

Experimental Economics and Behavioral Game Theory

實驗經濟學與行為賽局論

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EE-BGT, Lecture 1a

What are the Cores of Economics? (經濟學核心方法論為何?)

- ▶ Micro, Macro, Metrics (個體, 總體, 計量)?
 - ▶ Because they are first year graduate courses (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」?)
 - ▶ Methods to obtain and test scientific knowledge? (獲得與檢驗科學知識的方法?)
 - ▶ That would be a Tautology! (變成套套邏輯!)

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

Two Traditions of Experimental Econ. (實驗經濟學兩大傳統)

- ▶ Linking to Two Nobel Laureates of 2002 (對應到兩位諾獎得主)
- ▶ **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 Economics? (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 Experimental Econ. (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)

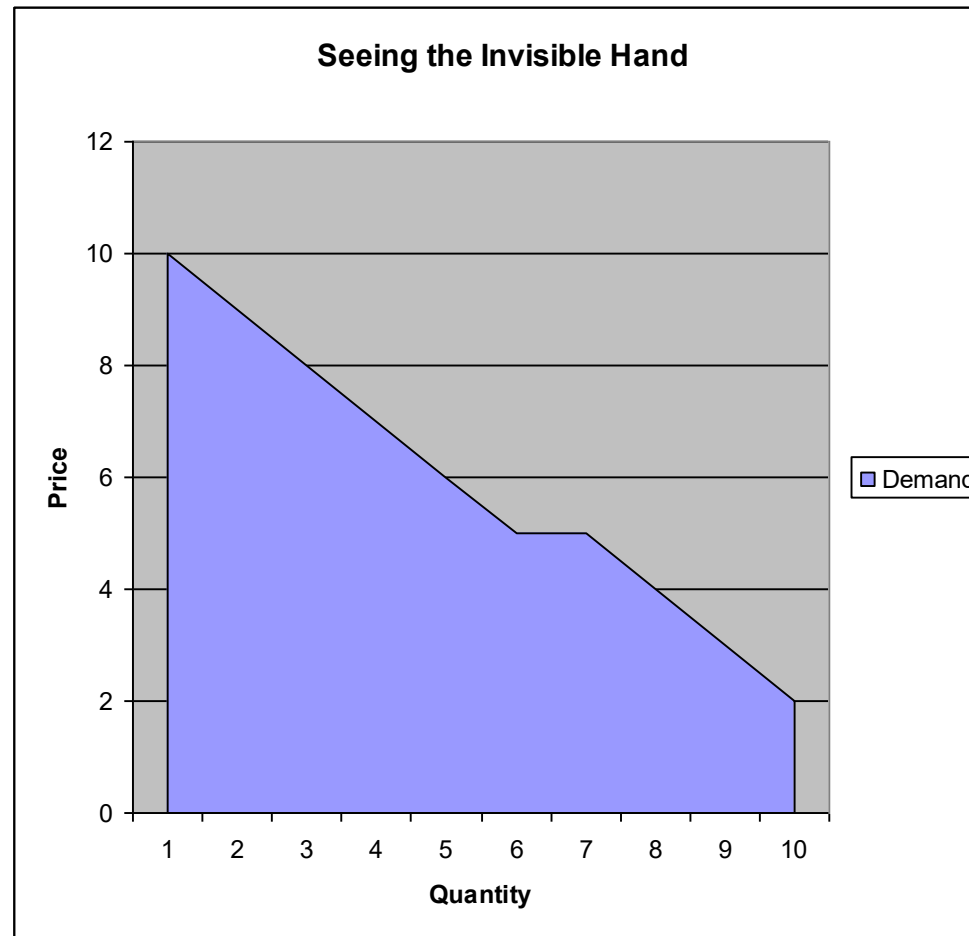
▶ **Alvin E. Roth (AER!)** (艾文·羅斯)

▶ Test this in the lab (在「實驗室」中驗證夏普利的理論)

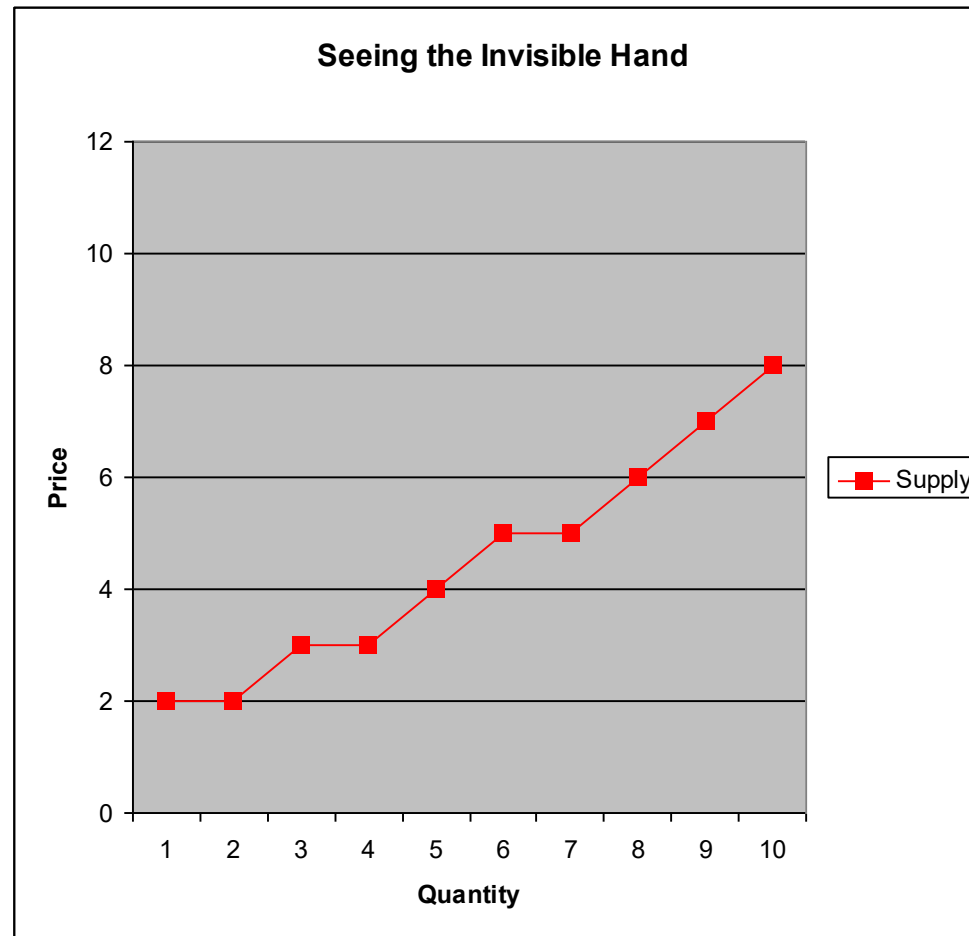
▶ Take this to the field (在「現場」設計穩定配對分發制度)

▶ Medical Residents, School Choice, Kidney Exchange... (實習醫生、學校分發、器官交換市場等等)

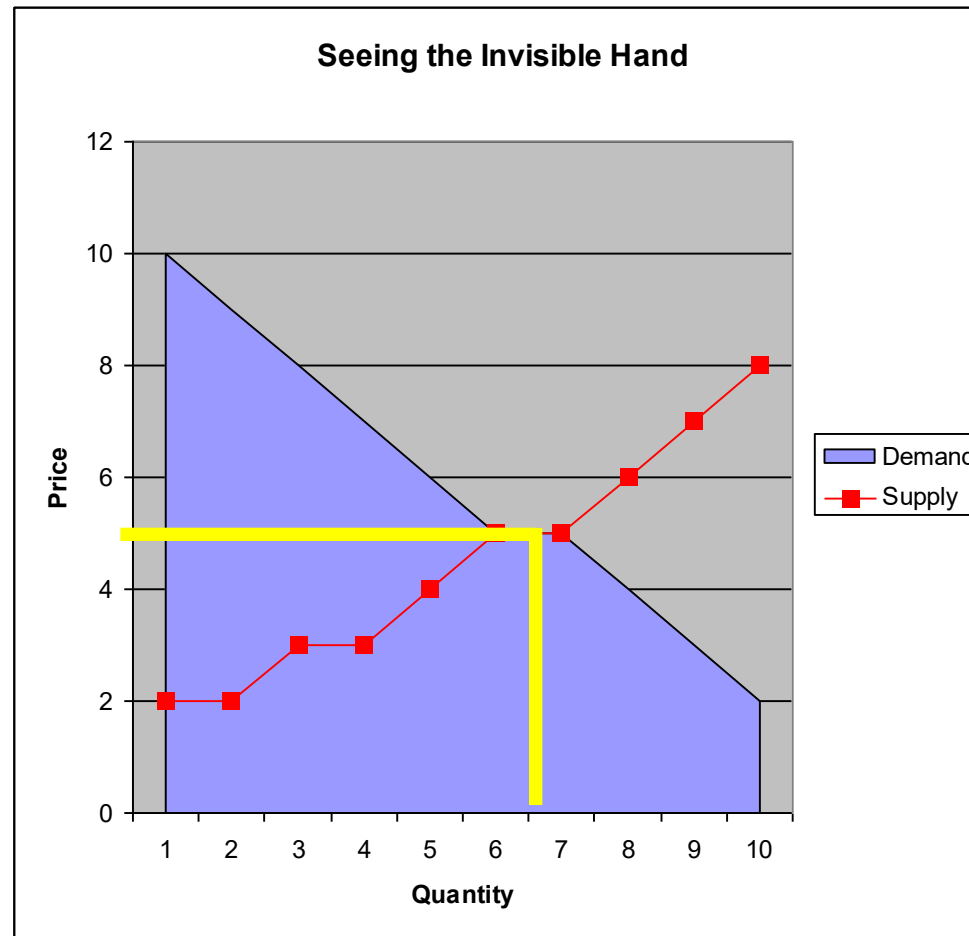
Seeing the Invisible Hand (發現看不見的手)



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 (成交价格)
 - 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

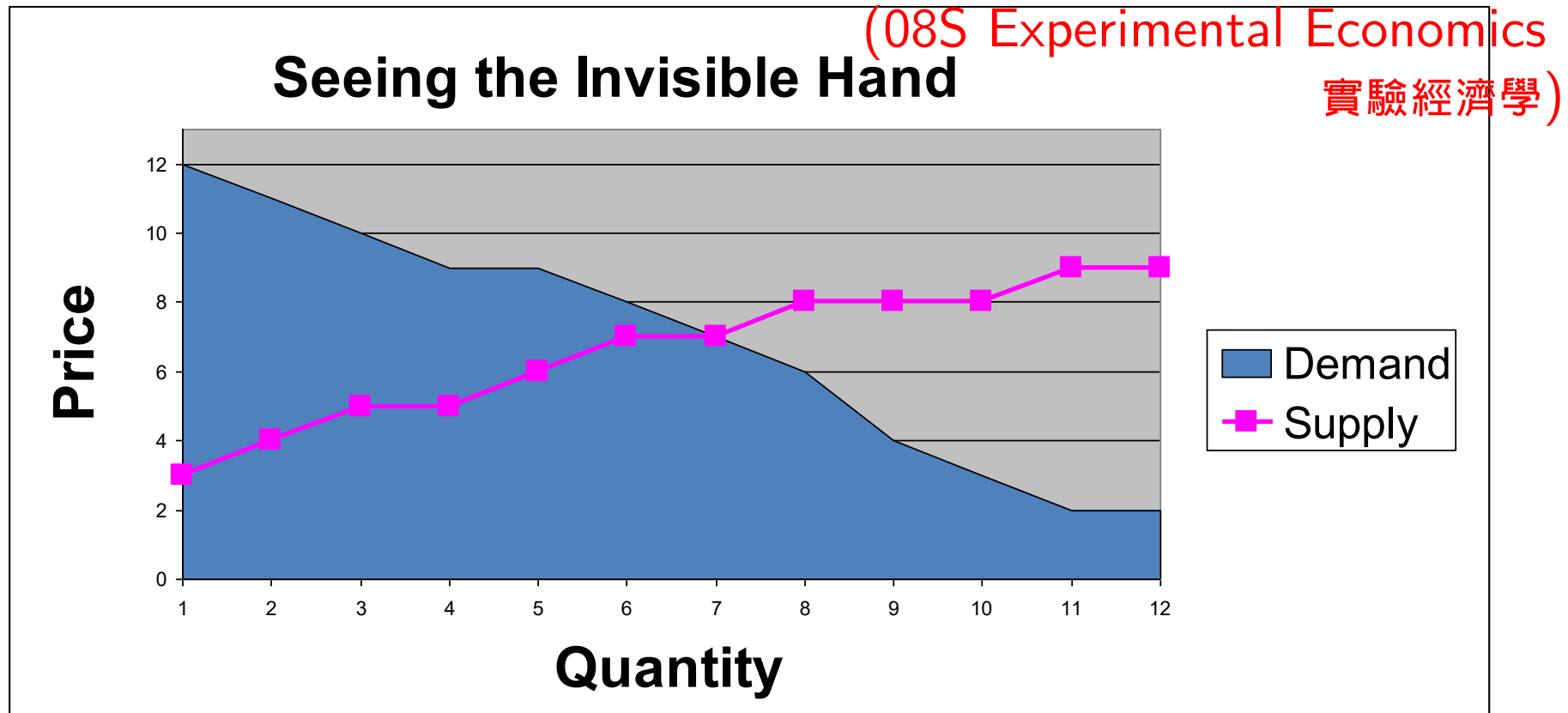


Seeing the Invisible Hand (發現看不見的手)

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

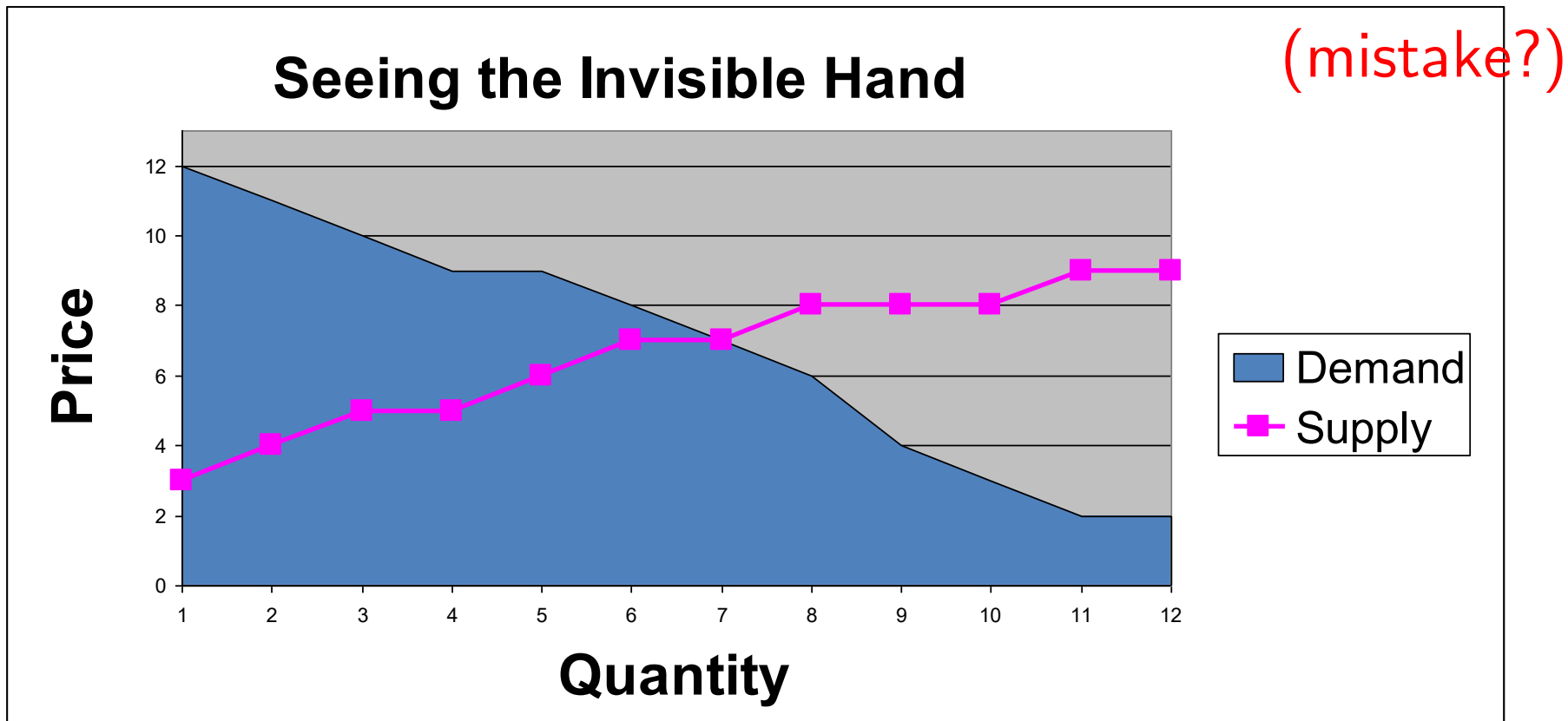
Seeing the Invisible Hand (發現看不見的手)

