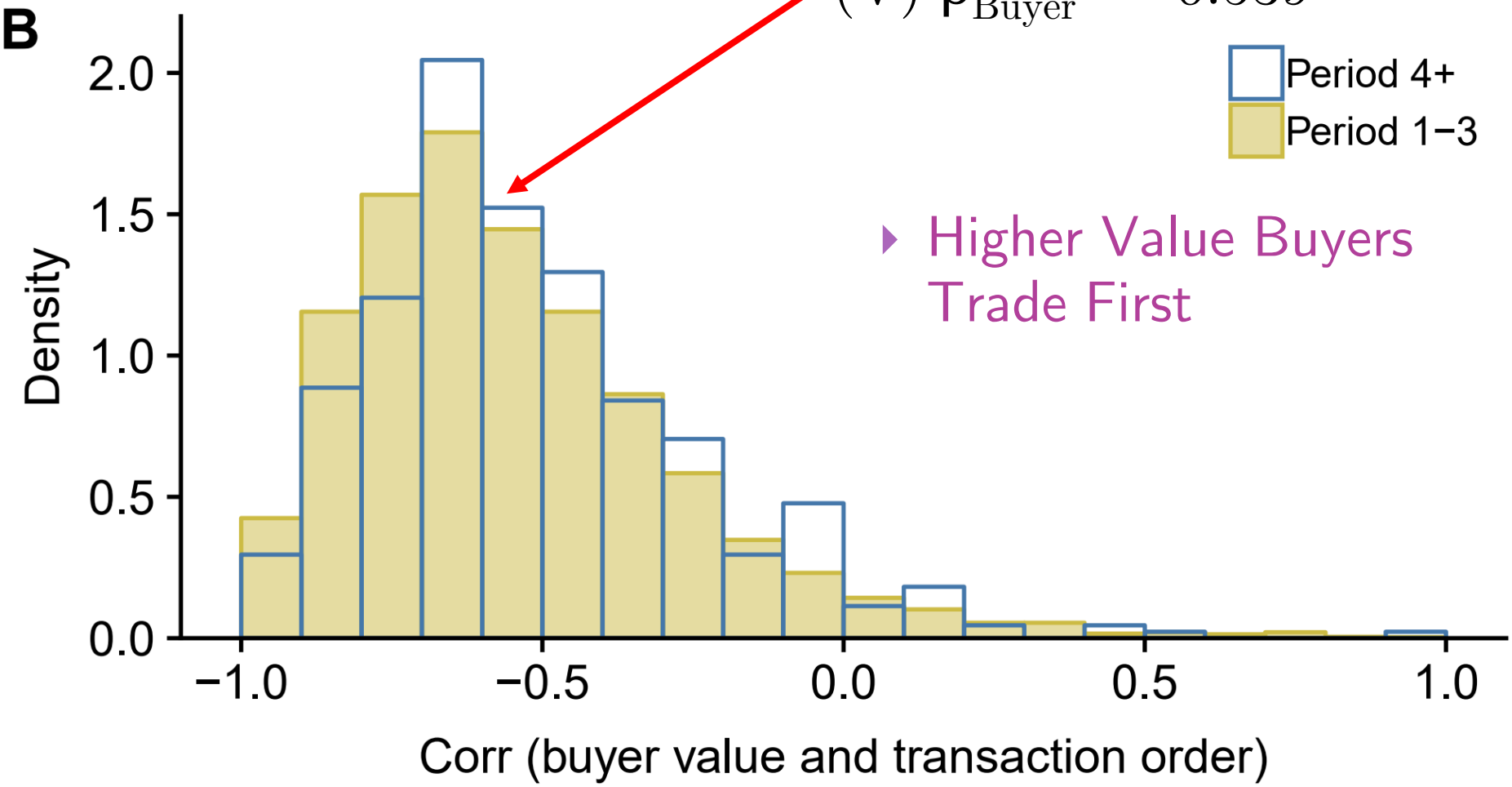


- 1st Trade:
  - On average 15.3% above CE
    - (t=1)
- Converge to:
  - 1.7% above CE

MobLab Double Auction: Seller Rank-Order Correlation (Transaction Order, Seller Cost)

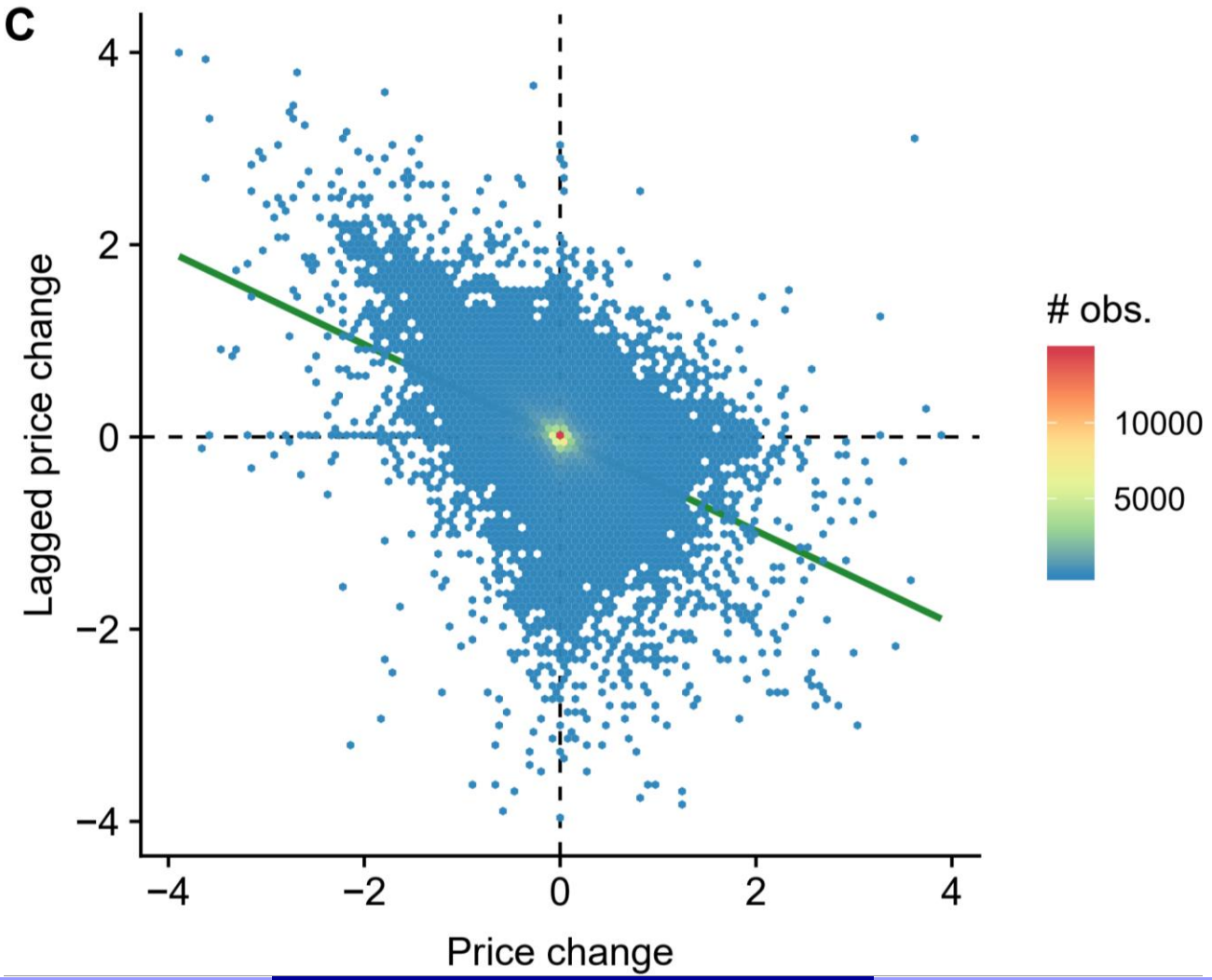


MobLab Double Auction: Buyer Rank-Order Correlation(Transaction Order, Buyer Value)

