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)

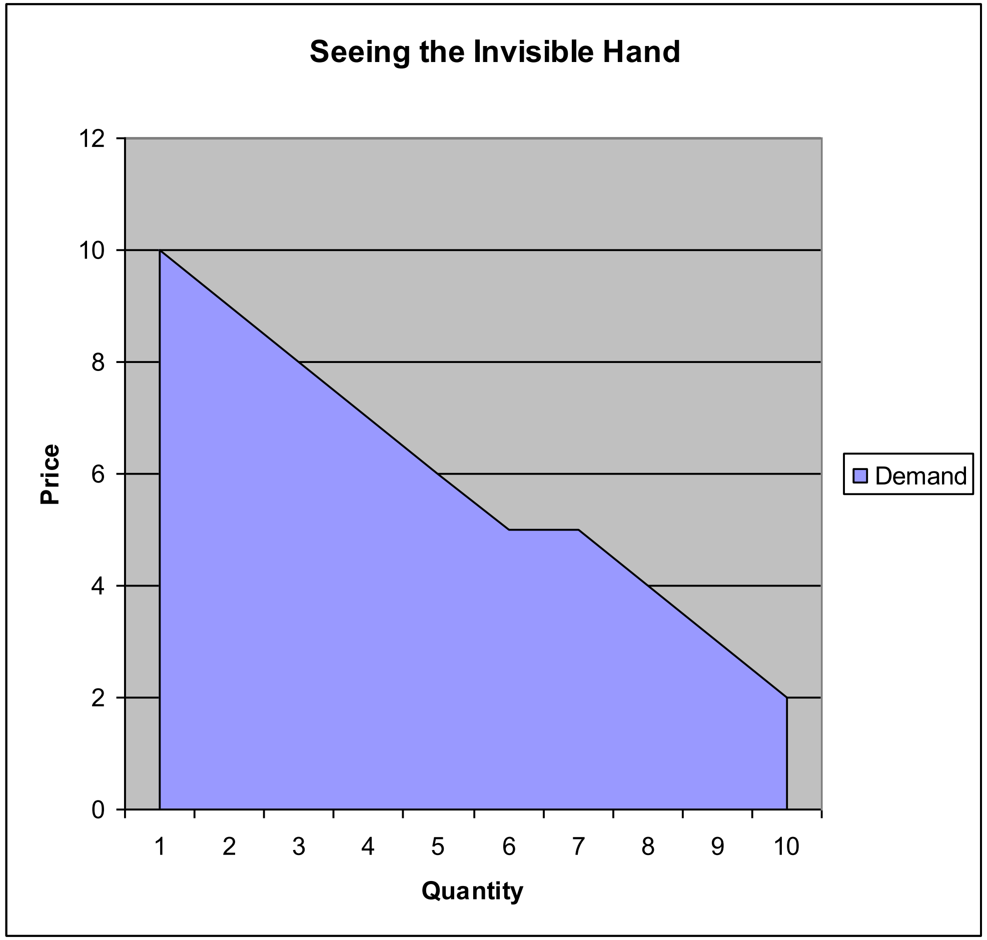
- The Pit Market (交易坑市場)
  - Chamberlin (JPE, 1948) (張伯倫)
  - Smith (JPE, 1962) (臥龍・史密斯)
- Experiment: Seeing the Invisible Hand
    - (課堂實驗：發現看不見的手)
  - Ran in Principles of Microeconomics Class
    - (在大一經濟學原理有做過)
  - See instructions (請見實驗說明)