- 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





Game Instructions



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

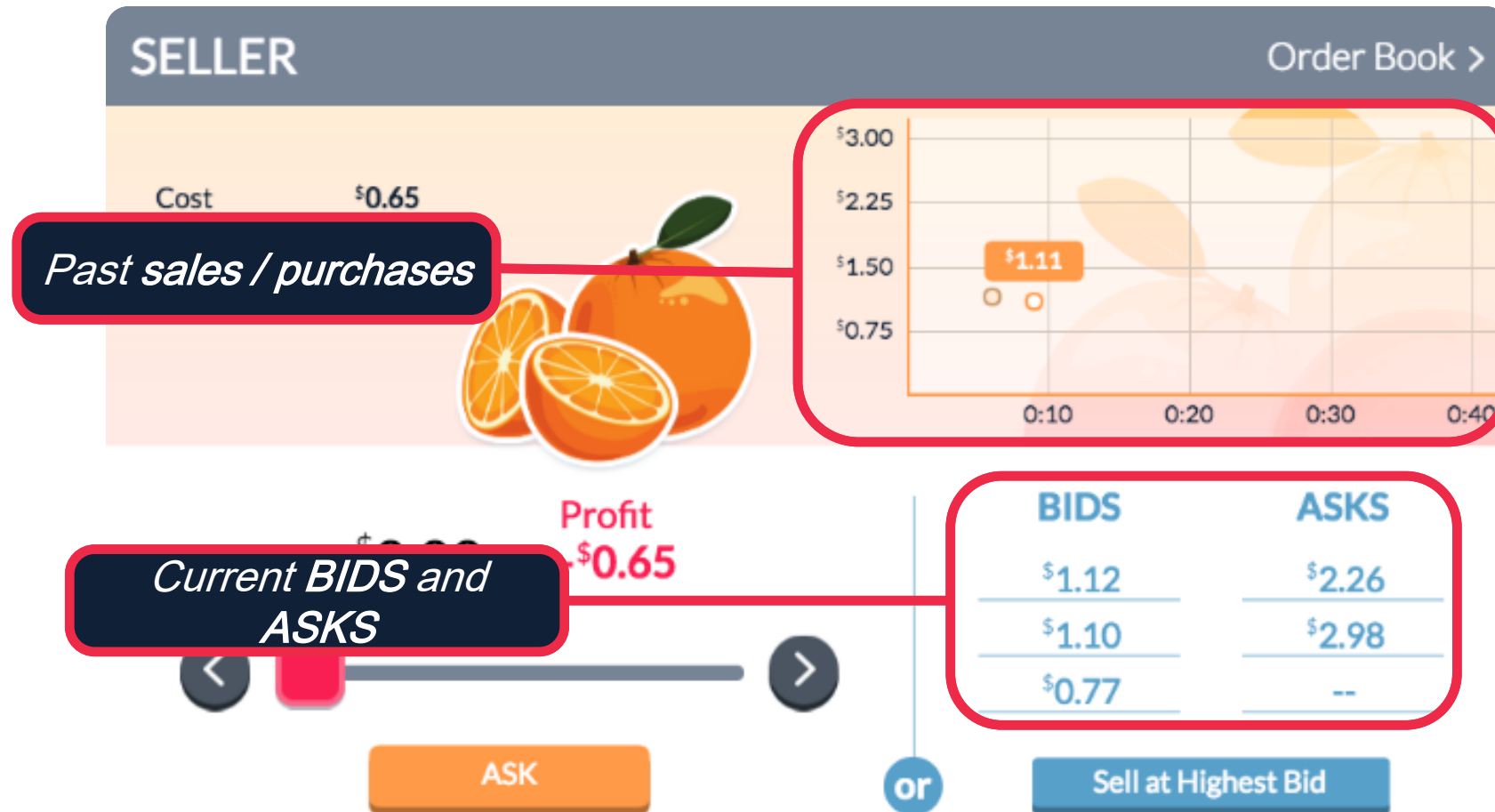
*Orange producer,
selling oranges*



*Hungry consumer,
buying oranges*



Bids are offers to buy



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

SELLER

Order Book >

Cost
Oranges
Earnings

\$0.65
3/3
\$0.00





\$0.00

Profit
-\$0.65

<



>

ASK

or

BIDS

ASKS

\$1.12

\$2.26

\$1.10

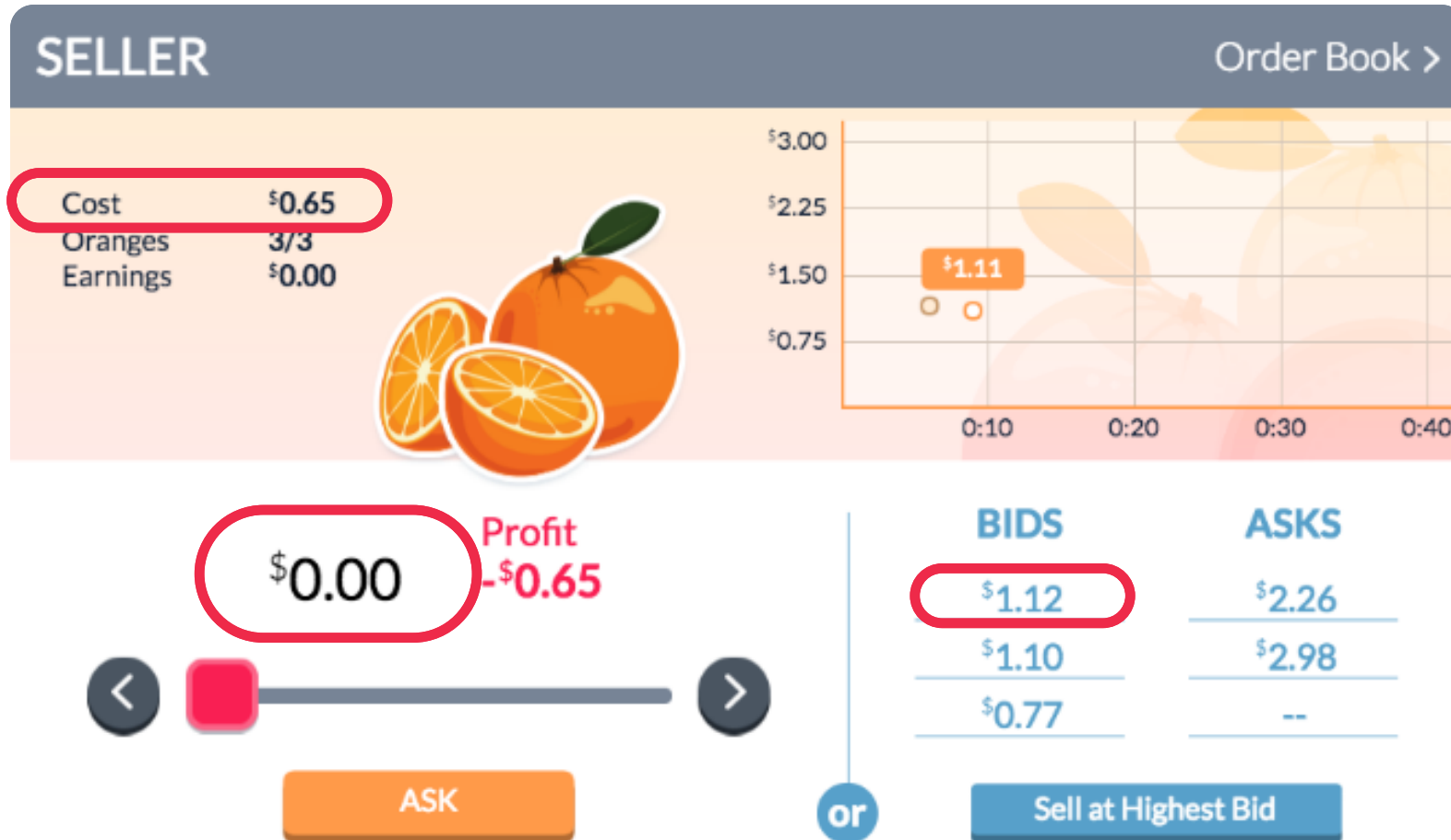
\$2.98

\$0.77

--

Sell at Highest Bid

Seller's Profit = Sale Price – Cost of Production



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

BUYER

Order Book >

Value
Oranges
Earnings

\$1.38
0/3
\$0.00





\$0.00

Profit
\$1.38

<



>

BID

or

BIDS

\$0.85

\$0.66

\$0.32

ASKS

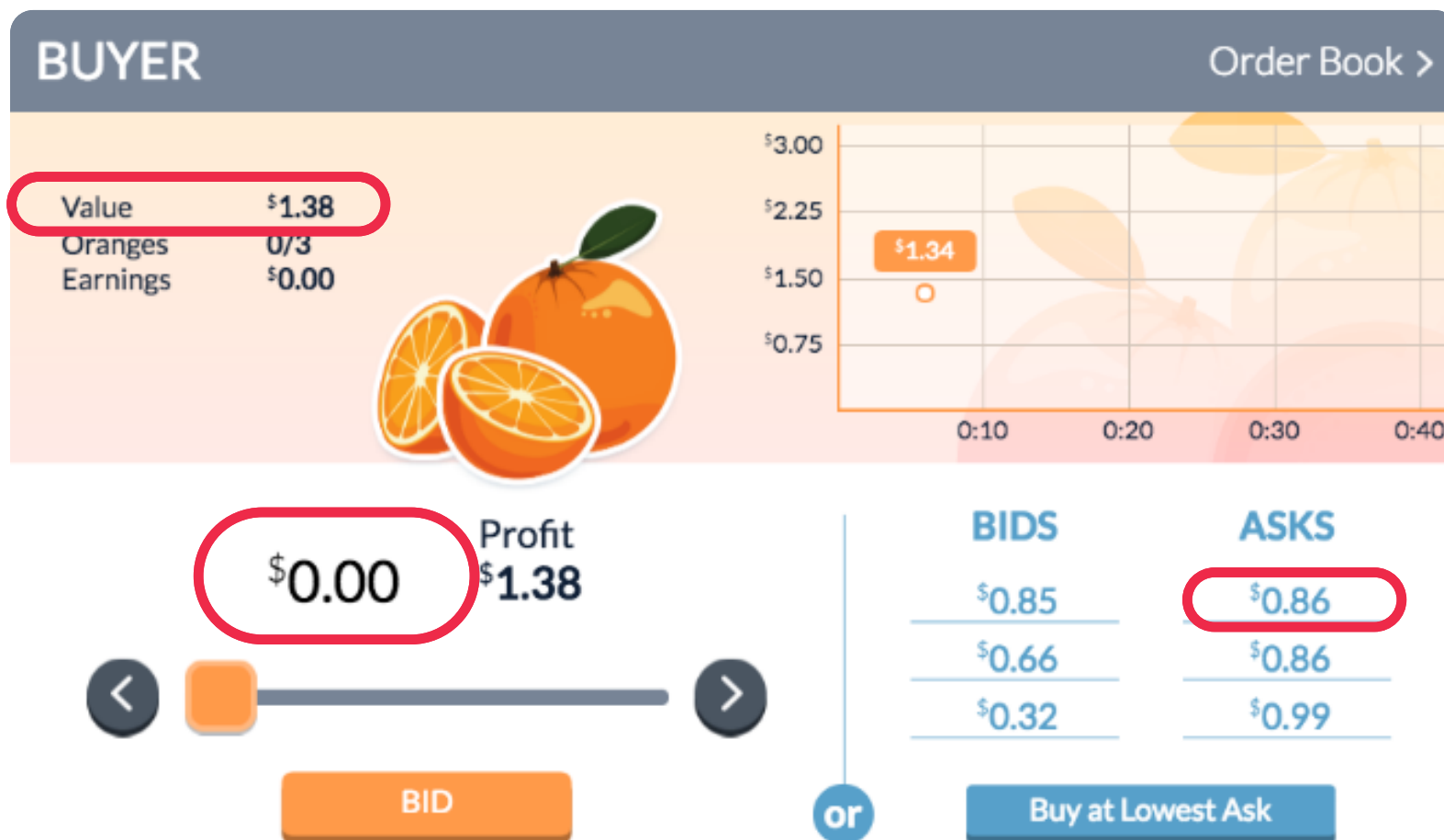
\$0.86

\$0.86

\$0.99

Buy at Lowest Ask

Buyer's Profit = Value of consumption – Purchase Price

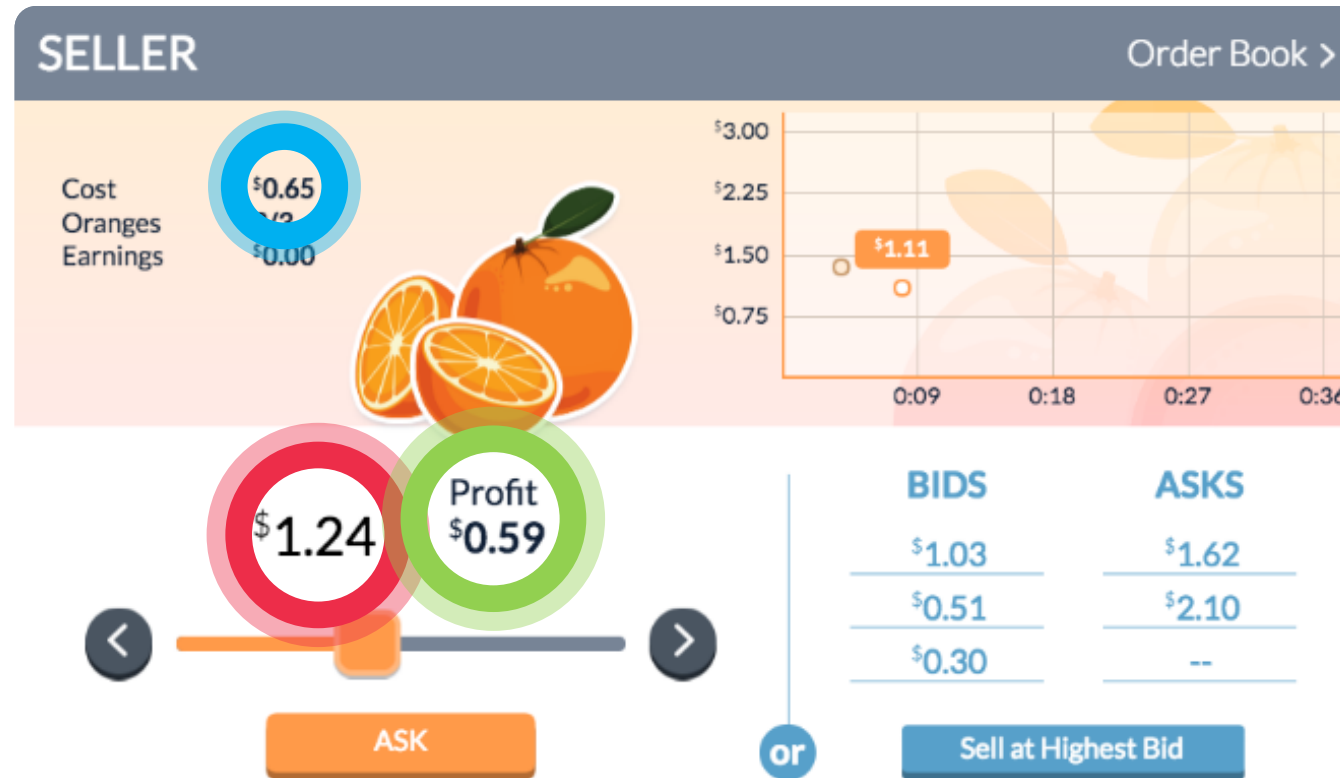


When does a transaction occur?

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

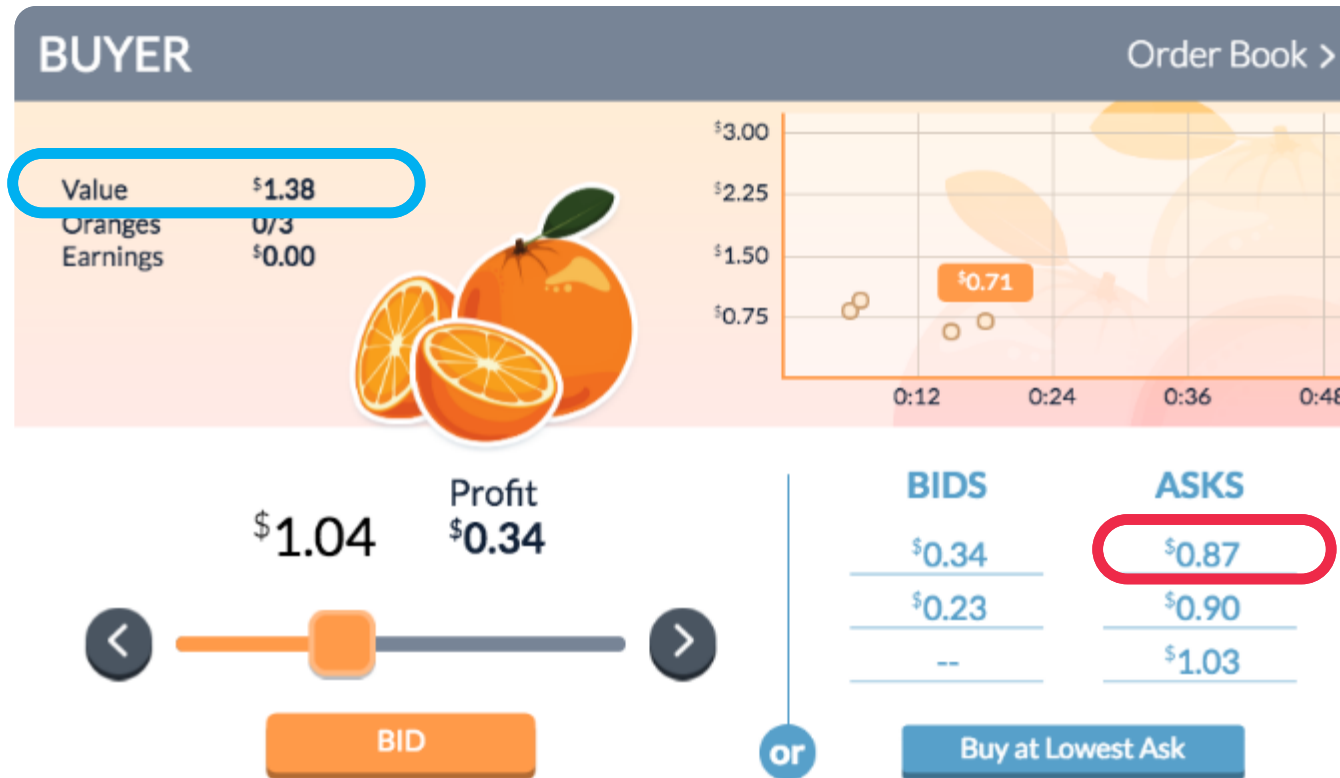


As a **seller**, what is your profit if someone accepts your ask of **\$1.24**?



$$\text{Sale Price} - \text{Cost} = \$1.24 - \$0.65 = \$0.59$$

As a buyer, what is your profit if you
“Buy at Lowest Ask”?



$$\text{Value} - \text{Purchase Price} = \$1.38 - \$0.87 = \$0.51$$

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- 1 Sign up as a student using your student Email

Student Sign Up

Learn complex concepts with more depth and context through the power of strategic social interactions

Name (Private)

First
Last

School/University Email

Confirm Email

Password

Enter Password
Confirm Password

- 2 Join the class



Welcome back!