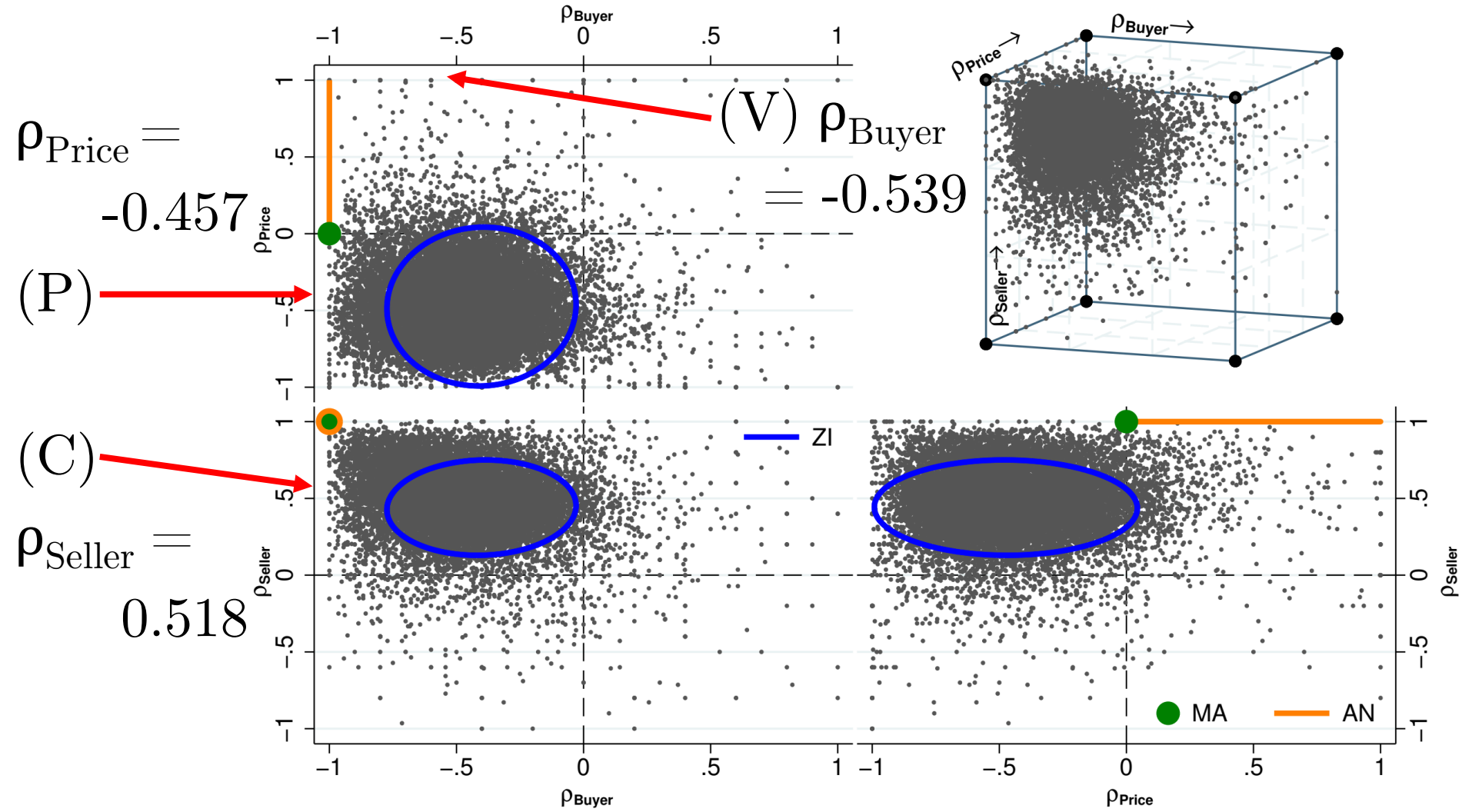


- Higher Value Buyers Trade First

MobLab Double Auction:
Price Change Autocorrelation = -0.457



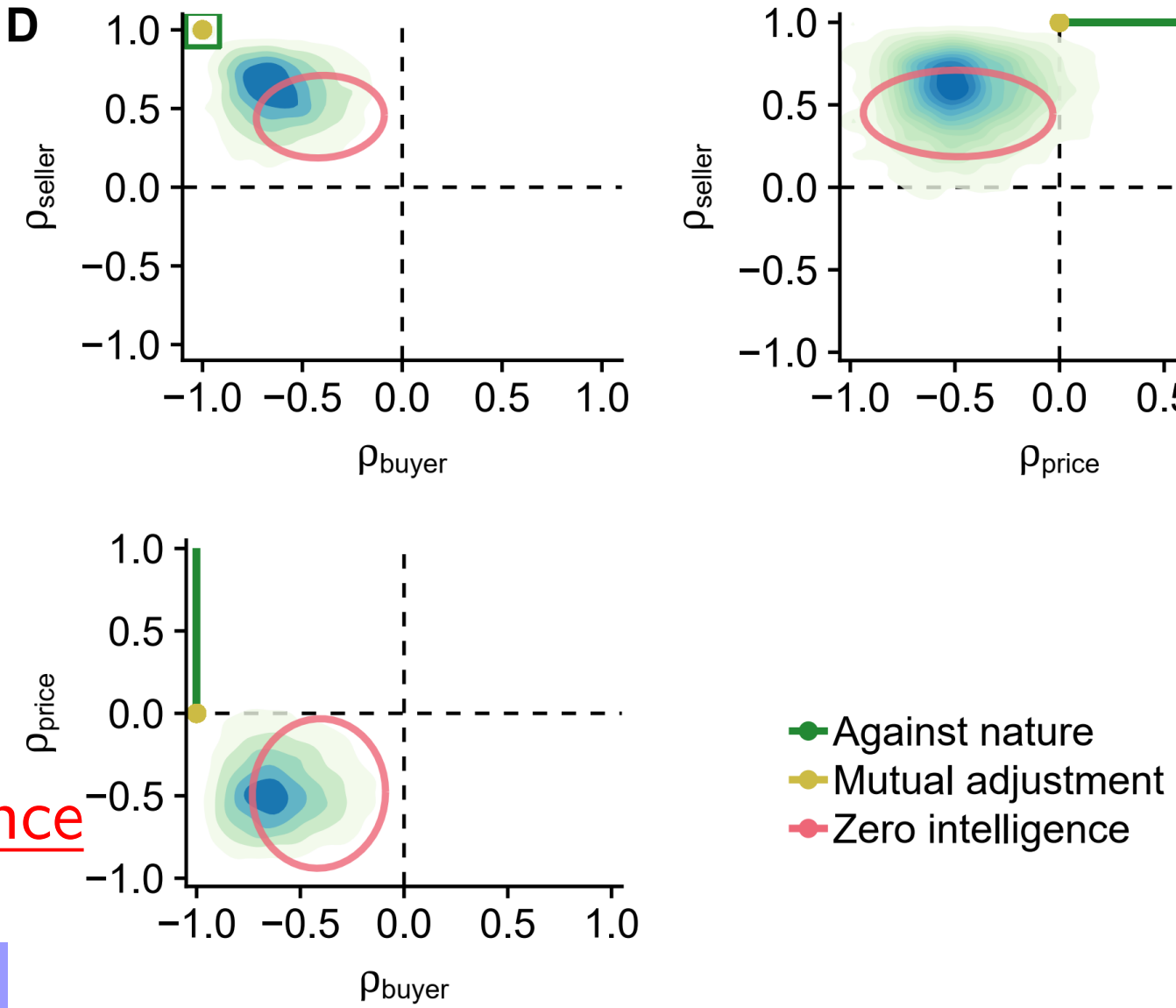
MobLab Double Auction:
Correlation Between Order and P/V/C



MobLab Double Auction:

Testing Theories of Price Formation

- MA: Wilson (1987)
- AN: Friedman (1991)
- ZI: 0-intelligence



Robustness:

Small vs. Large Markets: ZI or Not!!!

(N = 172)

Favor AN/MA!

(traders≤6)