 Active Sessions 

+

Enter a Class Code

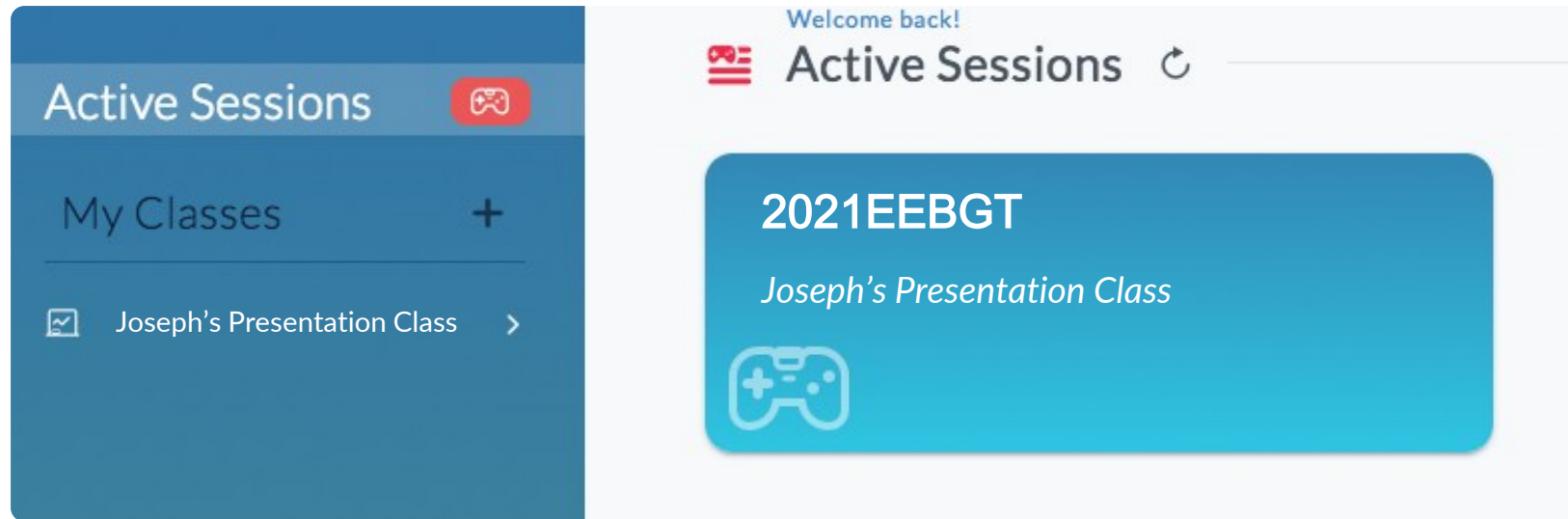
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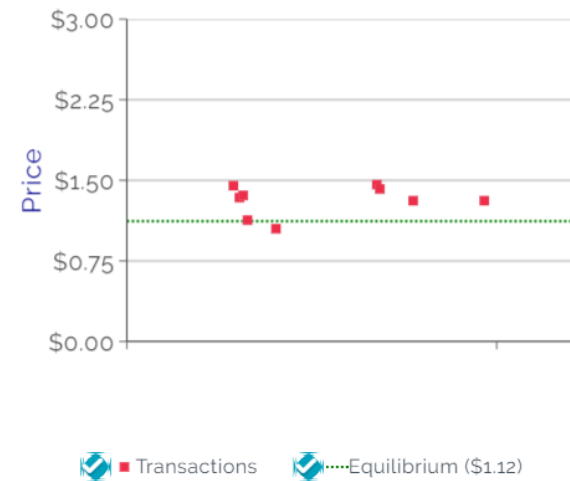
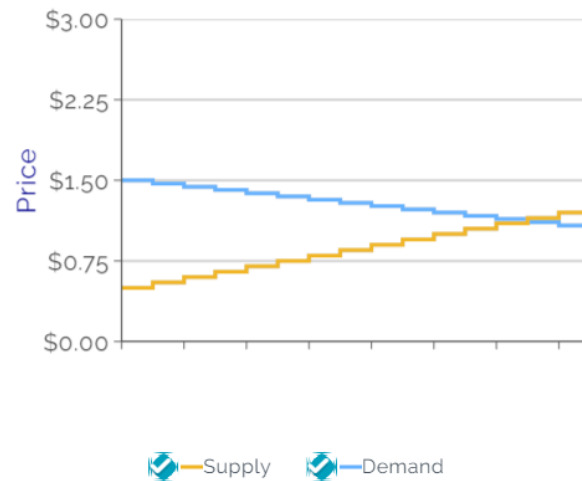
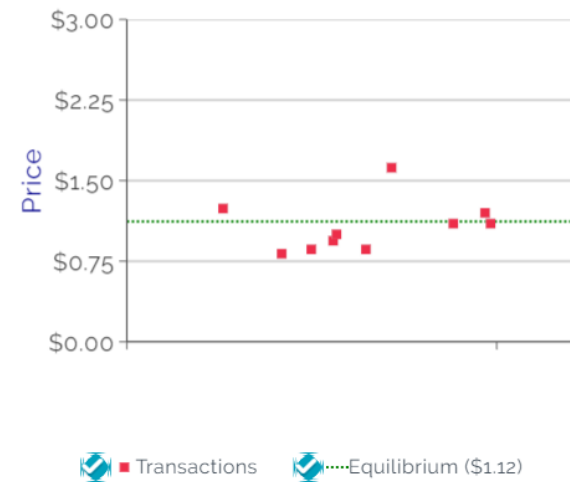
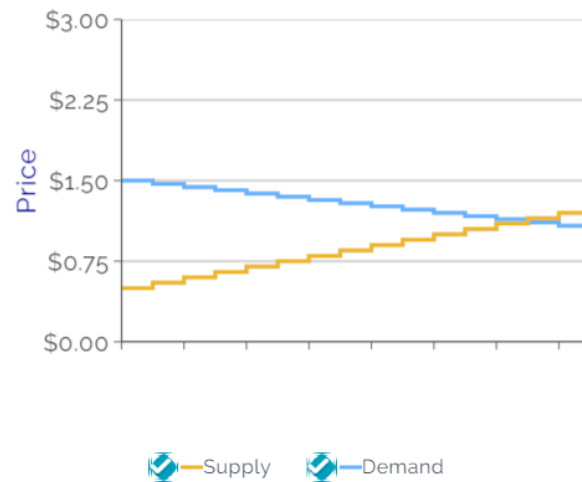
Class codes are given by instructors to allow their students to join a particular class.

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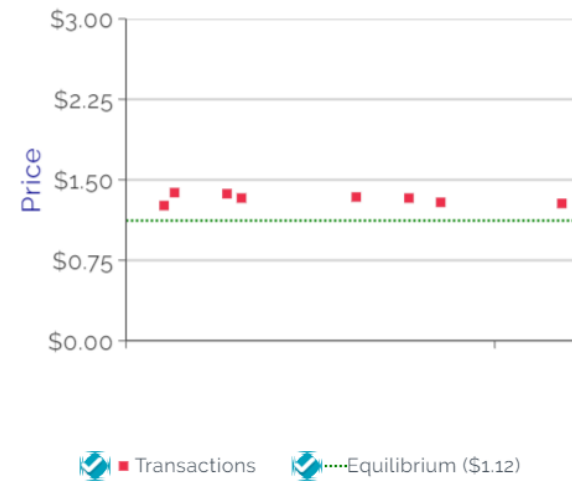
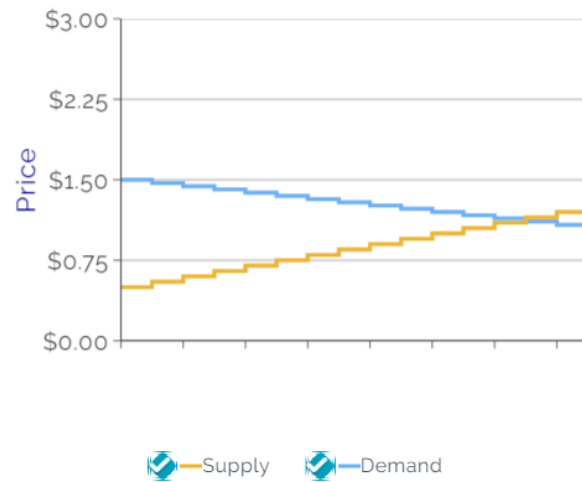
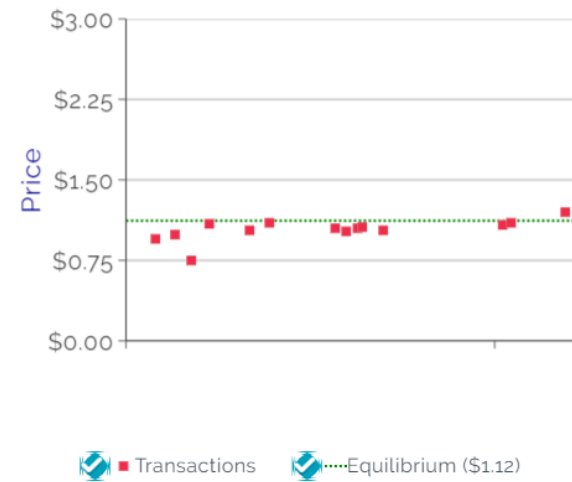
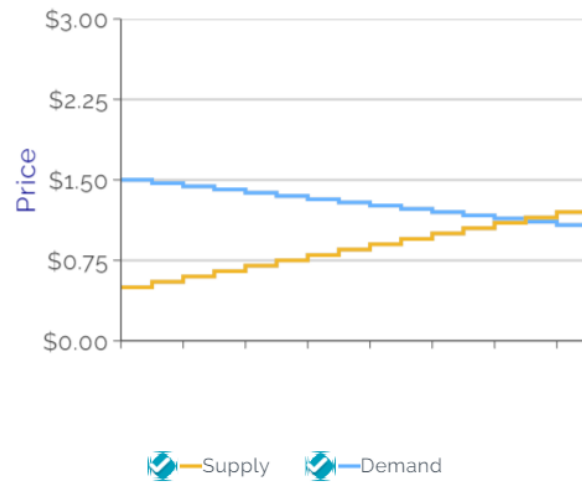


MobLab Double Auction: EE-BGT 21S Results: Round 1

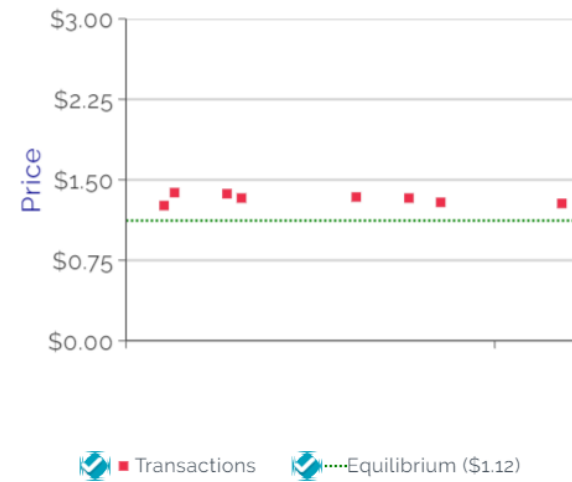
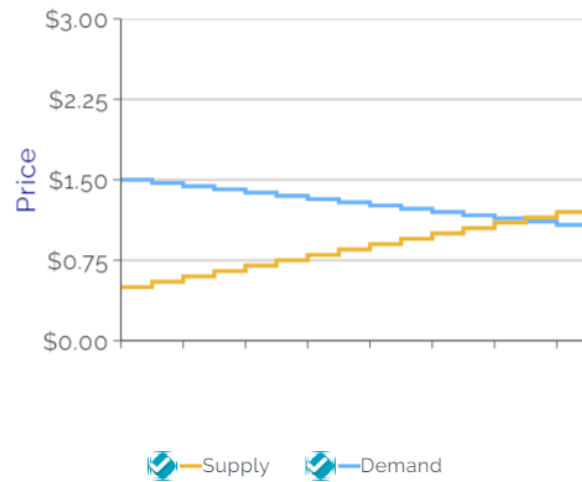
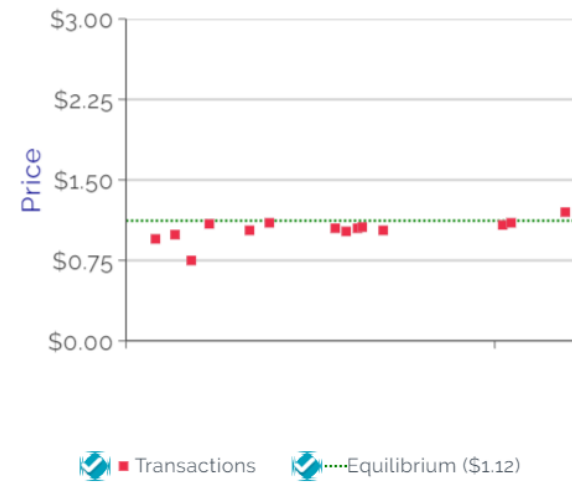
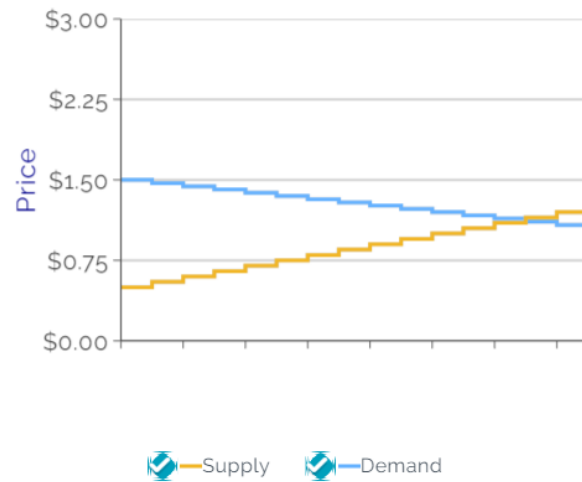


MobLab Double Auction:

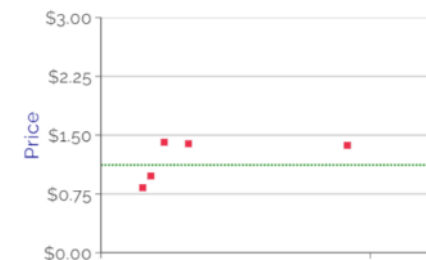
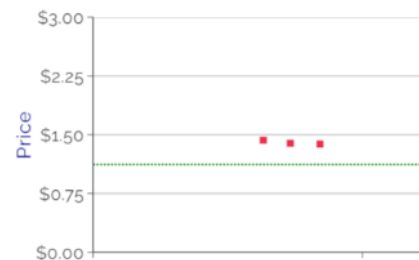
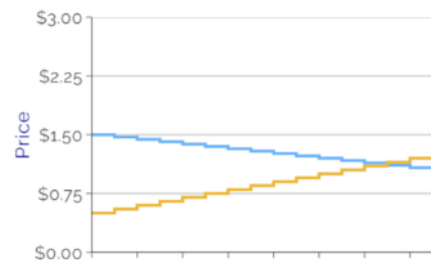
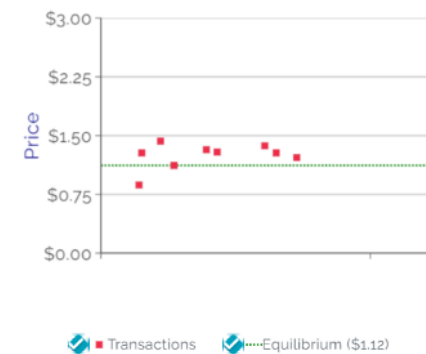
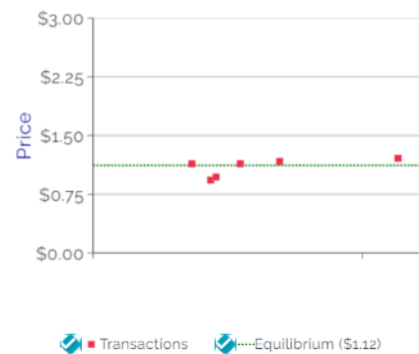
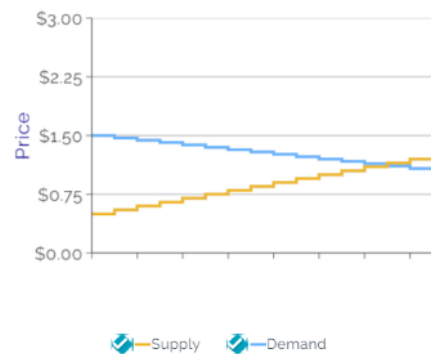
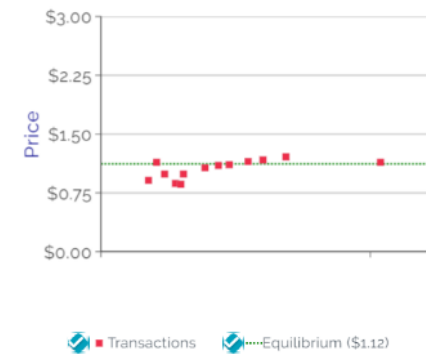
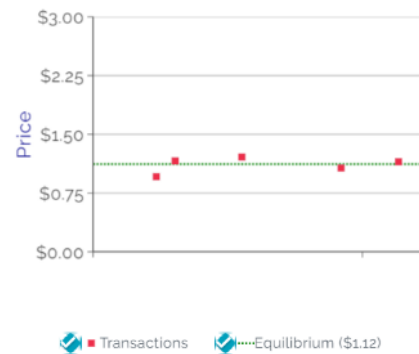
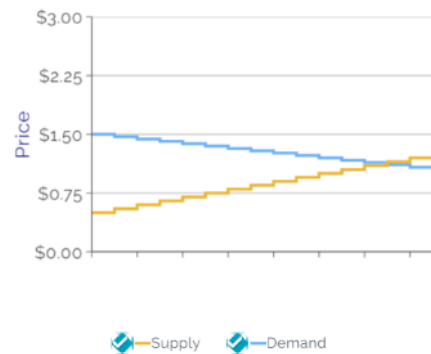
EE-BGT 21S Results: Round 2



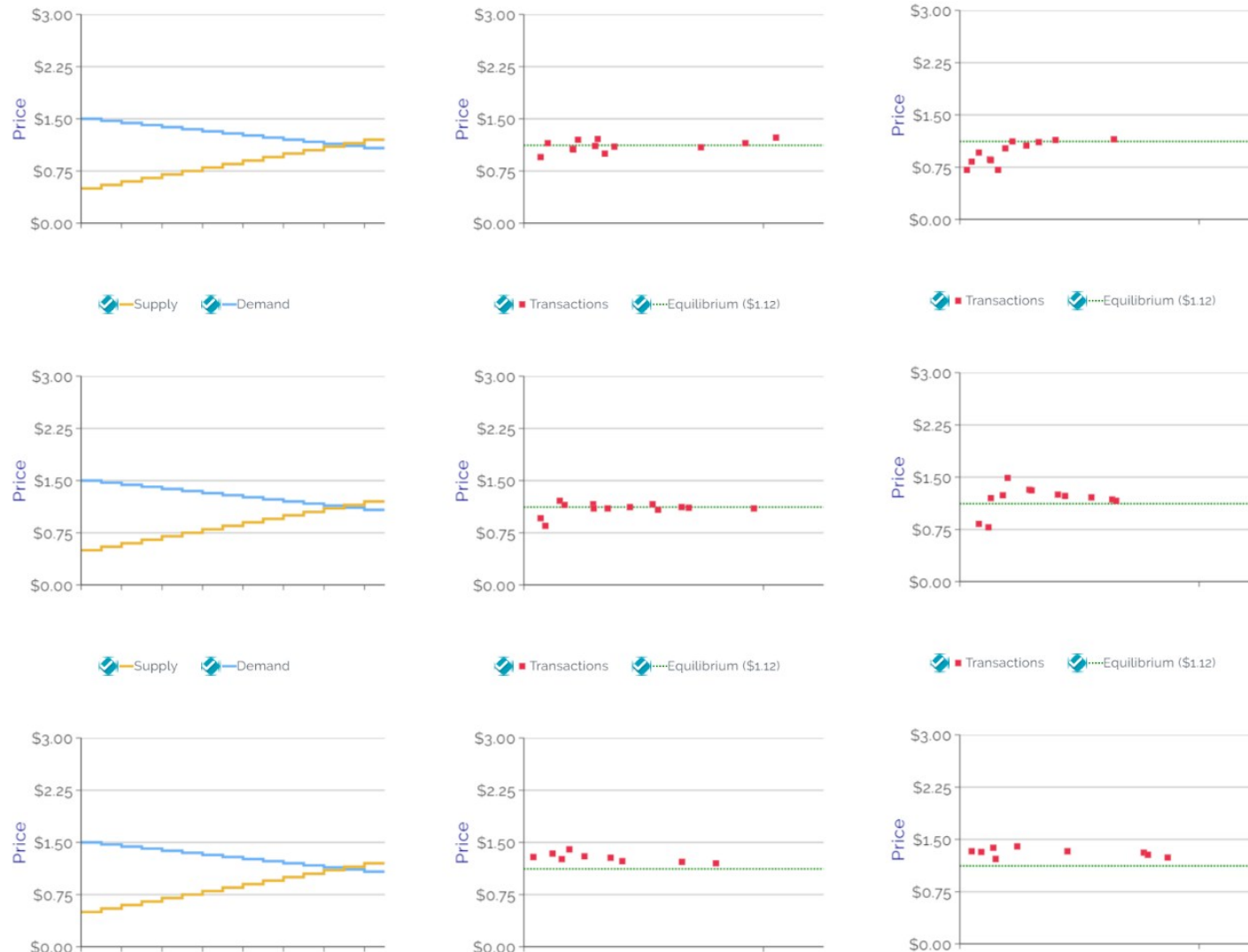
MobLab Double Auction: EE-BGT 21S Results: Round 3



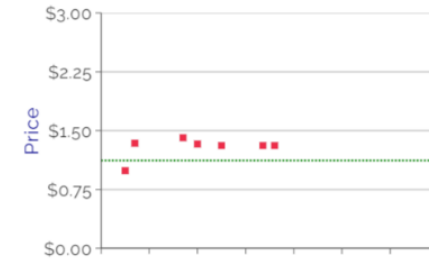
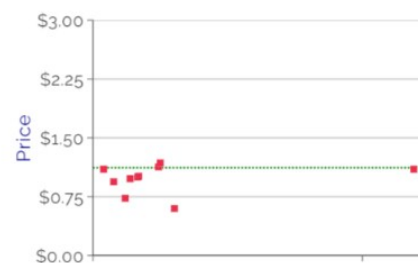
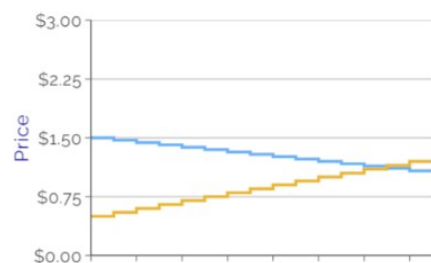
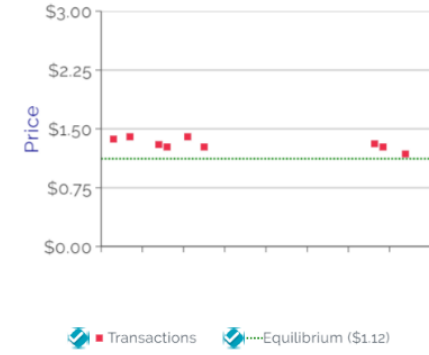
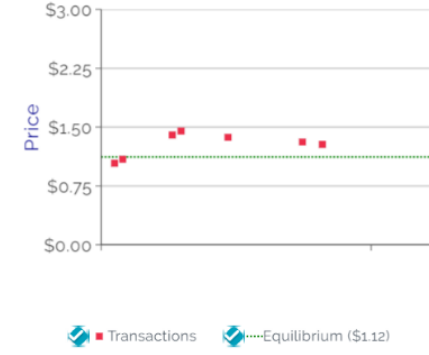
MobLab Double Auction: CCU Results: Round 1



MobLab Double Auction: CCU Results: Round 2

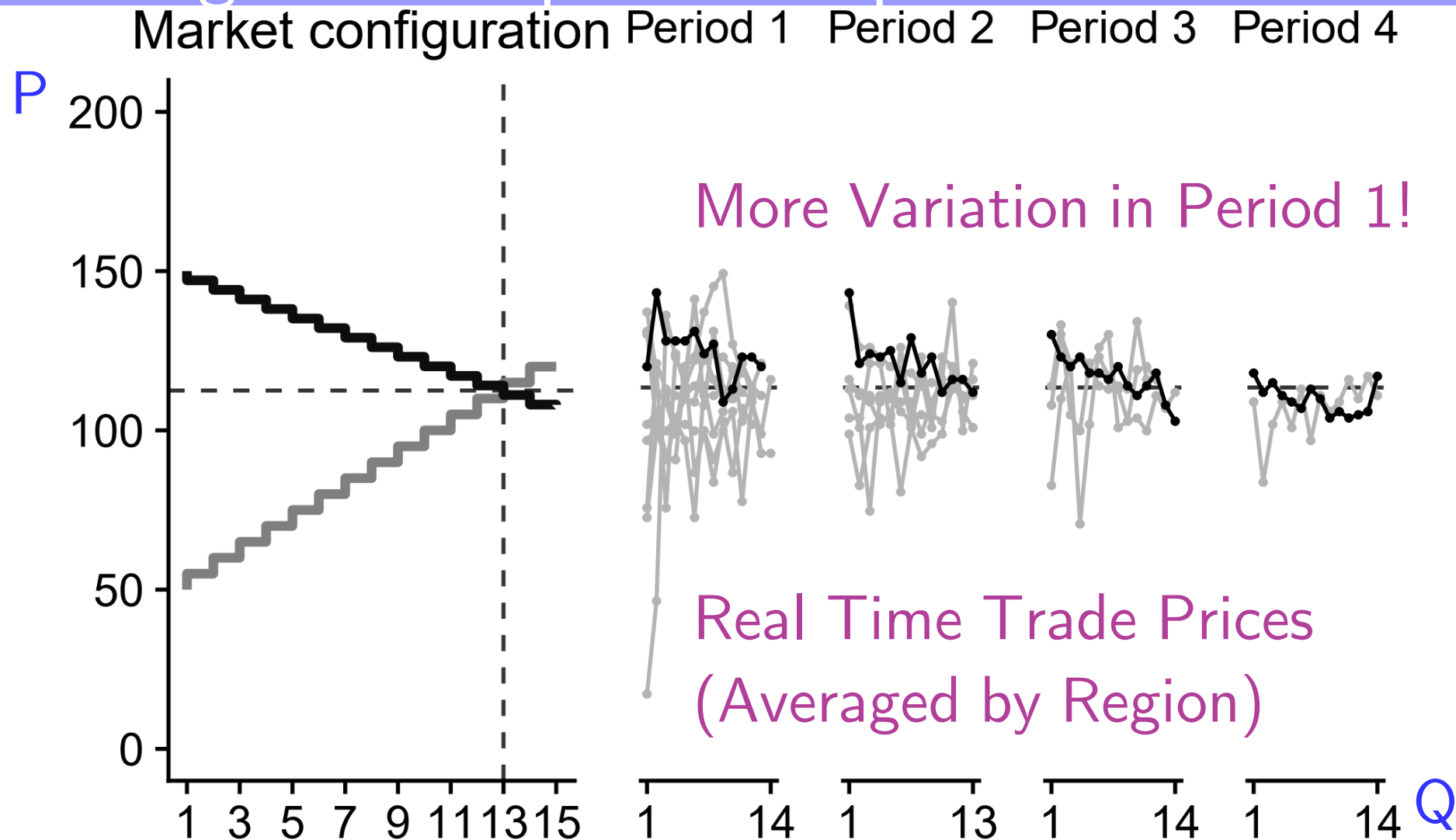


MobLab Double Auction: CCU Results: Round 3



MobLab Double Auction: Lin et al. (2020)

Prices Converge to Competitive Equilibrium



MobLab Double Auction:

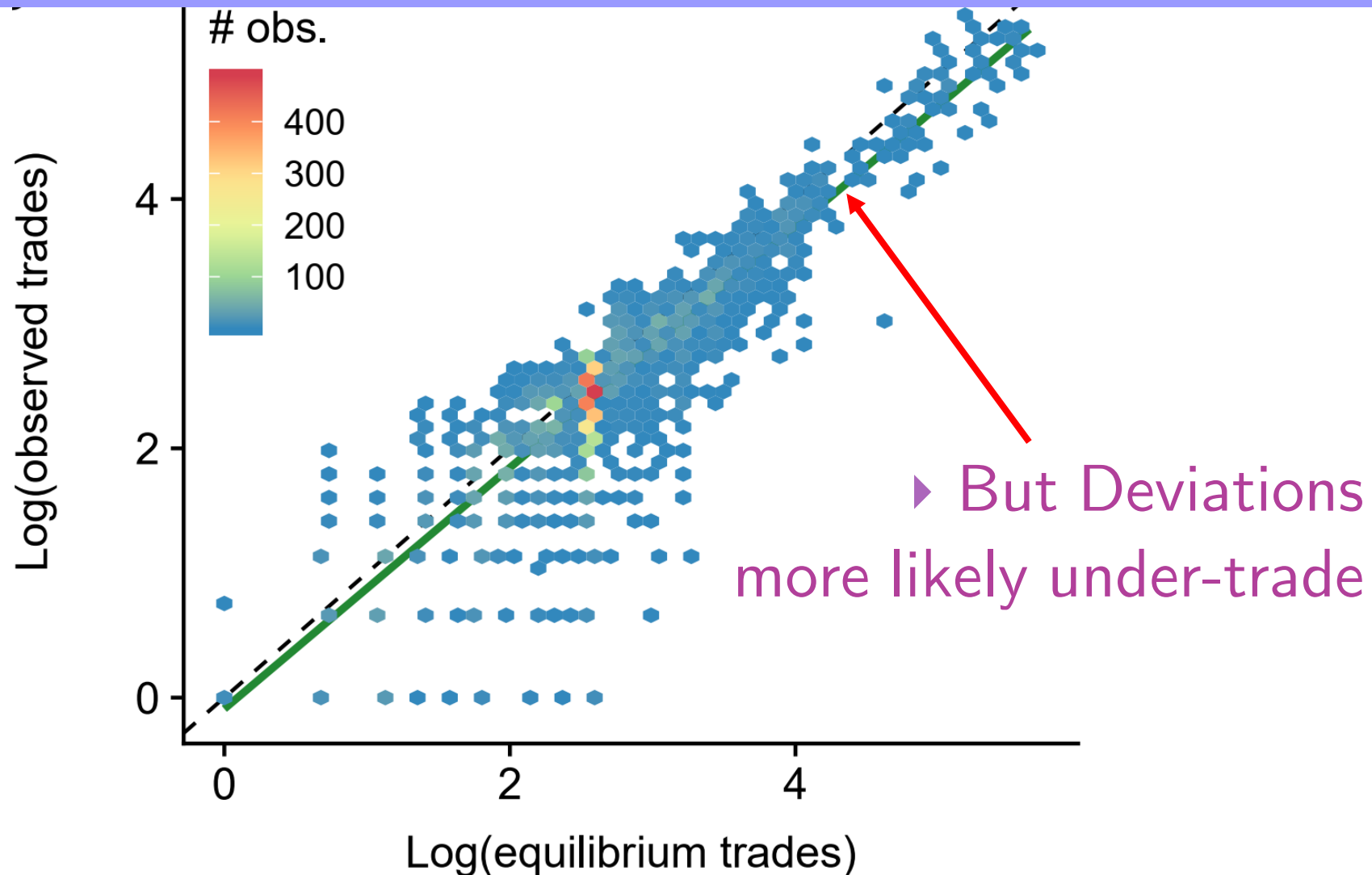
Summary Statistics

	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!



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

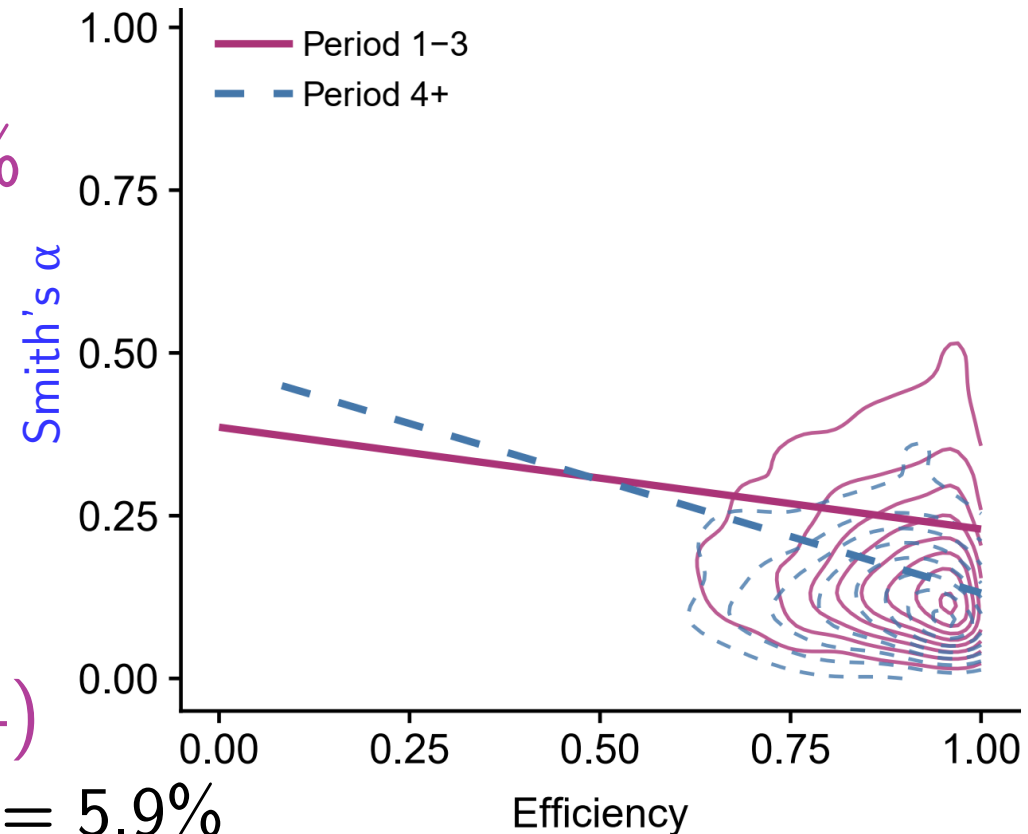
- ▶ Stable at 92%

- ▶ 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)

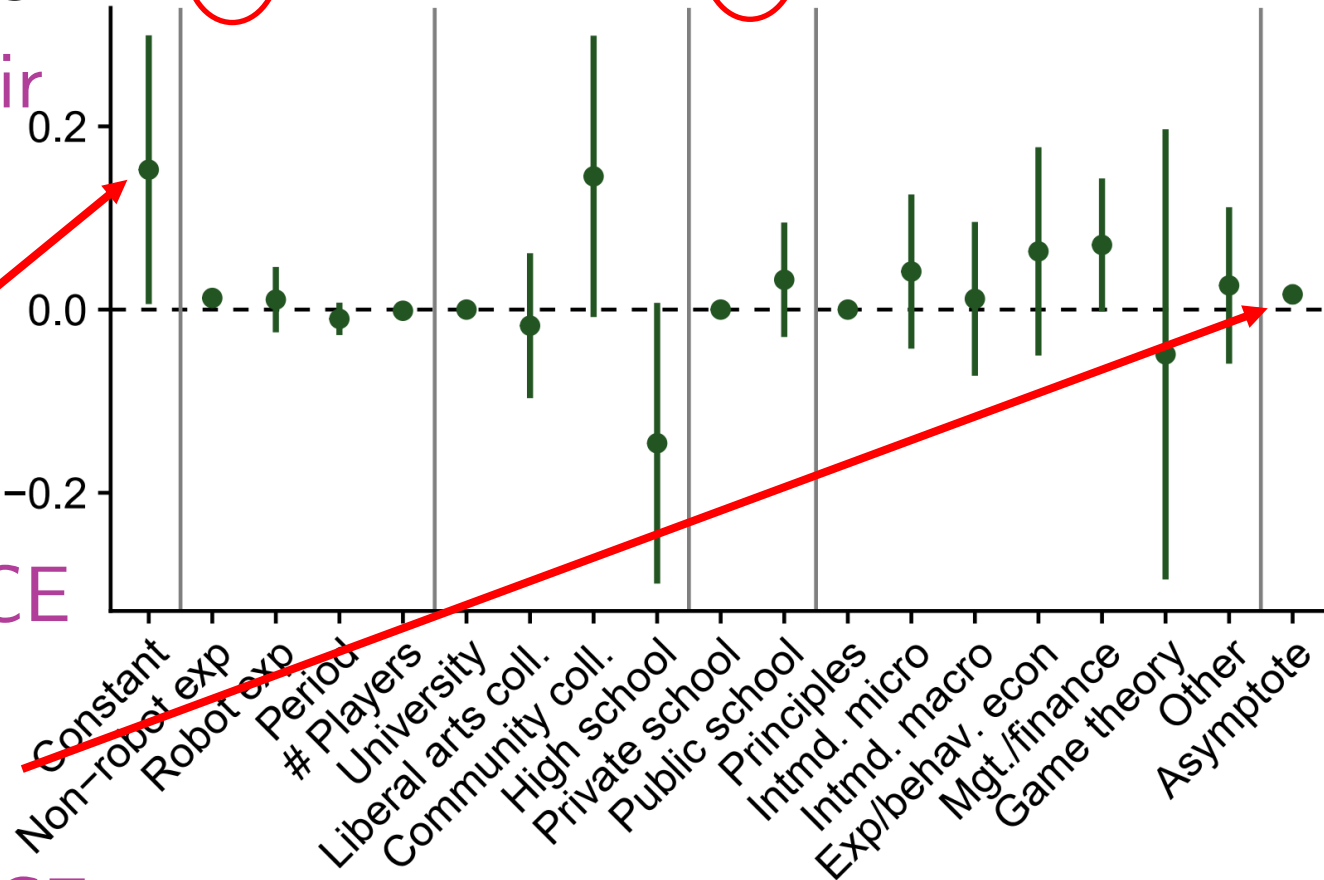
▶ 1st Trade:

▶ On average
15.3% above CE

▶ (t=1)