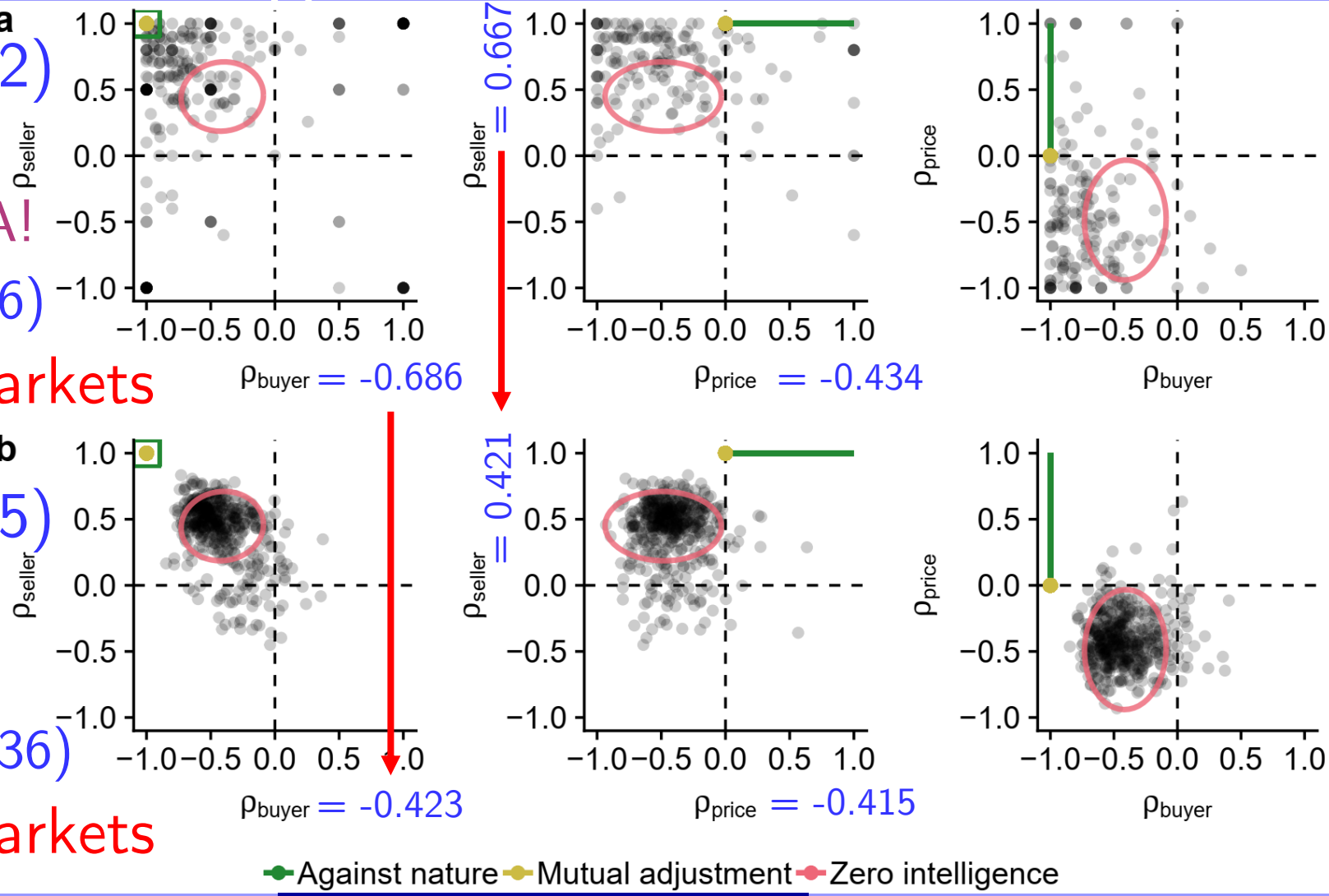
Small markets

(N = 455)

Favor ZI!

(traders≥36)

Large markets



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 (一致的實驗結果) and Behavioral Game Theory (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)
  - Theory of Games and Economic Behavior: 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

- 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: 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

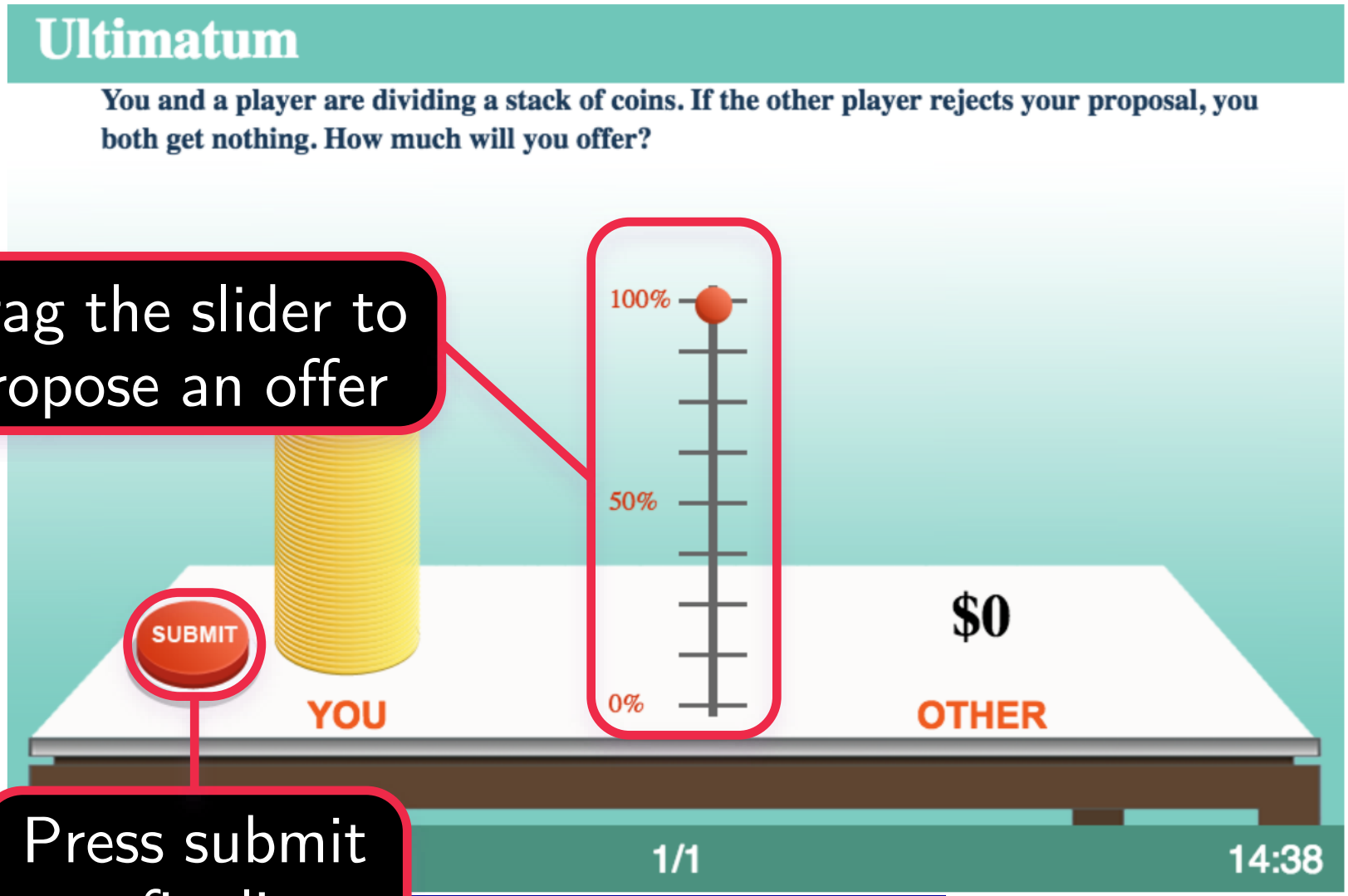
- Goal: Show how BGT can
  - explain what people do more accurately
- by extending game theory to include:
  - social preferences (fairness),
  - limited strategic thinking, and
  - learning.
    - 目的：說明行為賽局論如何更準確預測人們的行為，把社會(公平)偏好、有限理性思考和學習過程引入數學賽局論。

1. Ultimatum Bargaining (最後通牒談判)

- 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)

MobLab Ultimatum Game:

Proposer



Drag the slider to propose an offer

Press submit to finalize

MobLab Ultimatum Game:

Respondent

1. Ultimatum Bargaining (最後通牒談判)

- 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)

1. Ultimatum Bargaining (最後通牒談判)

- 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 et al. (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