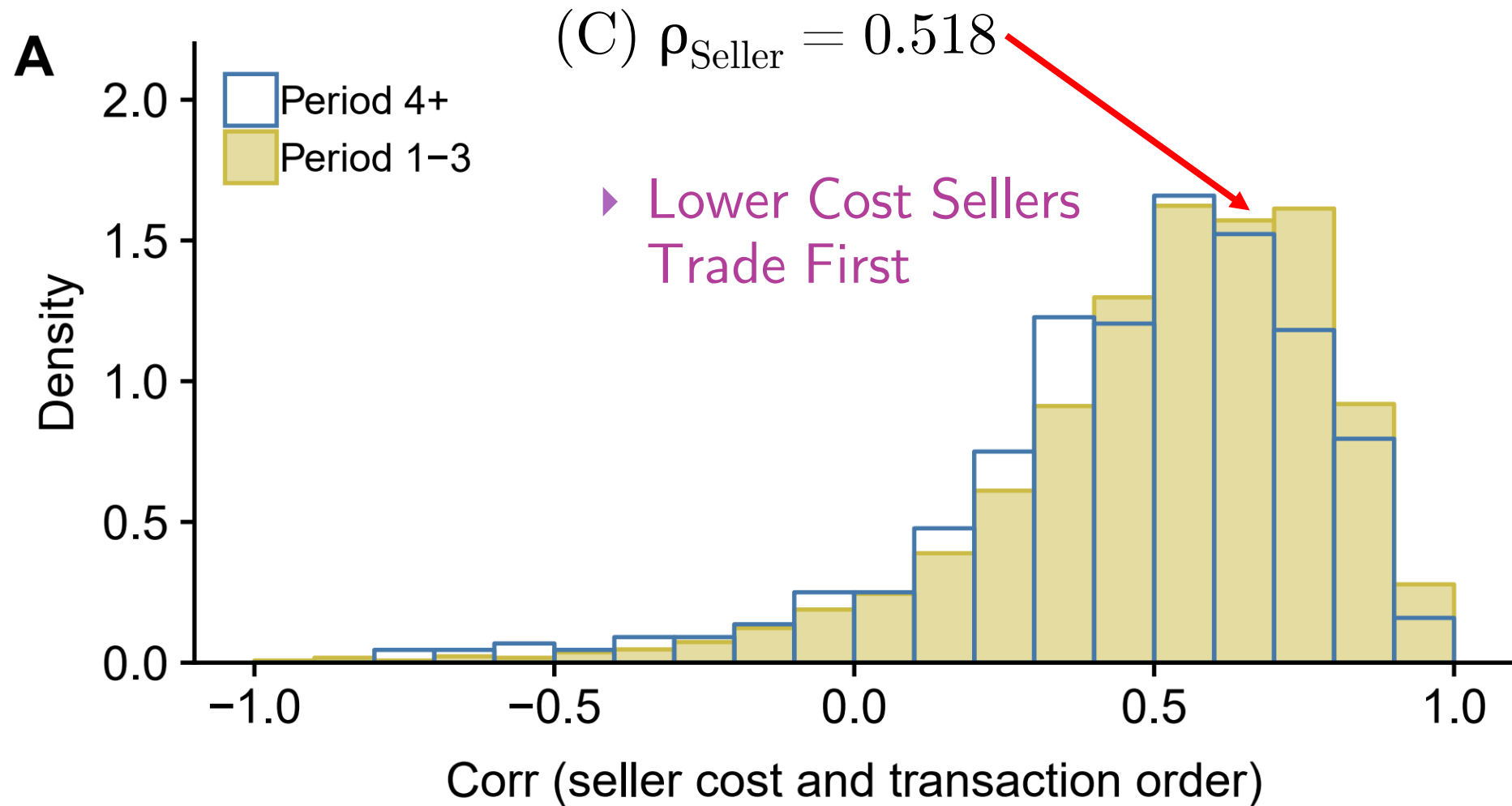
▶ Converge to:

▶ 1.7% above CE



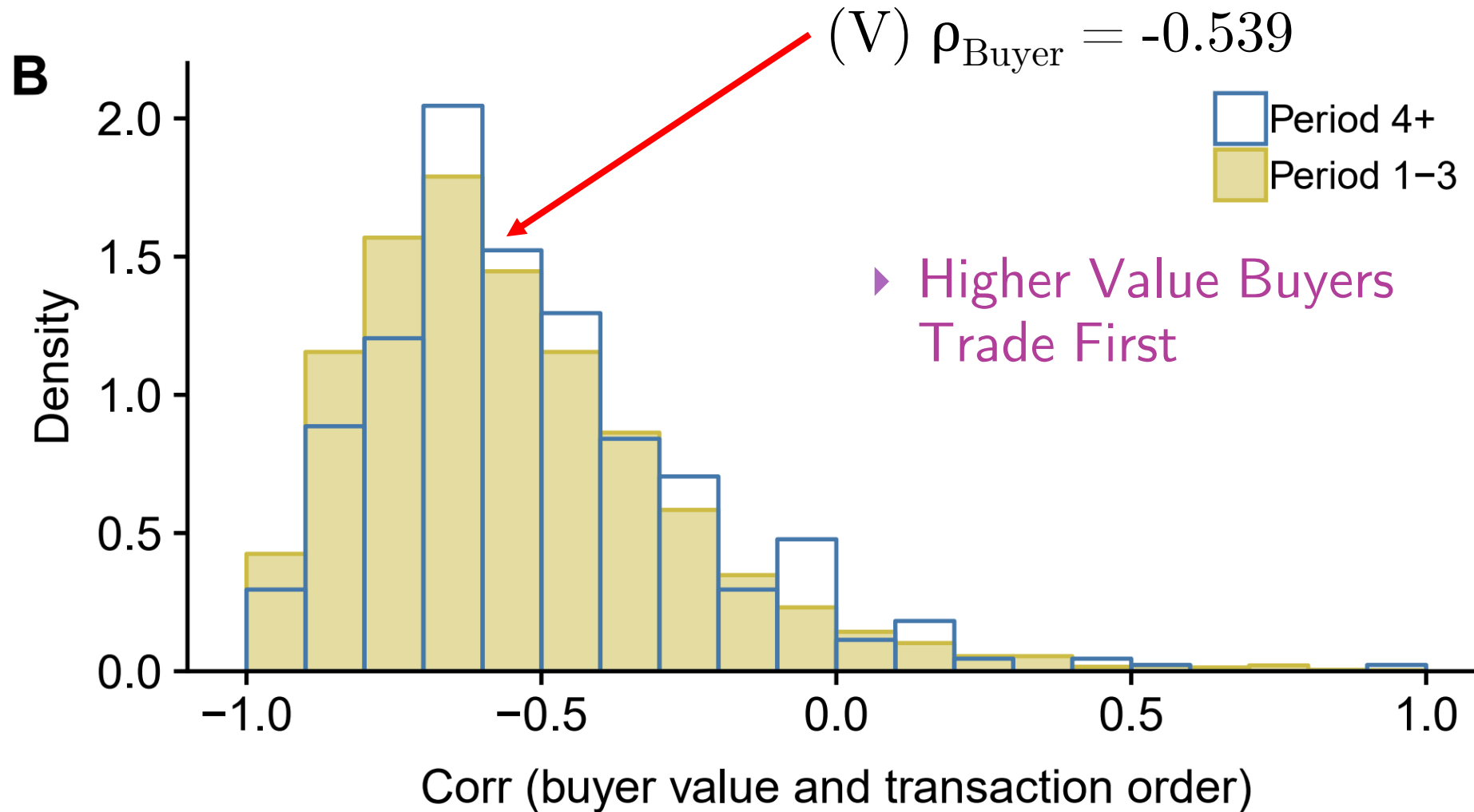
MobLab Double Auction: Seller Rank-Order

Correlation(Transaction Order, Seller Cost)



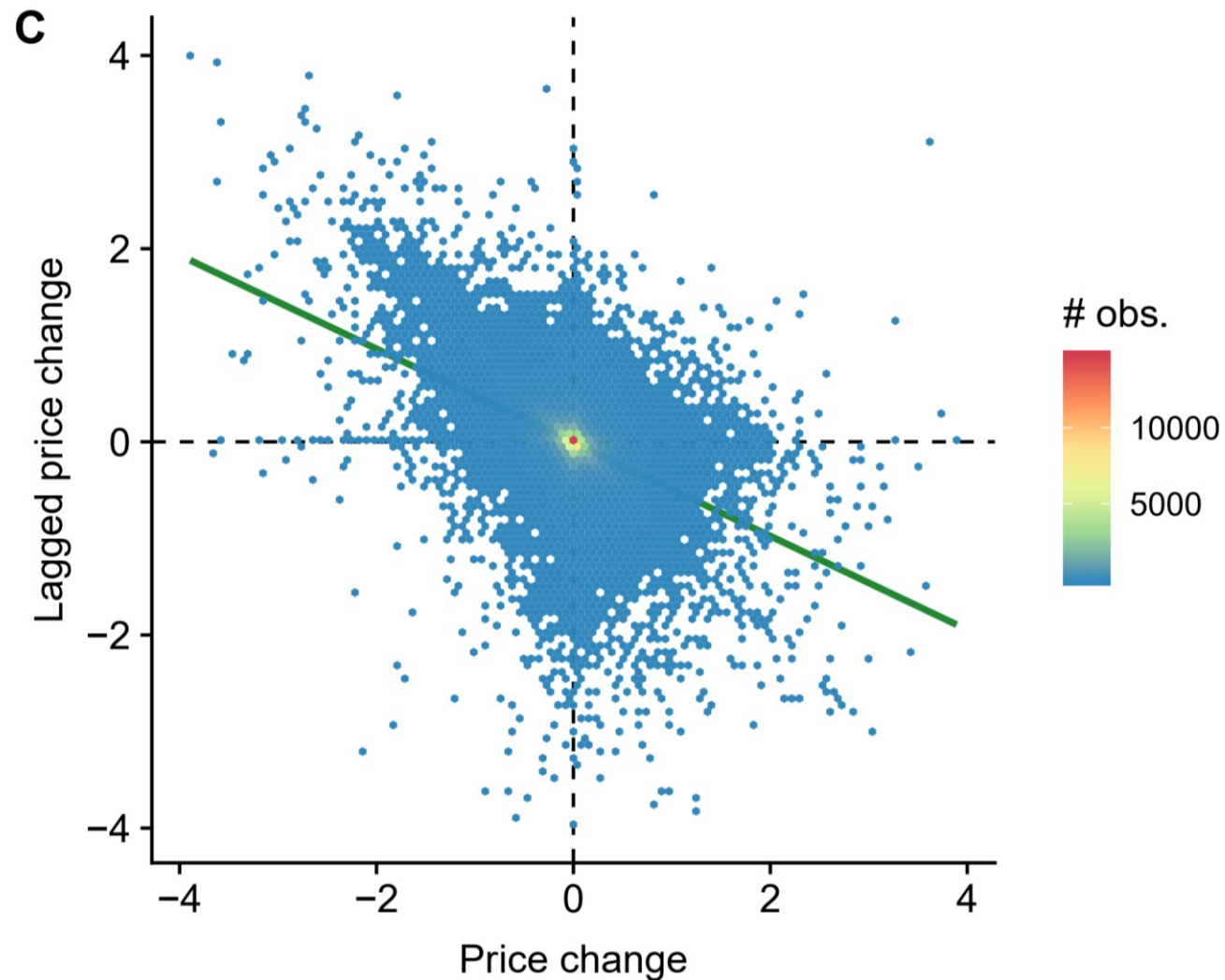
MobLab Double Auction: Buyer Rank-Order

Correlation(Transaction Order, Buyer Value)



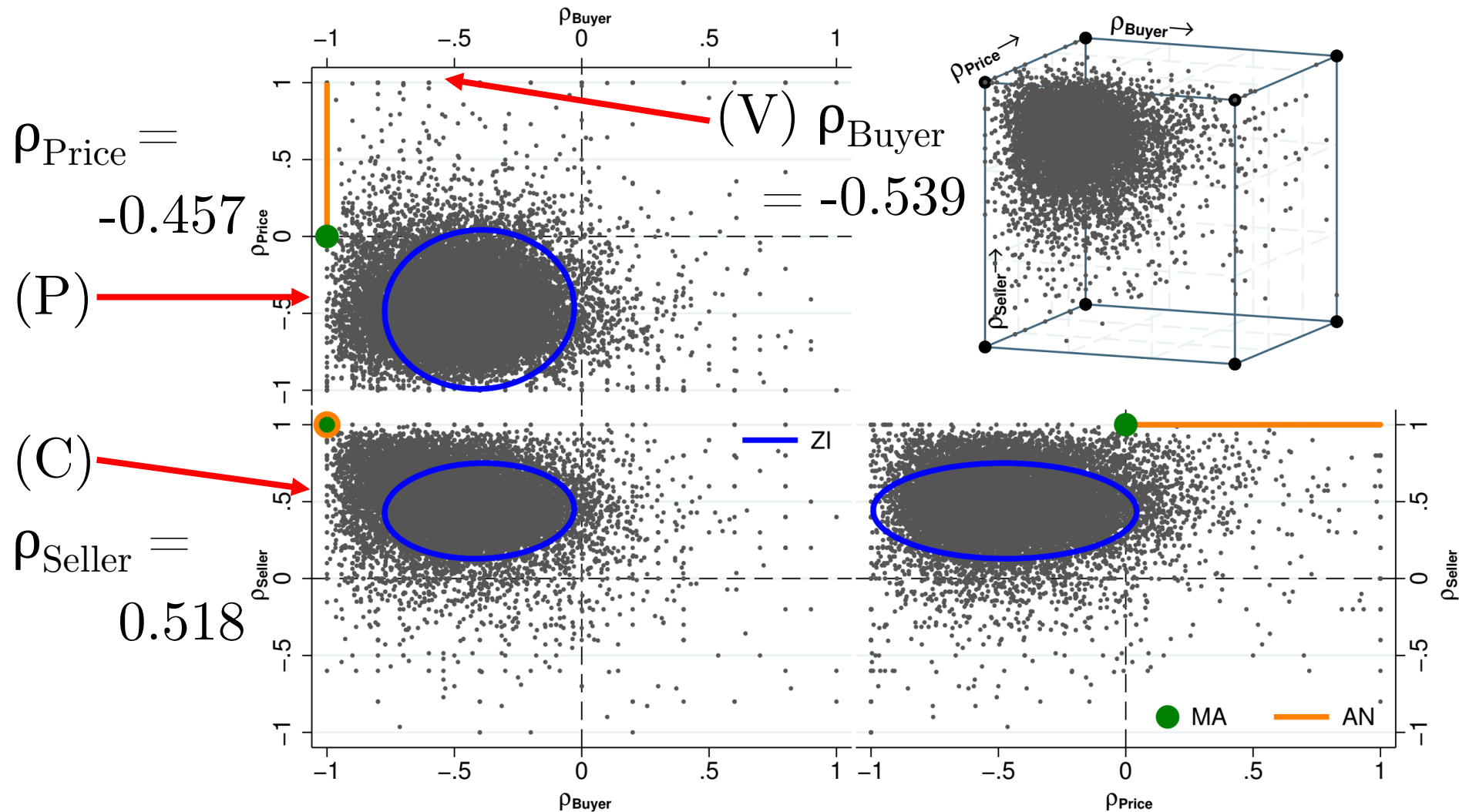
MobLab Double Auction:

Price Change Autocorrelation = -0.457



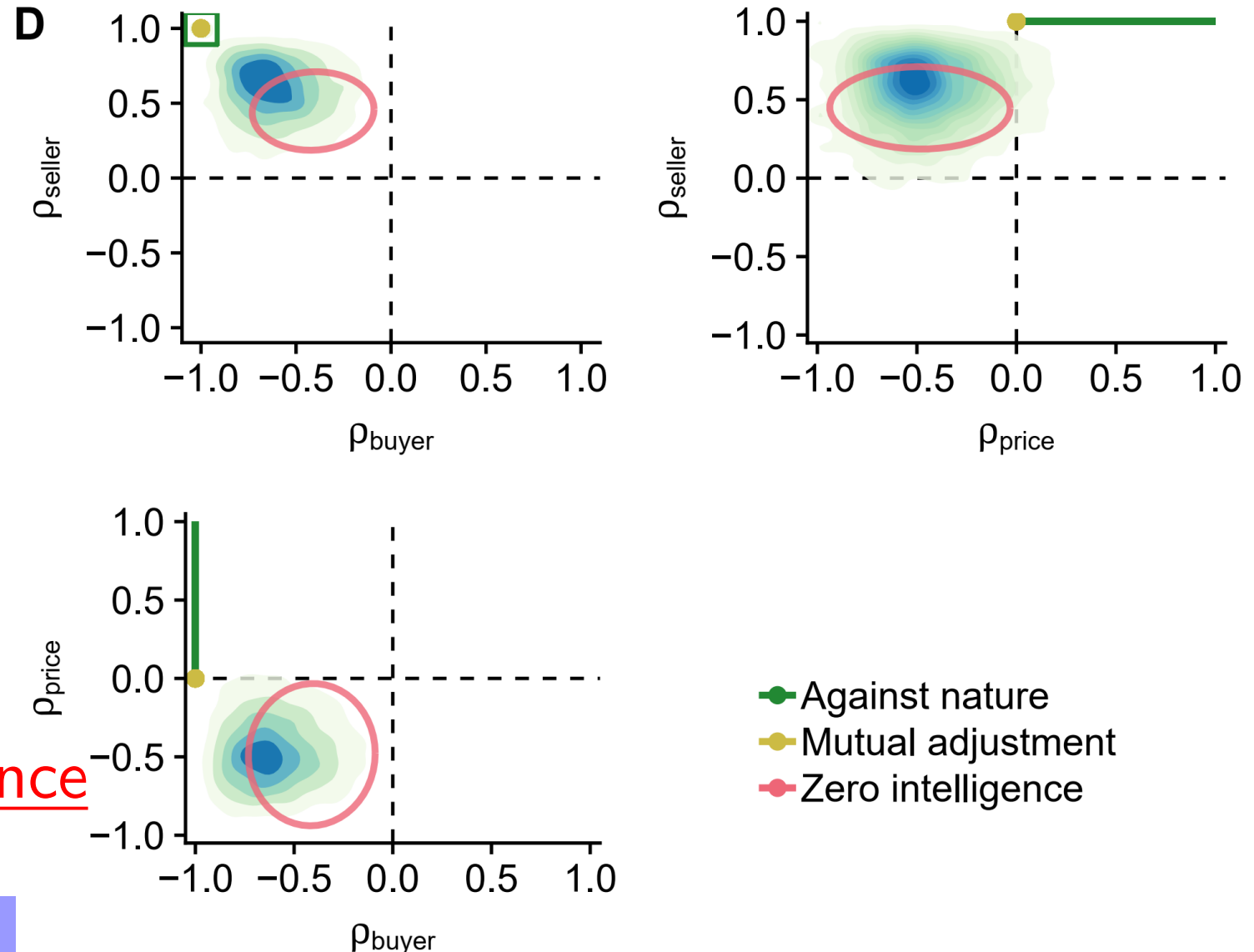
MobLab Double Auction:

Correlation Between Order and P/V/C



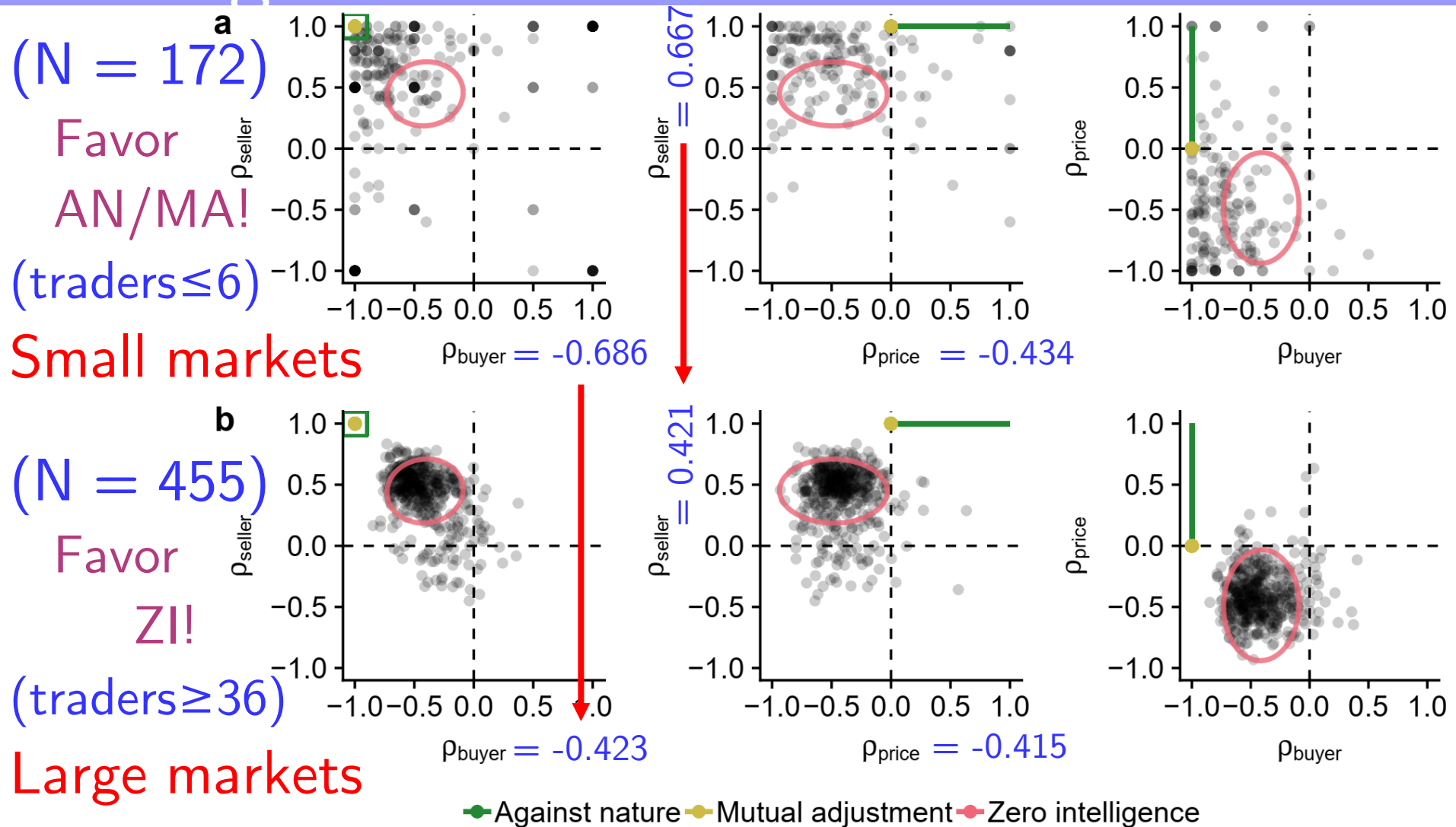
MobLab Double Auction: Testing Theories of Price Formation

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



Robustness:

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



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?)

- ▶ What happens if people or nations interact. (研究「人們」互動的結果)
- ▶ Game: Taxonomy of strategic situations (賽局: 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? (何謂「行為」賽局論?)

- ▶ Von Neumann and Morgenstern (1944):
 - ▶ Theory of Games and Economic Behavior
- ▶ “Our knowledge of the relevant facts of economics is incomparably smaller than...
 - ▶ 「跟物理學(在三百年前)數理化的時候相比,
- ▶ ...that commanded in physics at the time when mathematization of that subject was achieved...”
 - ▶ 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? (何謂「行為」賽局論?)

- ▶ Von Neumann and Morgenstern (1944):
 - ▶ Theory of Games and Economic Behavior
- ▶ “It would have been absurd in physics to expect Kepler and Newton without Tycho Brahe---and...
 - ▶ 「在物理學上，要是沒有第谷的天文觀測紀錄，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? (賽局論有啥用?)

- ▶ 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 Study: Auction Theory & Real World Auctions
 - ▶ 案例研究：拍賣理論和真實世界裡的拍賣
 - ▶ Auction Theory (拍賣理論) vs. Experimental Evidence (實驗結果)
vs. Real World Auction Design (拍賣制度設計)

Three Examples of BGT (行為賽局論:三個例子)

- ▶ BGT: what players actually do (根據大量「爾虞我詐」的實驗結果來看人們實際怎麼做)
 - ▶ By utilizing results from hundreds of experiment
- 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)
 - ▶ How BGT can explain what people do more accurately by
 - ▶ Extending GT to include social preferences (fairness), limited strategic thinking, and learning. (為了更準確預測人們的行為, 行為賽局論如何把社會(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) vs. Respondent (回應者)

- ▶ **Action** of Proposer: (提議者的決策)

- ▶ First makes a proposal on how to split \$100: 10-90, 20-80, 30-70, 40-60, 50-50,... (提議如何瓜分新台幣100元)

- ▶ **Action** of Respondent: (回應者的決策)

- ▶ Accepts or Rejects the proposal. (接受或拒絕提議)

- ▶ **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

Ultimatum

You and a player are dividing a stack of coins. If the other player rejects your proposal, you both get nothing. How much will you offer?

Drag the slider to propose an offer

SUBMIT

YOU

100%

50%

0%

\$0

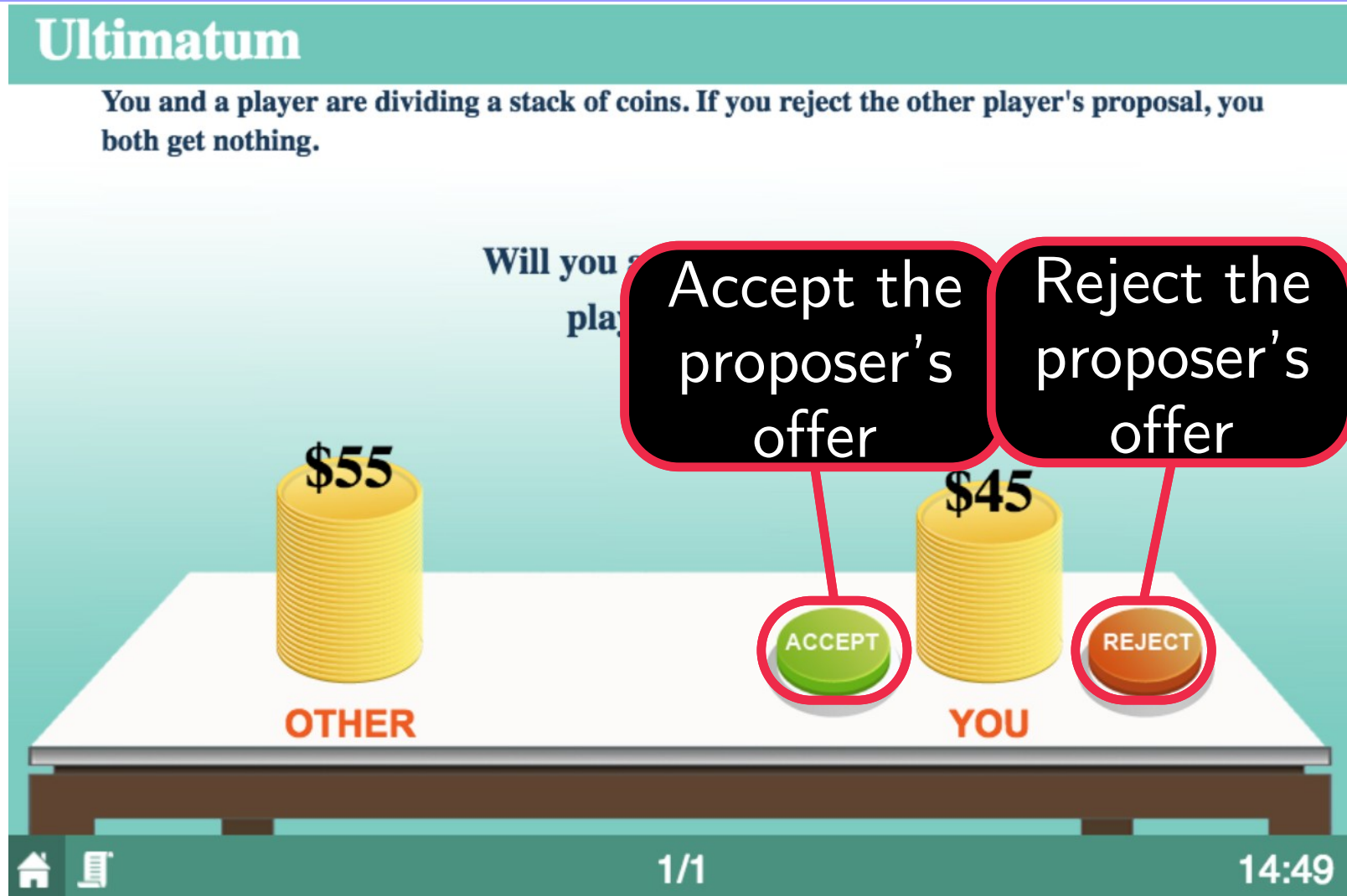
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MobLab Ultimatum Game: Respondent



1. Ultimatum Bargaining (最後通牒談判)

- ▶ Photographer vs. Tourist (觀光景點攝影師兜售照片會不會獅子大開口?)
- ▶ AGT Predictions (數學賽局論的預測)
 - ▶ Responders (will) accept any low offer (再不公平的提議回應者都會接受)
 - ▶ Proposers (can) offer unfairly (提議者可以提出極不公平方案)
- ▶ Experimental Results (實驗結果)
 - ▶ Responders reject unfair offers (回應者會拒絕不公平方案)
 - ▶ Proposers often offer fairly (50-50) (提議合理方案像是平分)
- ▶ 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 (but with social preferences!)
 - ▶ (但仍是理性思考，只是有社會偏好、厭惡不公平)
- ▶ Further Investigation: BGT, Ch.2 (延伸研究: BGT第二章)
 - ▶ 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)

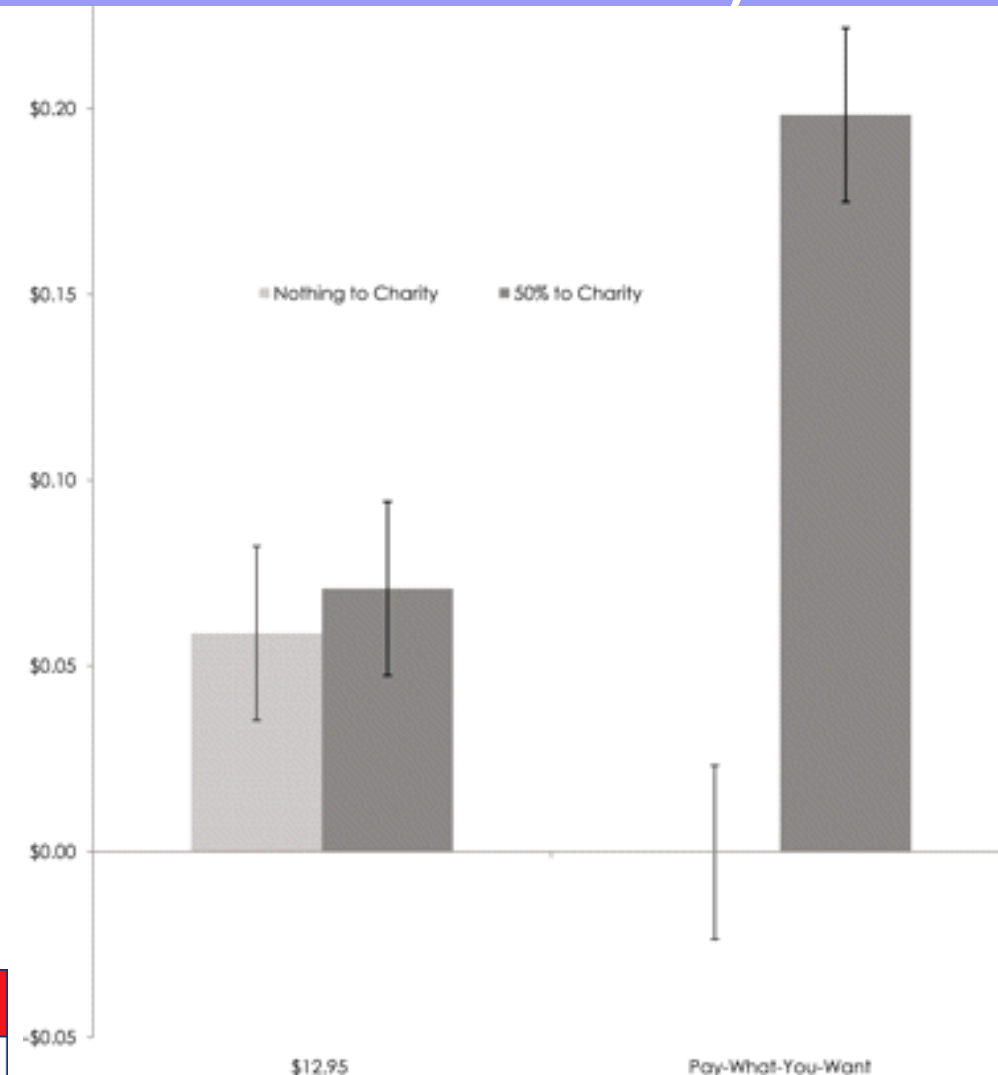
Disneyland Photo Field Experiment (還真的有攝影師開價的實驗)

- ▶ 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*
 - ▶ (*) Did not really increase firm total donation to Charity!

Profit Per Rider (\$\$ 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!
- ▶ Results will likely change if honestly disclosed...



MobLab Ultimatum Game:

Proposer

Ultimatum

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Drag the slider to propose an offer

SUBMIT

YOU

100%

50%

0%

\$0

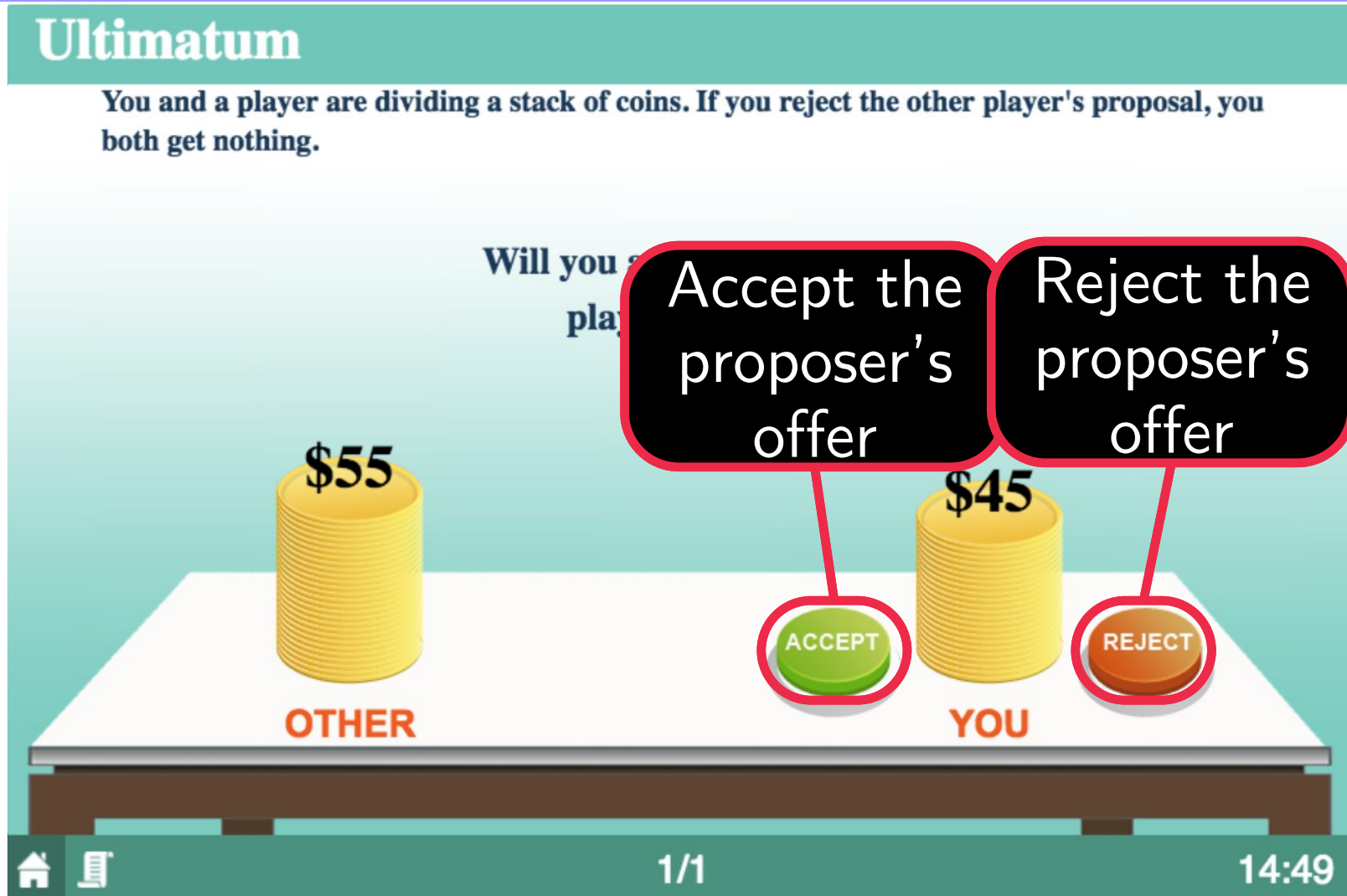
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Press submit to finalize