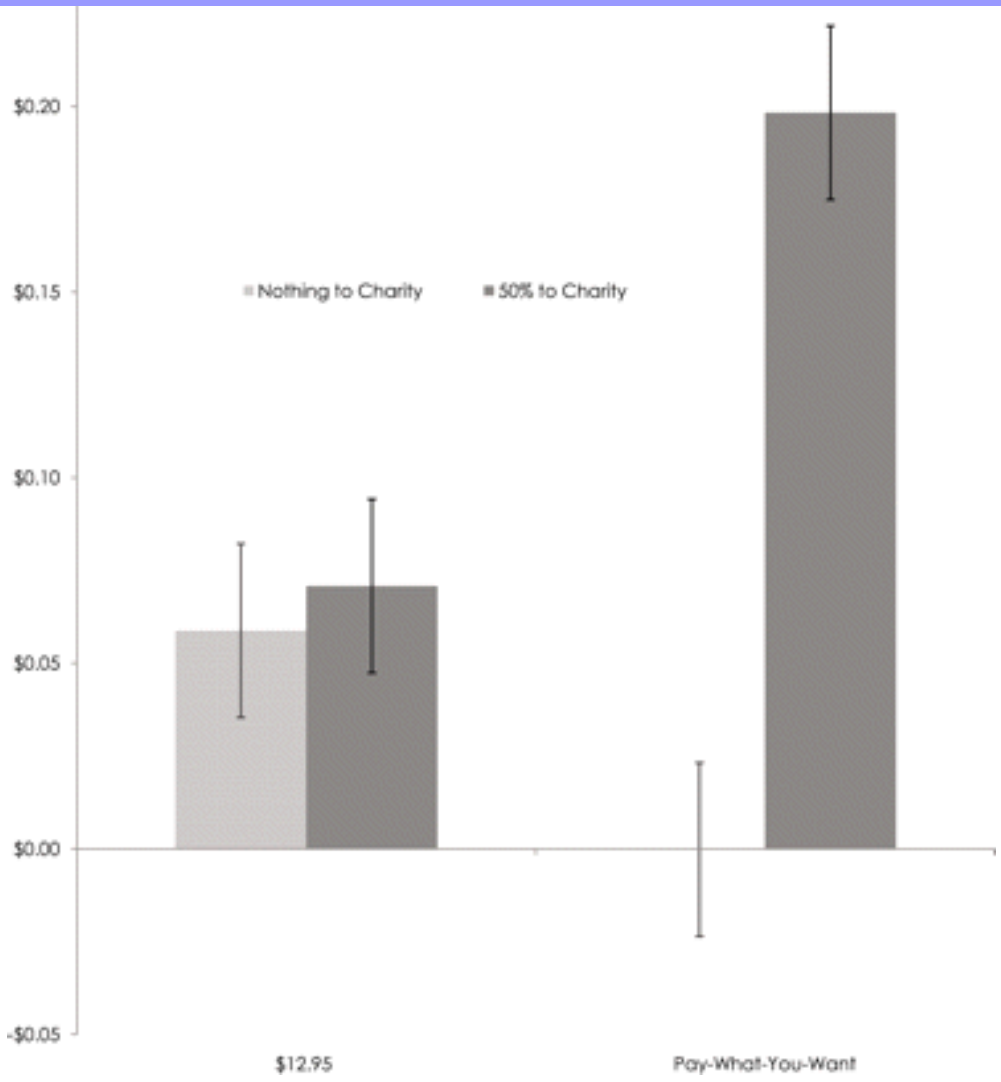
Disneyland Photo Field Experiment 還真的

- 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:

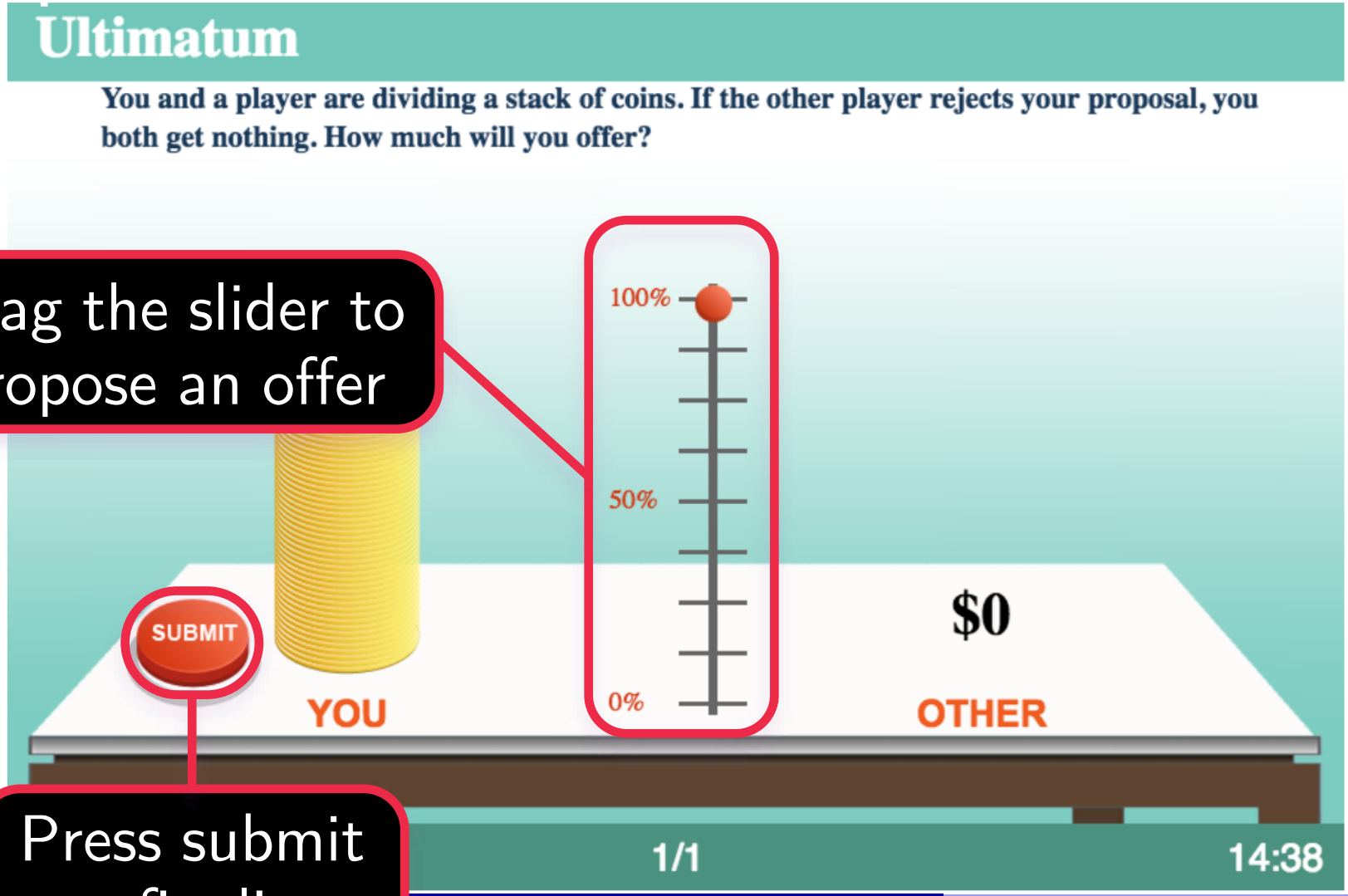
- This is profitable only because Disney did not really donate more money to charity!
- Instead reduced regular donations by the same amount!
- Likely to change results if disclosed...



Science
AAAS

MobLab Ultimatum Game:

Proposer



Drag the slider to propose an offer

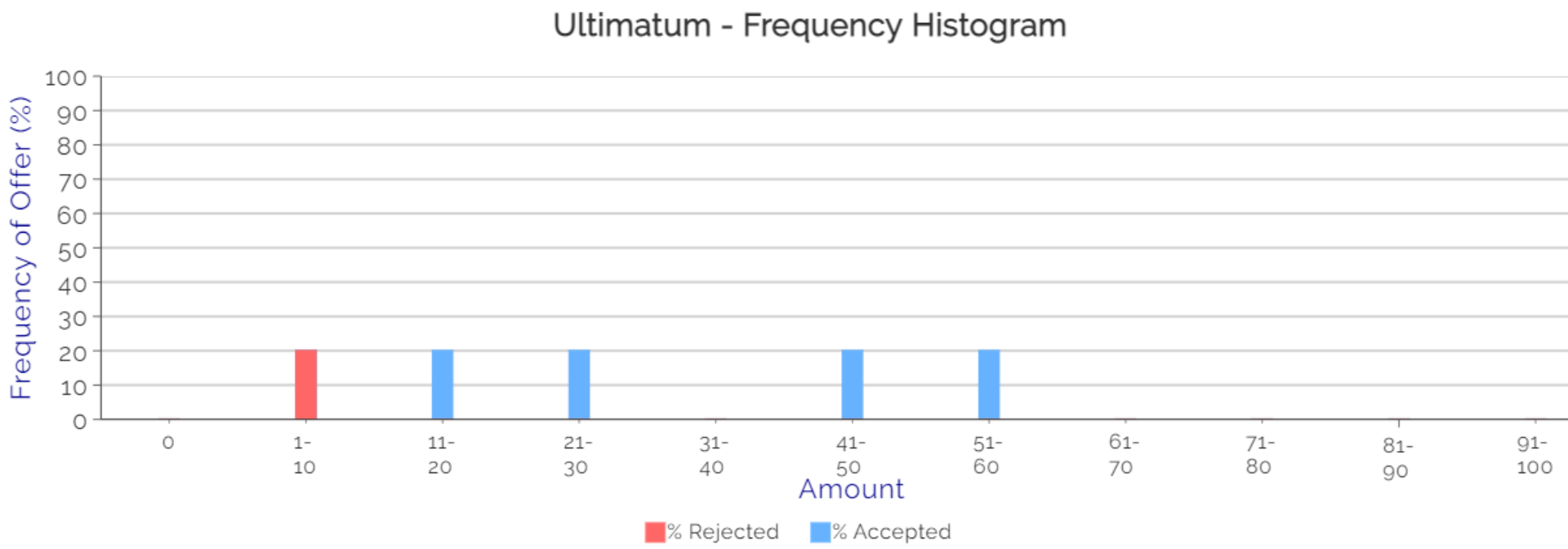
Press submit to finalize

MobLab Ultimatum Game:

Respondent

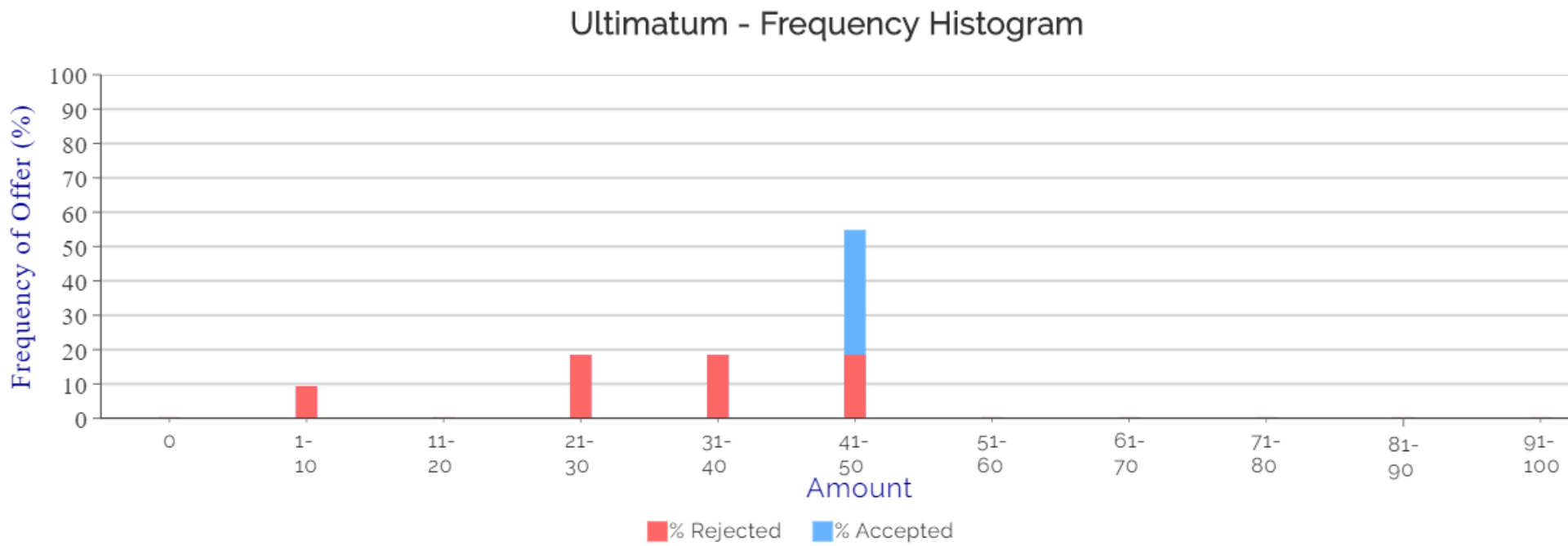
MobLab Ultimatum Game:
EE-BGT 21S Results:

# of Groups	Total Pie	Avg. Offer	Avg. Accepted Offer	Avg. Rejected Offer	Mode Offer	Rejection %
5	100	33.20	39.00	10.00	10	20.00

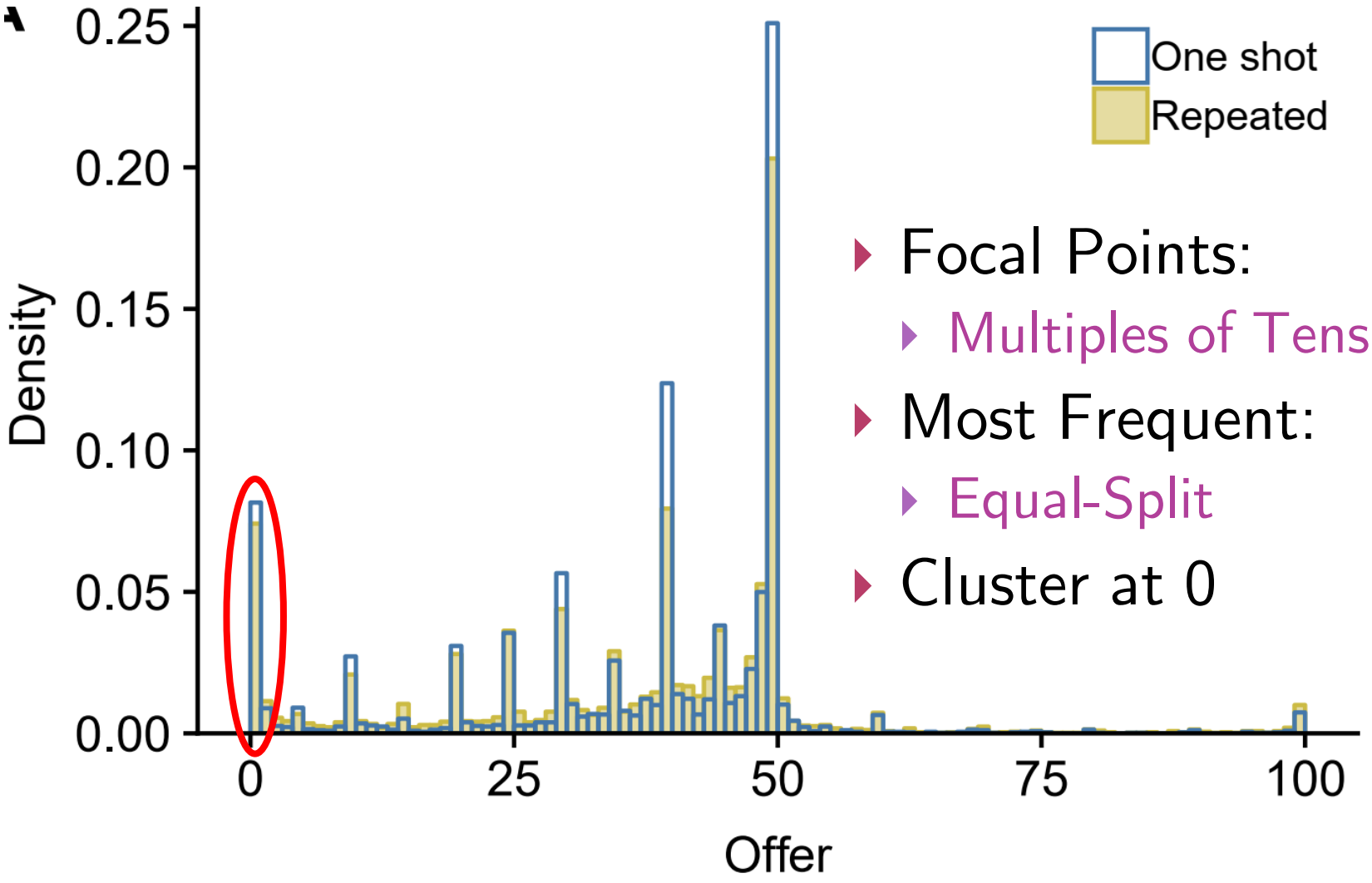


MobLab Ultimatum Game:
CCU Results:

# of Groups	Total Pie	Avg. Offer	Avg. Accepted Offer	Avg. Rejected Offer	Mode Offer	Rejection %
11	100	37.55	49.75	30.57	50	63.64