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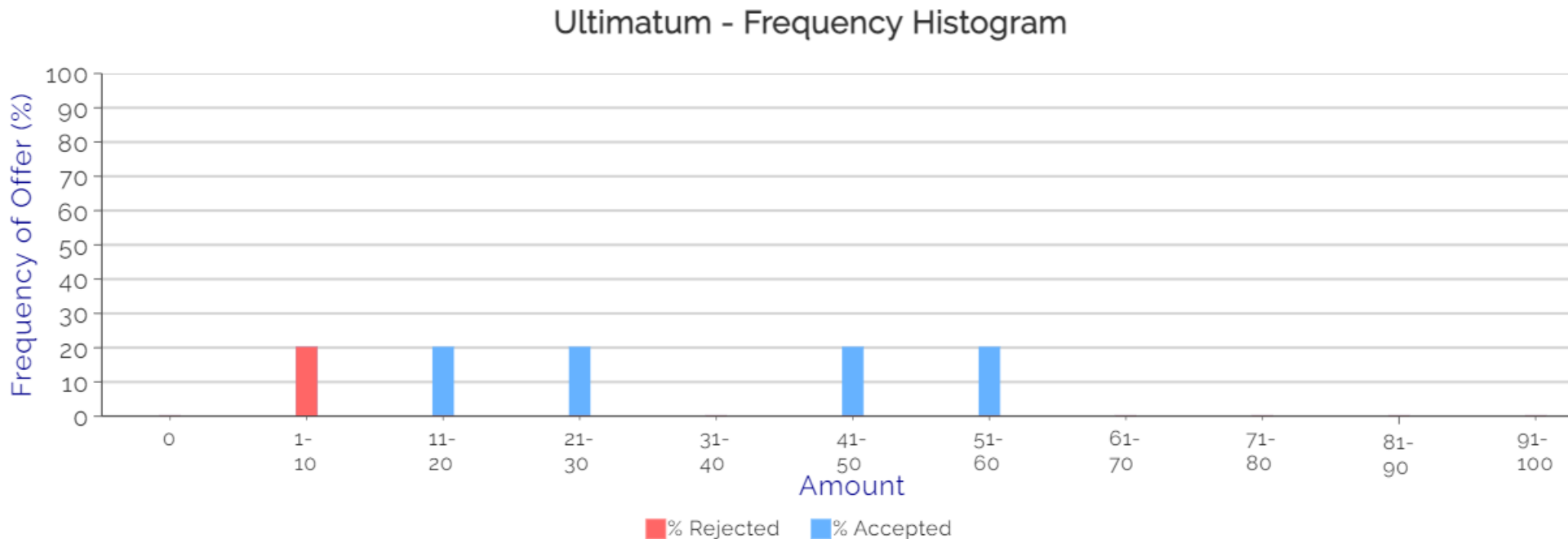
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MobLab Ultimatum Game: Respondent



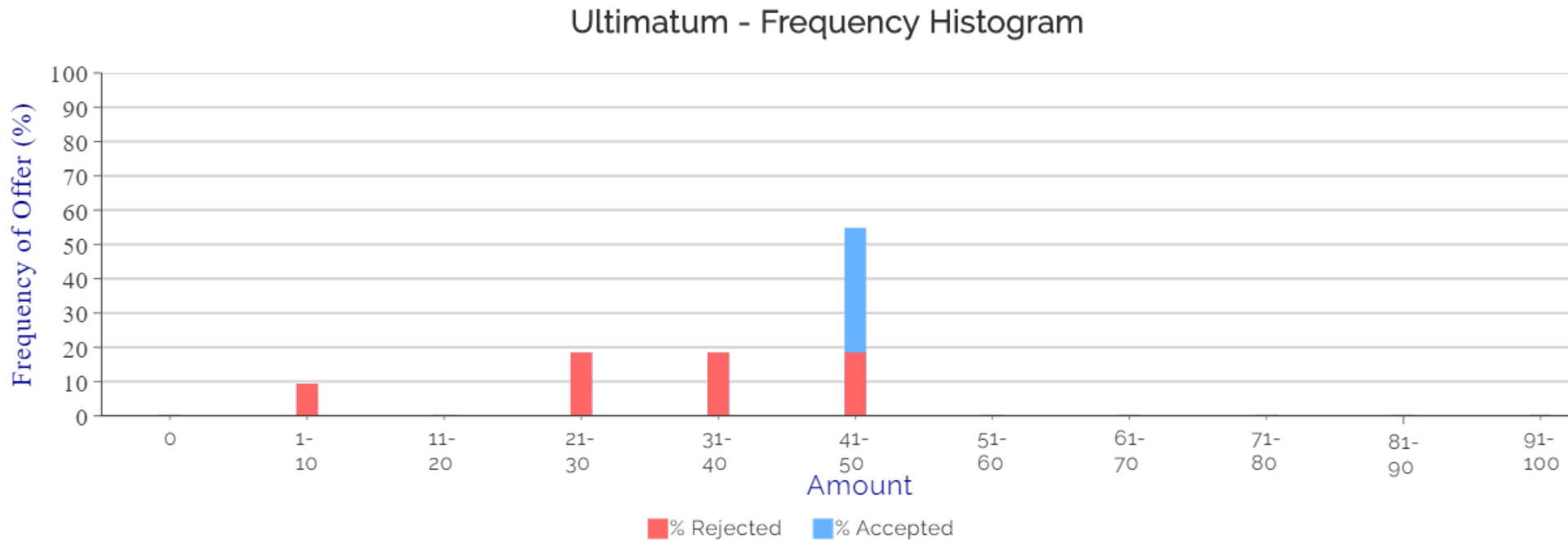
MobLab Ultimatum Game: EE-BGT 21S Results:

# 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

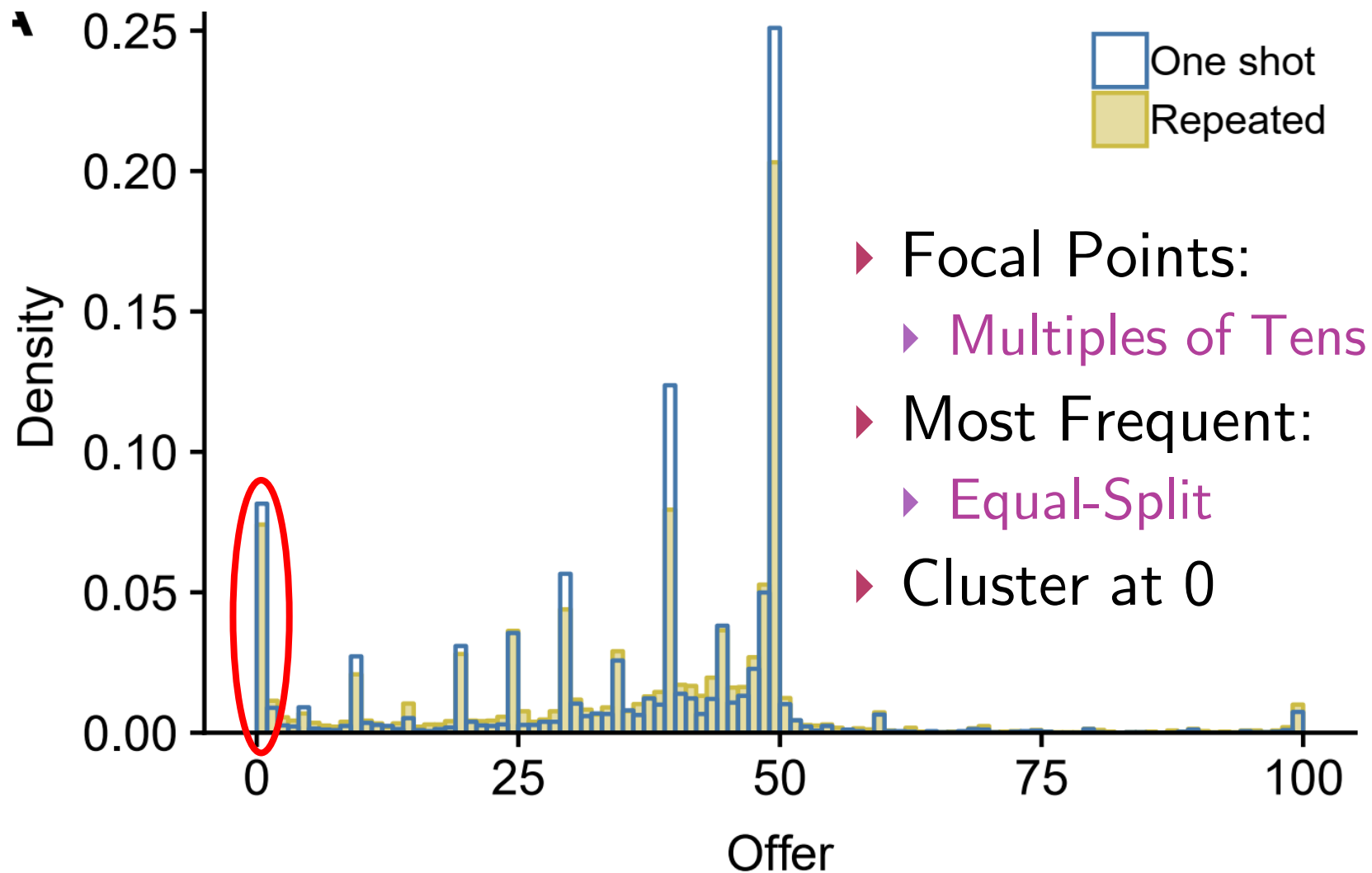


MobLab Ultimatum Game: CCU Results:

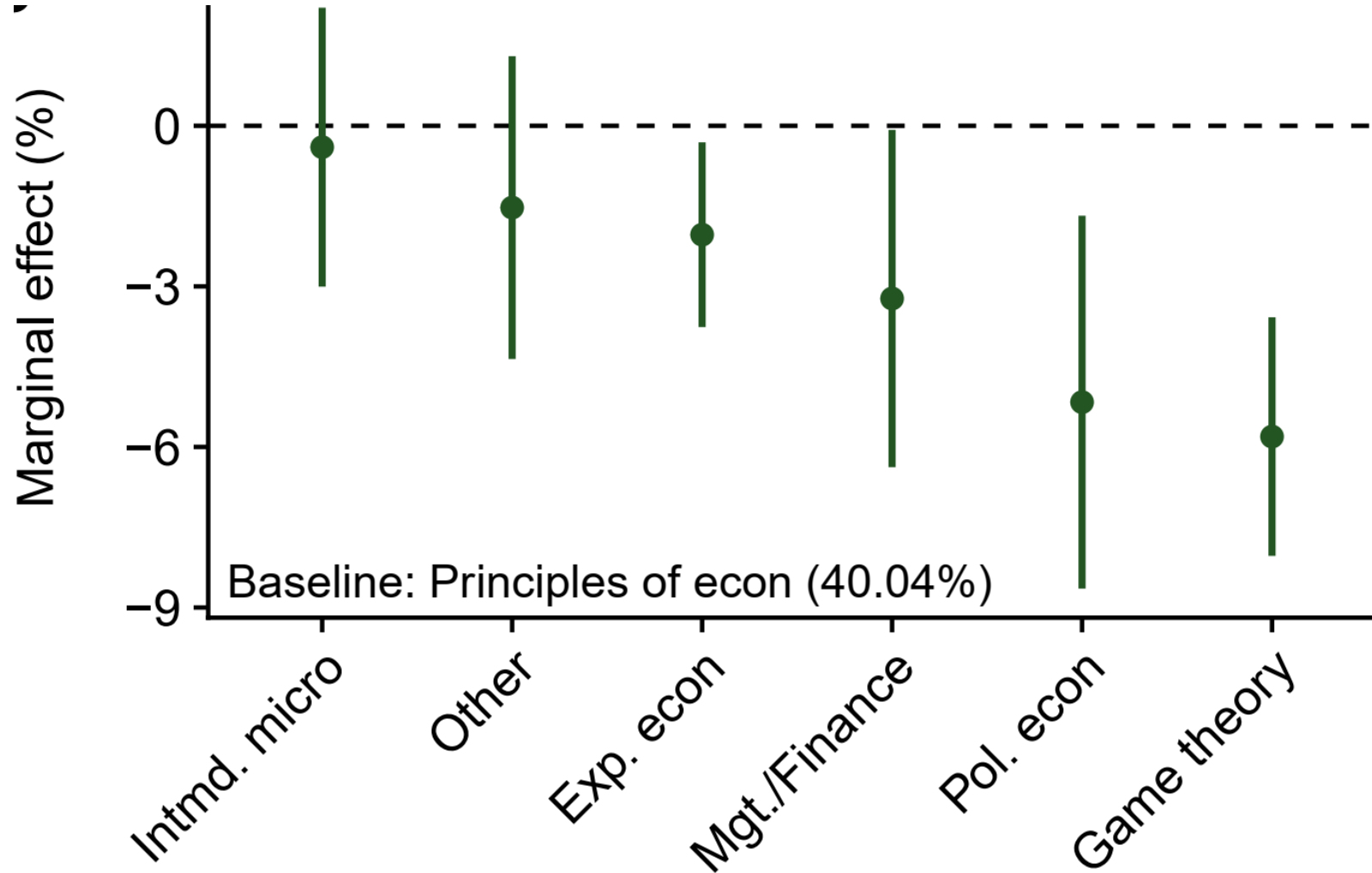
# of Groups	Total Pie	Avg. Offer	Avg. Accepted Offer	Avg. Rejected Offer	Mode Offer	Rejection %
11	100	37.55	49.75	30.57	50	63.64



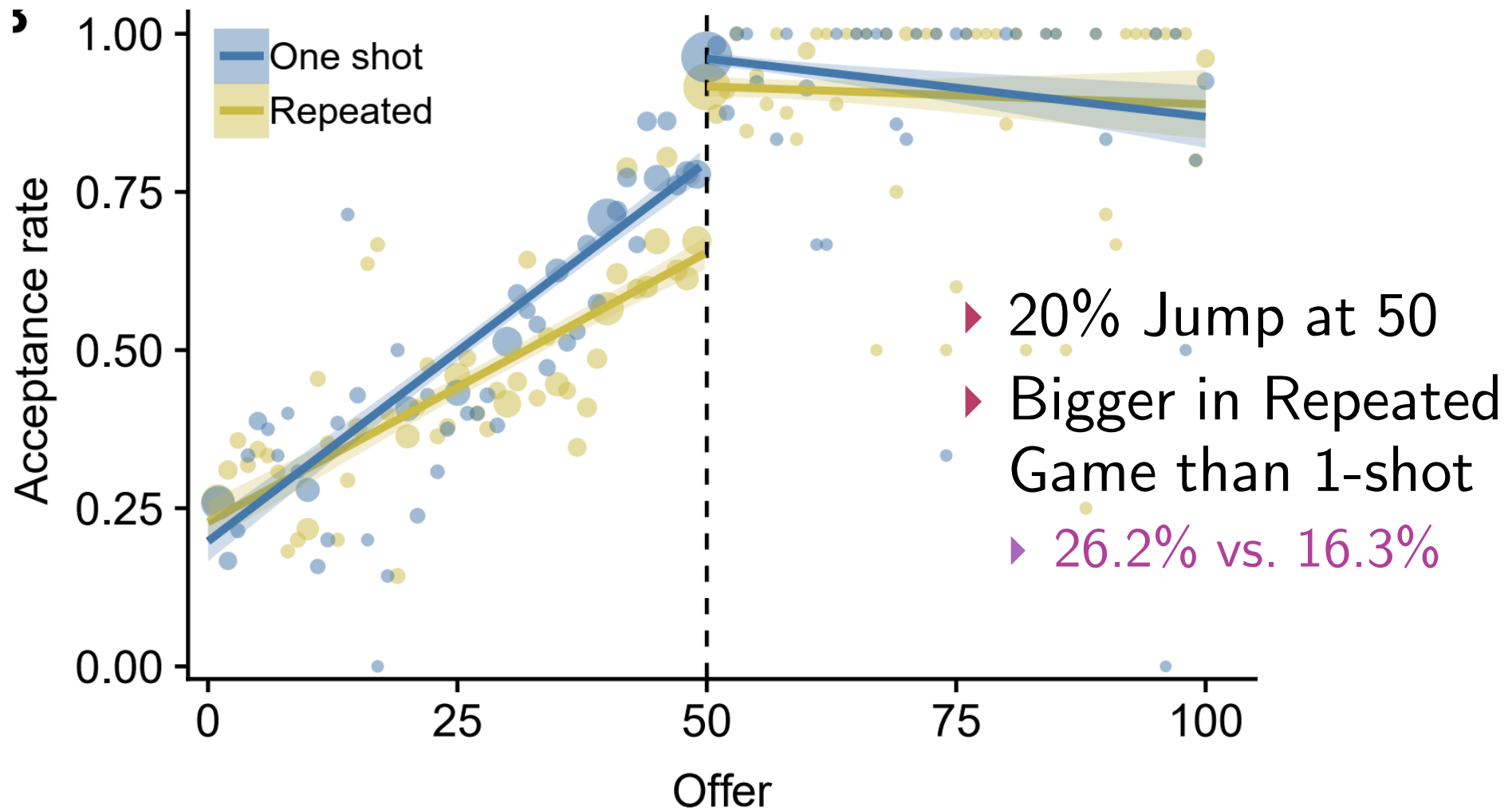
MobLab Ultimatum Game: Proposal Offers



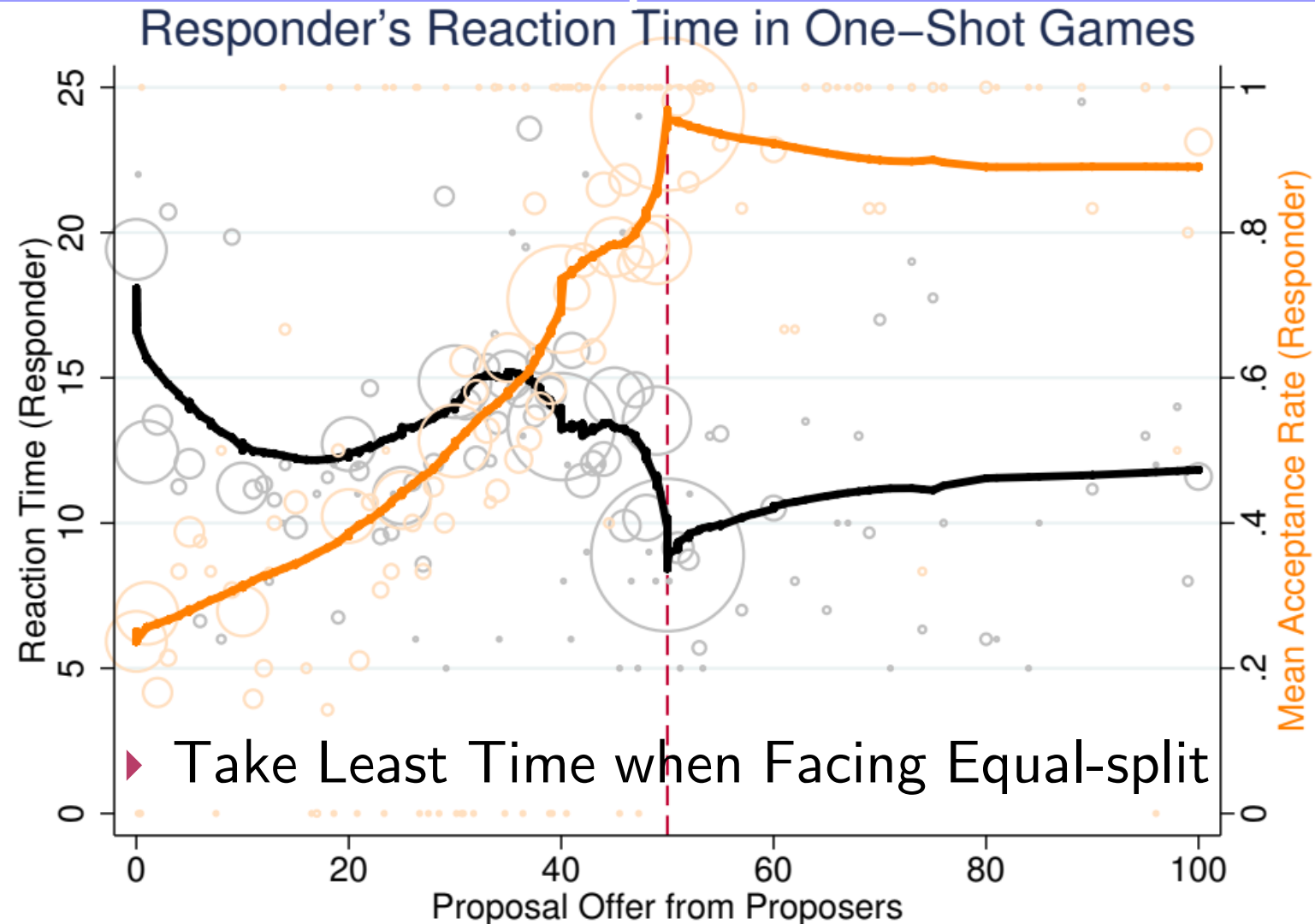
MobLab Ultimatum Game: Proposal Offer - Class Effect