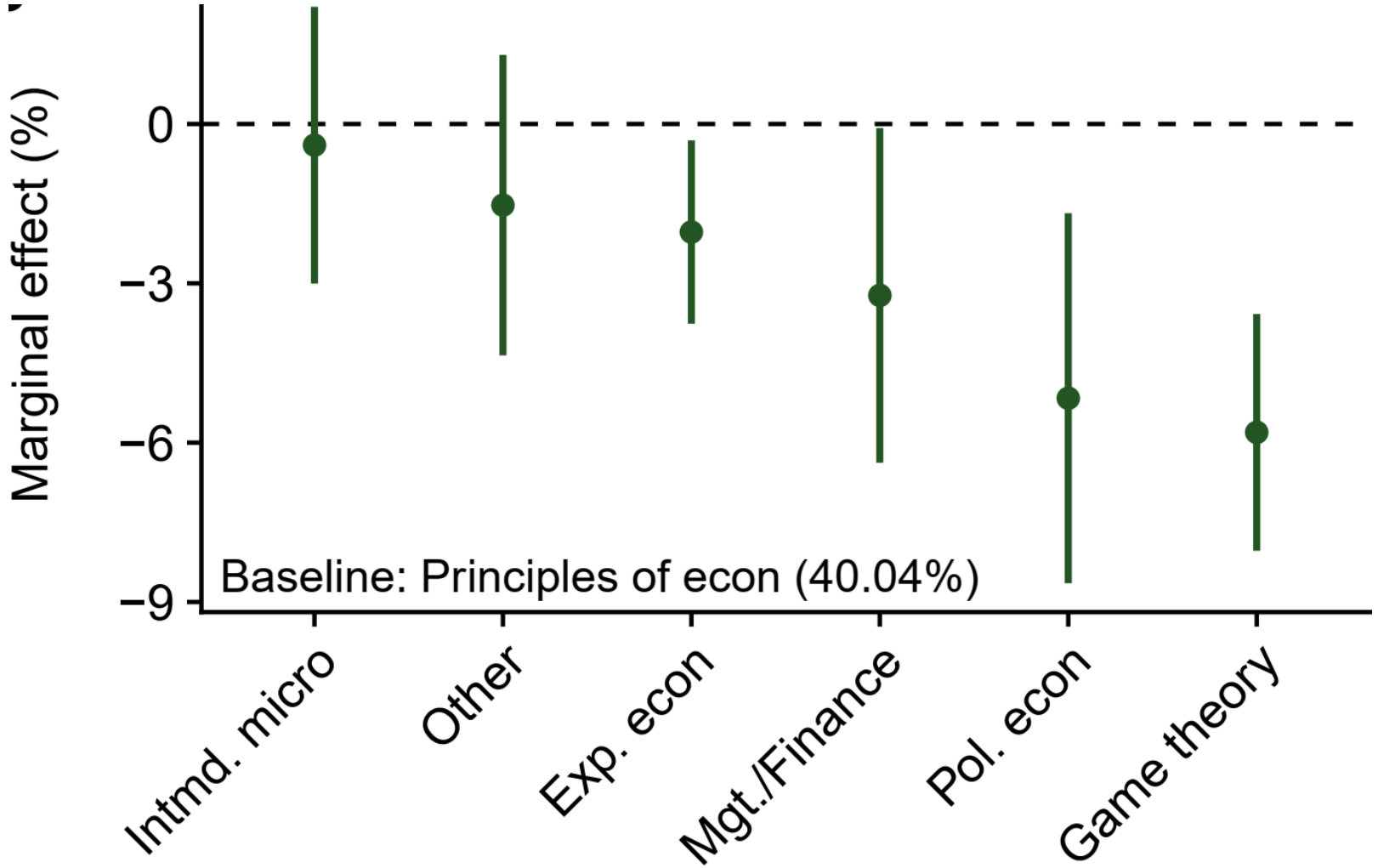


MobLab Ultimatum Game:
Proposal Offers



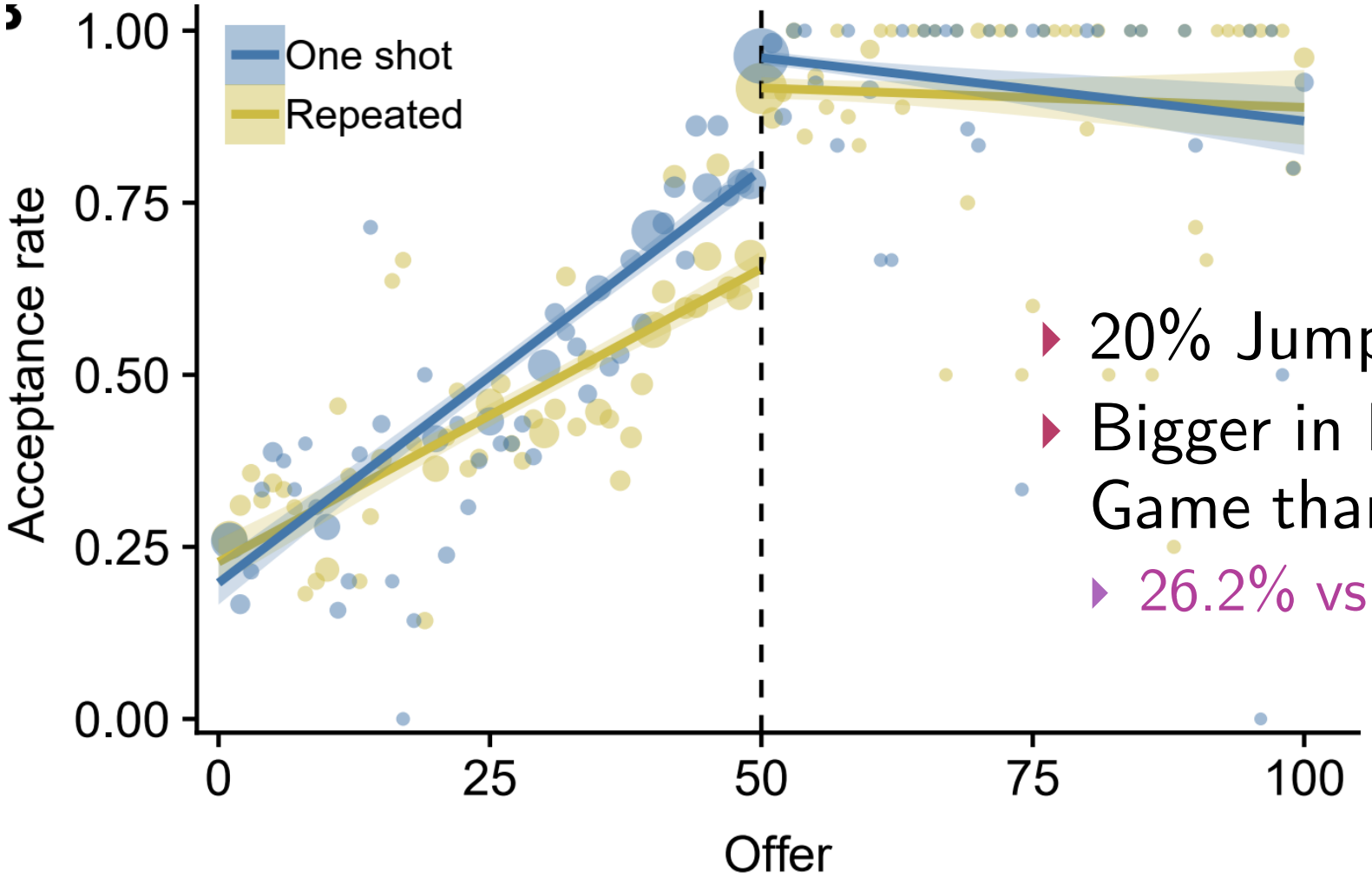
- Focal Points:
  - Multiples of Tens
- Most Frequent:
  - Equal-Split
- Cluster at 0