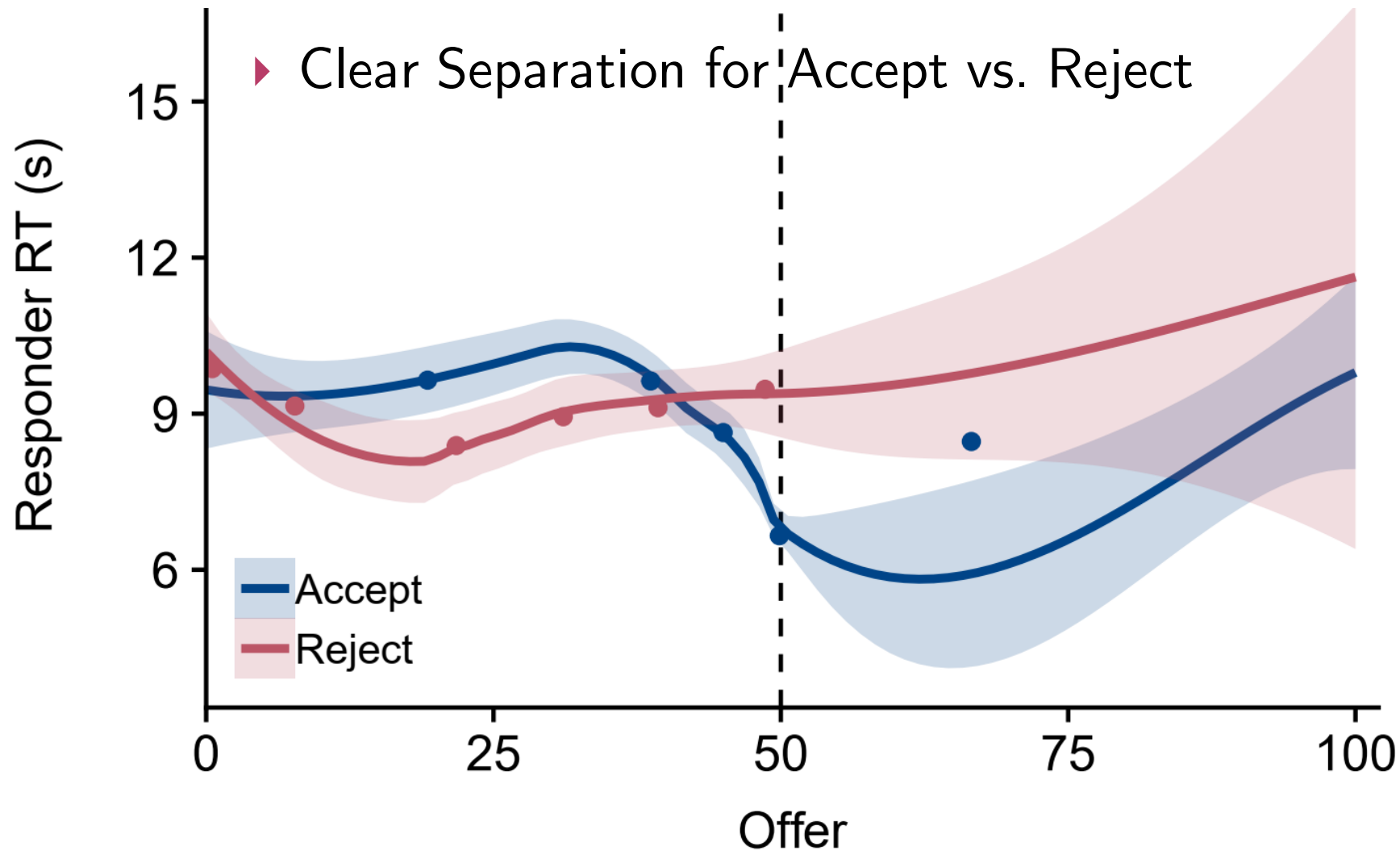
MobLab Ultimatum Game: Acceptance Rate (Fit 2-part Regression)



MobLab Ultimatum Game: Acceptance Rate and Response Time



MobLab Ultimatum Game: Response Time



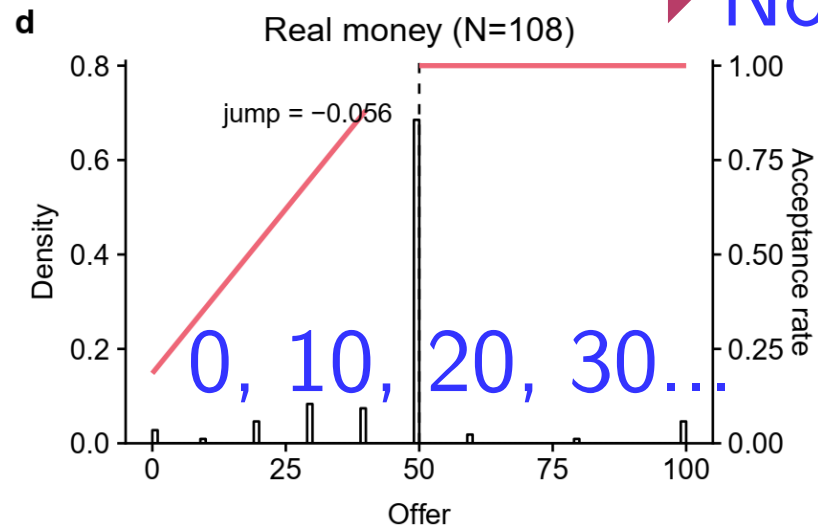
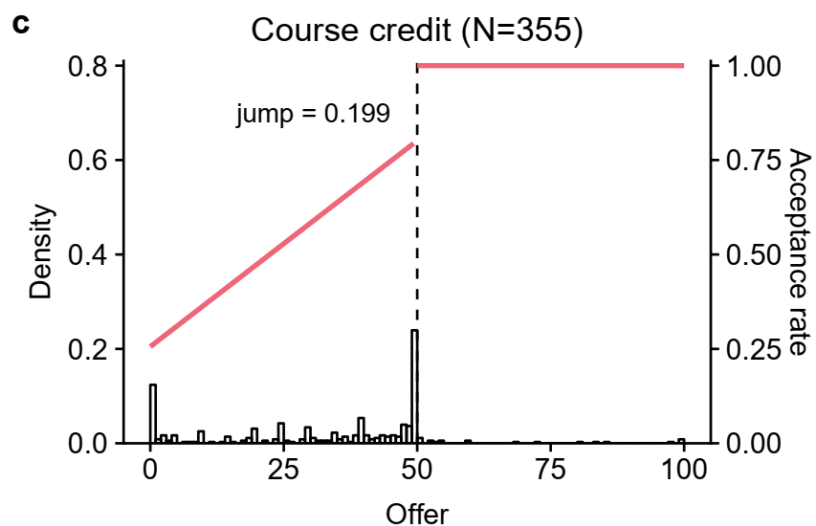
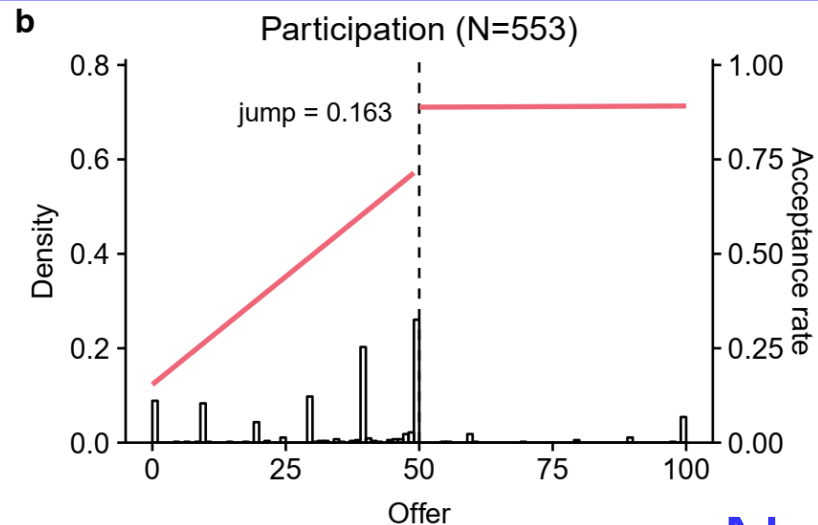
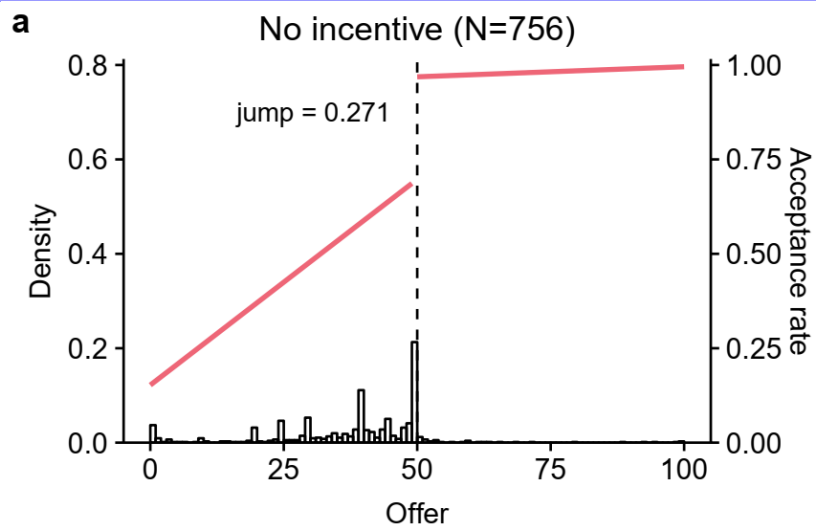
MobLab Ultimatum Game:

Robustness: Do Incentives Matter?

- ▶ Find Syllabi online (1,772 out of 10,507 observations)
 - ▶ Classify incentives for 58 out of 490 sessions
 1. Course Points (n=355): Performance as grades
 2. Participation (n=553): Participate in enough
 3. No Incentive (n=756): None of the above
- ▶ Compared to 1-3, **Real Money (n=108)** had:
 - ▶ Much more 50-50 (More than Double!)
 - ▶ Average Proposal 47.22 ($>34.00-39.17$ of others)
 - ▶ Acceptance rate = 91.7% ($>61.8-67.3\%$)

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SLAC

MobLab Ultimatum Game: Robustness: Do Incentives Matter?



► No 49 vs. 50!

2. p -Beauty Contest (選美結果預測賽局)

- ▶ Keynes consider asset markets like a beauty contest:
- ▶ Newspaper shows 6 pictures for people to choose one
- ▶ 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,
 - ▶ 「這不是要挑每個人各自認為最漂亮的[臉蛋],
- ▶ nor even those which average opinion genuinely thinks the prettiest.
 - ▶ 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
 - ▶ 我們已經想到第三層去,
 - ▶ anticipating what average opinion expects the average opinion to be.
 - ▶ 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)

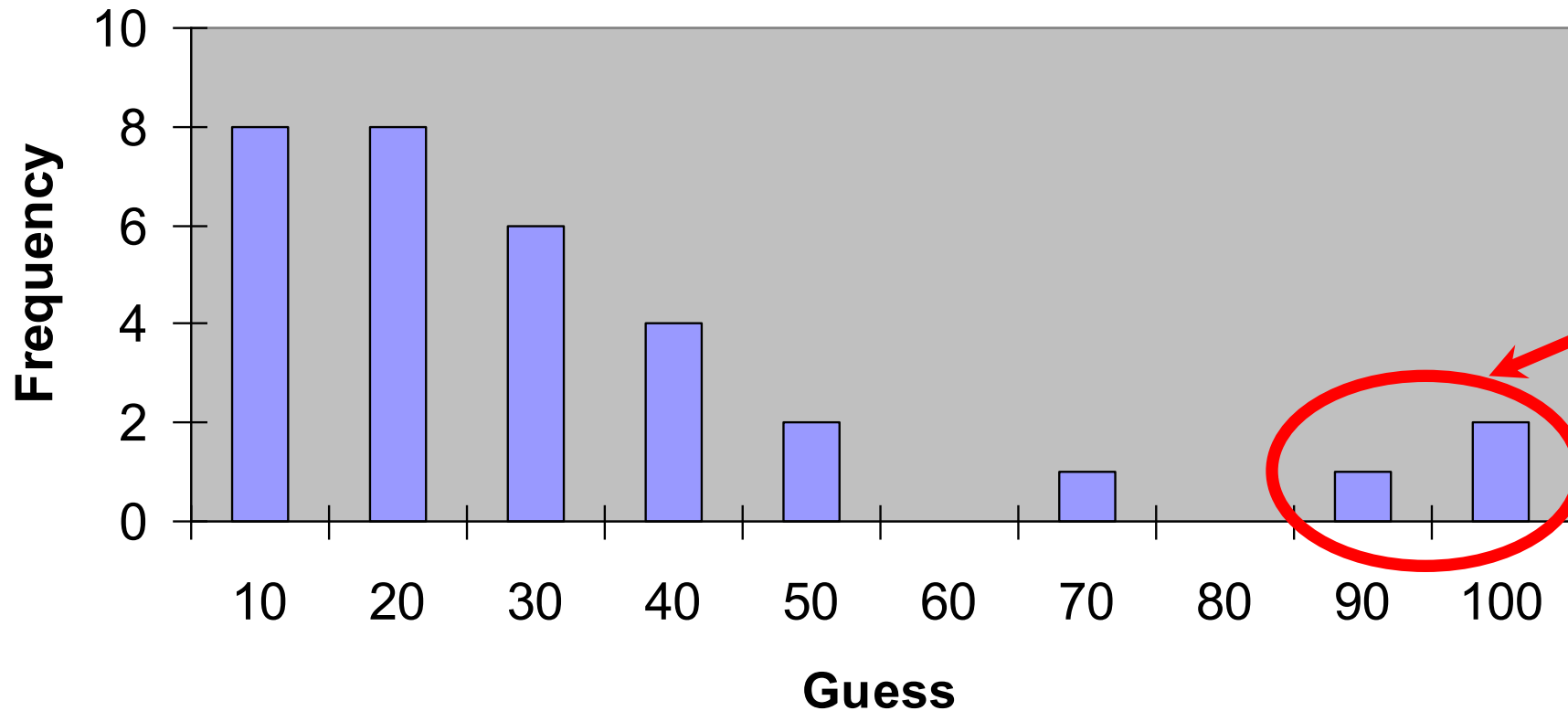
- ▶ **p-Beauty Contest** (選美結果預測賽局, 又稱「猜測(平均的三分之二)賽局」)
 - ▶ aka Guessing Game or $2/3$ of the Average Game
- ▶ **Environment:** (遊戲規則)
- ▶ **N Players** (參與者)
- ▶ **Action** of Players: (參與者的決策)
 - ▶ Each player guess a number from 0-100 (每位參與者都猜一個0-100數字)
- ▶ **Outcome:** (結果)
 - ▶ Number closest to $p=2/3$ 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後，唯一剩下策略是「大家都選0」、就是唯一的Nash均衡)
- ▶ Experimental Results (實驗結果)
 - ▶ First-round choices around 21-40 (首次多半猜21-40)
 - ▶ Converge to 0 within 10 rounds (同一群人重複做會在十回合內收斂到均衡)
- ▶ BGT Explanation: (行為賽局論的解釋)
 - ▶ Limited Iterated Reasoning (Level- k) (多層次思考能想的步驟有限)
 - ▶ Learning: Towards Equilibrium (學習「到」均衡)

Results from 2008 Classroom Experiment (2008課堂實驗結果)

p-Beauty Contest Results



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 people form a group, each choose 1-14 (一組七人, 各自選1-14)
- ▶ Payoff based on **your choice** and **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)

Group Median

3. Continue

My Own Choice

	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

Group Median

3. Continue

My Own Choice

	3	4	5	6	7	8	9	10	11	12
3	60	66	70	74	72	1	-20	-32	-41	-48
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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
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 - ▶ 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?

3. Continental Divide (產業發展分水嶺)

- ▶ AGT Predictions (數學賽局論的預測)
 - ▶ Multiple Equilibrium: 3 or 12 (兩個均衡)
- ▶ Experimental Results (實驗結果)
 - ▶ Don't always gravitate toward Good Equilibrium (不見得收斂到好均衡)
 - ▶ Small history accidents have big LR impact (歷史的偶然影響長期結果)
- ▶ BGT Explanation (行為賽局論的解釋)
 - ▶ Learning in the Basin of Attraction (在「引力範圍」內被牽引)
 - ▶ Initial Conditions: Lucky 7 vs. 8? (初始條件 Lucky 7 vs. 一路發)

Experimental Regularity (有一致的結果，然後呢?)

- ▶ **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?!
 - ▶ (做出來囚犯兩難的實驗結果「難以置信」，就沒有進一步發展下去了?)

Experimental Regularity (有一致的結果，然後呢?)

► How others react to (experimental) data?

► (反對實驗方法的意見)

1. People are confused, not motivated (人們搞錯了、沒誘因?!)

► But: Good design reduces confusion, induces behavior

► (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?!)

► But: “Democracy is the worse form of government, except for all the others.” (Winston Churchill)

► (邱吉爾：「民主政治是最糟的政治制度，但其他卻是更不可行的政治制度。」)

Experimental Regularity (有一致的結果，然後呢?)

▶ How others react to (experimental) data?

- ▶ (反對實驗方法的意見)

3. People were playing a different game (人們其實在做別的?!)

▶ So are all as-if models of the economy!

- ▶ (也許是「美麗人生」，但所有 as-if 的經濟模型都如此!)

4. Non-rational behavior cannot be modeled (非理性就是亂選?!)

▶ Not if people are Predictably Irrational!

- ▶ (不見得！非理性還是可能具備可預測性!)

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！