MobLab Ultimatum Game:
Proposal Offer - Class Effect



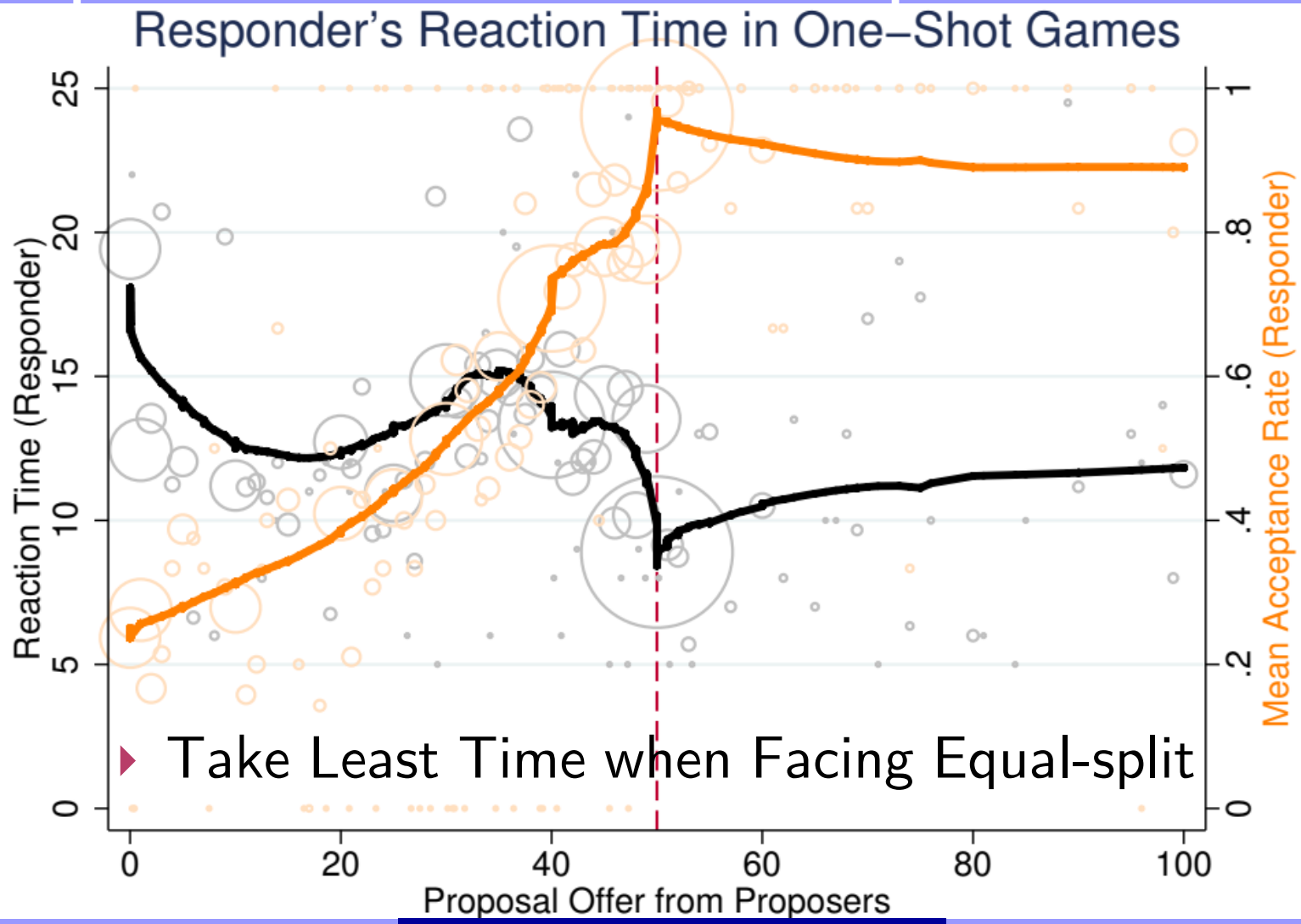
MobLab Ultimatum Game:

Acceptance Rate (Fit 2-part Regression)



- 20% Jump at 50
- Bigger in Repeated Game than 1-shot
  - 26.2% vs. 16.3%

MobLab Ultimatum Game:
Acceptance Rate and Response Time

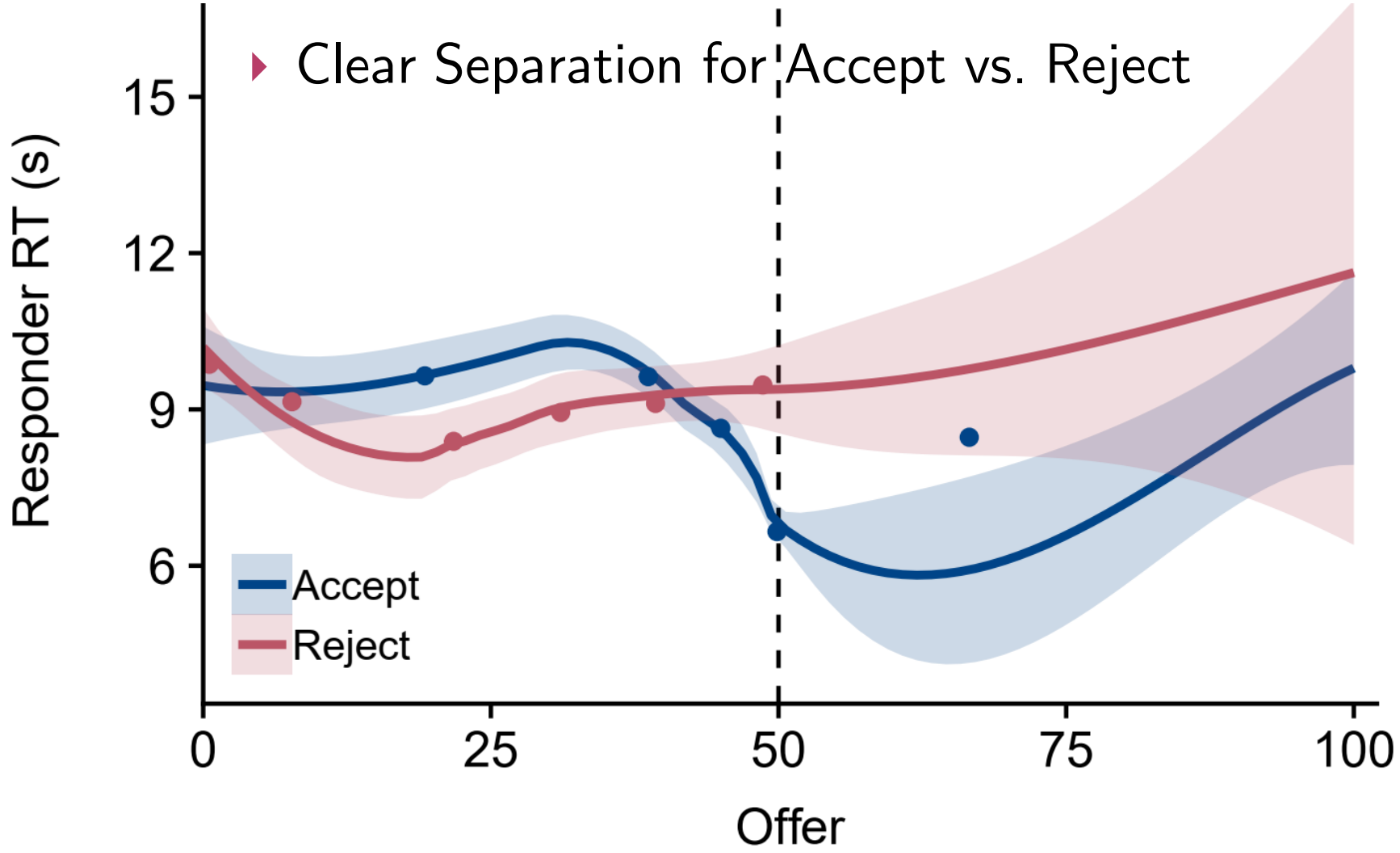


- Take Least Time when Facing Equal-split

MobLab Ultimatum Game:

Response Time

- Clear Separation for Accept vs. Reject

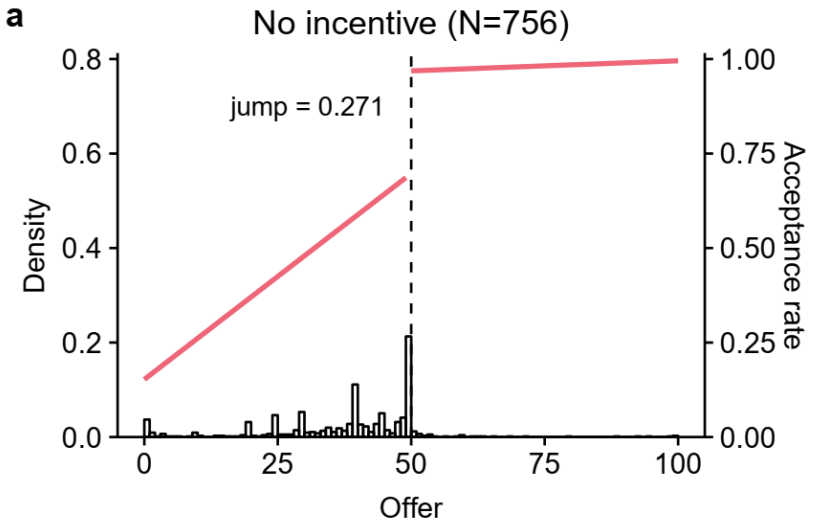


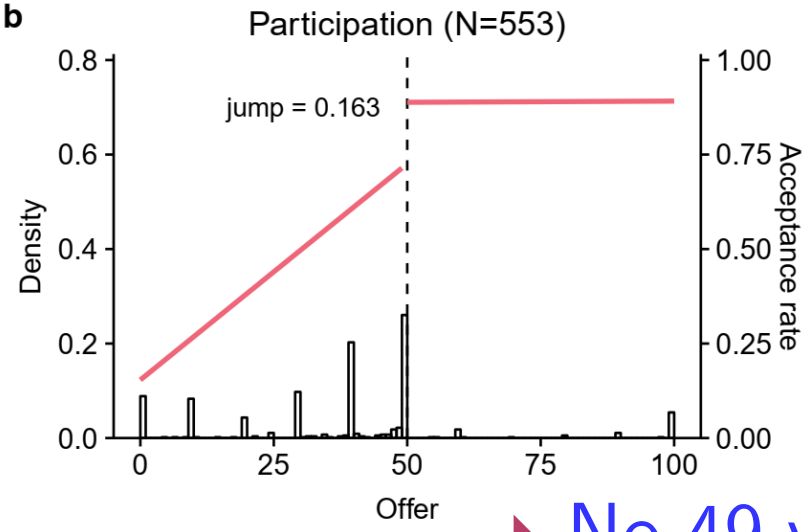
MobLab Ultimatum Game:
Robustness: Do Incentives Matter?

- Find Syllabi online (58 out of 490 sessions)
  - 1,772 out of 10,507 observations
- Separate Real Money (n=108) from:
  1. Course Points (n=355): Performance as grades
  2. Participation (n=553): Participate in enough
  3. No Incentive (n=756): None of the above
  - Real Money: Exp/Beh Econ@US-south SLAC
  - Much more 50-50 (More than Double!)
  - Average Proposal 47.22 (>34.00–39.17 of others)
  - Acceptance rate = 91.7% (>61.8–67.3%)

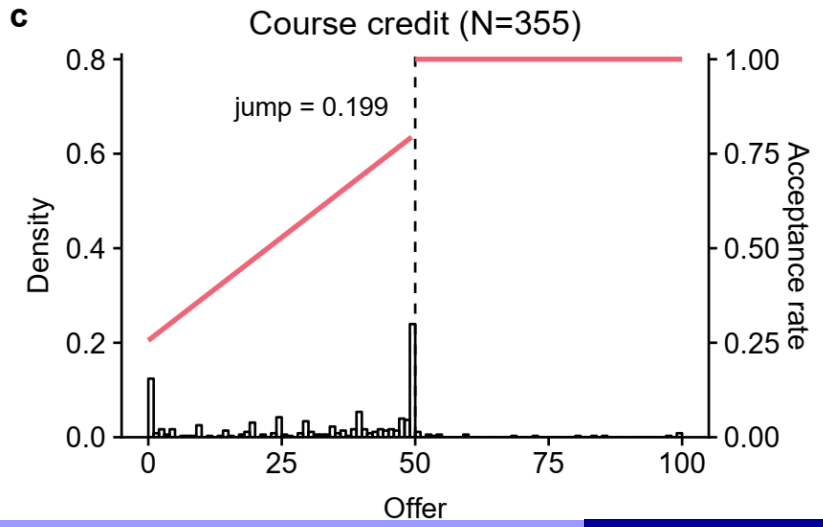
MobLab Ultimatum Game:

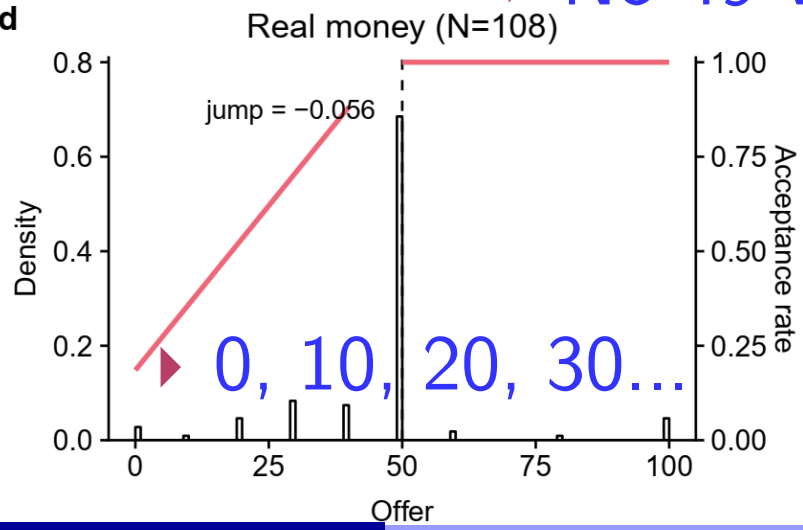
Robustness: Do Incentives Matter?





- No 49 vs. 50!





- 0, 10, 20, 30...

2. p-Beauty Contest (選美結果預測賽局)

- 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。

2. p-Beauty Contest (選美結果預測賽局)

- 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)

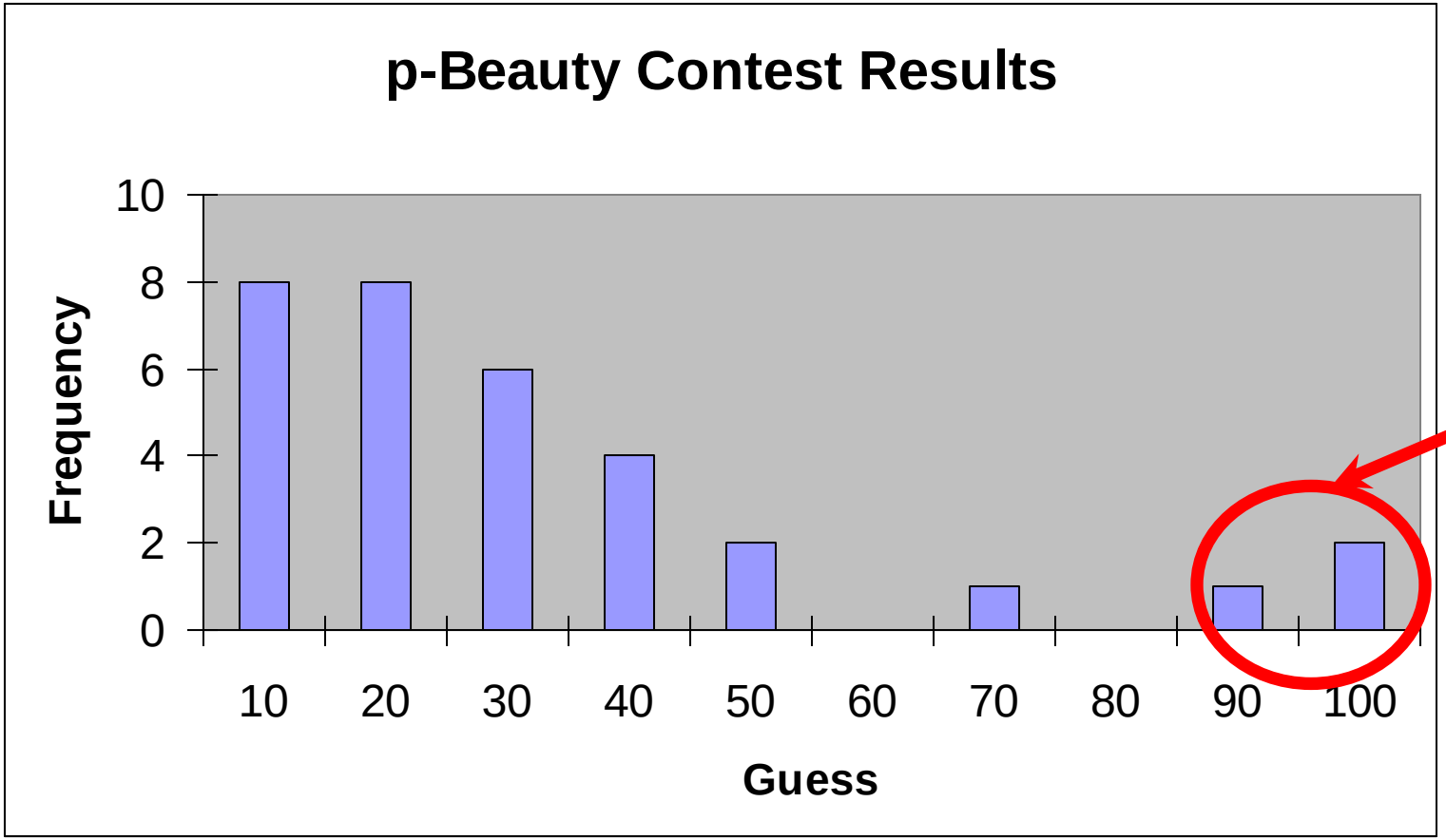
2. *p*-Beauty Contest (選美結果預測賽局)

- 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

2. p-Beauty Contest (選美結果預測賽局)

- Each pick 0-100 to predict 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

3. Continental Divide (產業發展分水嶺)

- 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)

My #

Group median

Continental [illegible]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

My #

Group median

Continental [illegible]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

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，你會獨排衆議，還是隨波逐流？

3. Continental Divide (產業發展分水嶺)

- 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...
- But got "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
   - Good design reduces confusion, induces behavior
   - 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
   - "Democracy is the worse form of government, except for all the others." by Winston Churchill
   - 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

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:

3. People were playing a different game
   - So are all as-if models of the economy!
     - 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
   - Not if people are predictably irrational!
     - 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
- Take-home:
  - 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!