Market Design: Nobel Prize of 2012

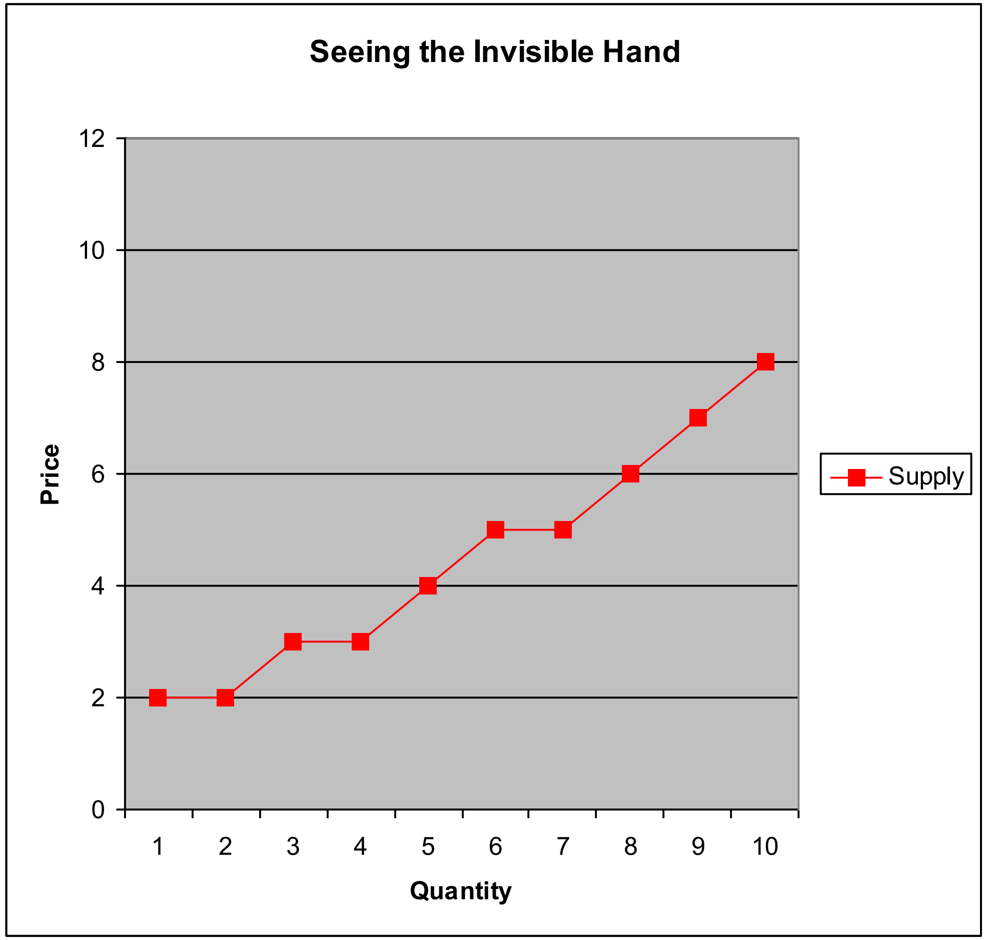
□ 市場設計：2012年瑞典央行紀念諾貝爾經濟科學獎得主

- 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)

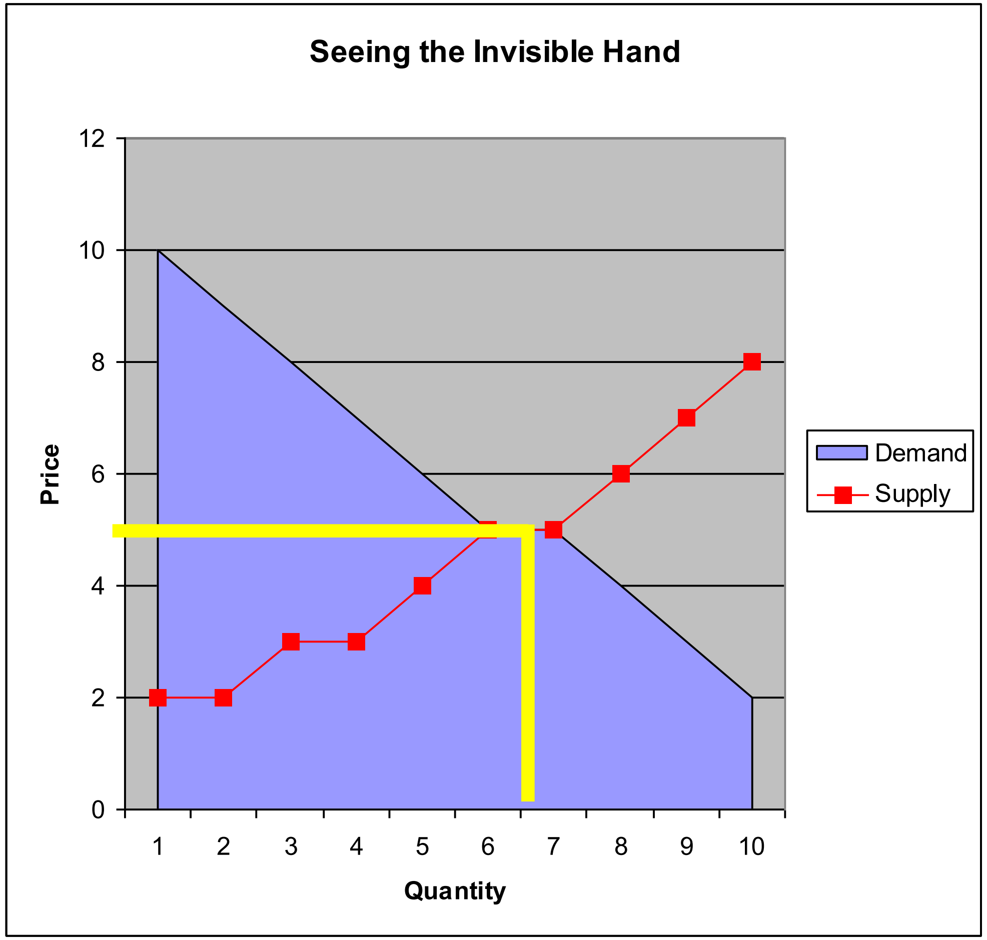
Seeing the Invisible Hand (發現看不見的手)



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)

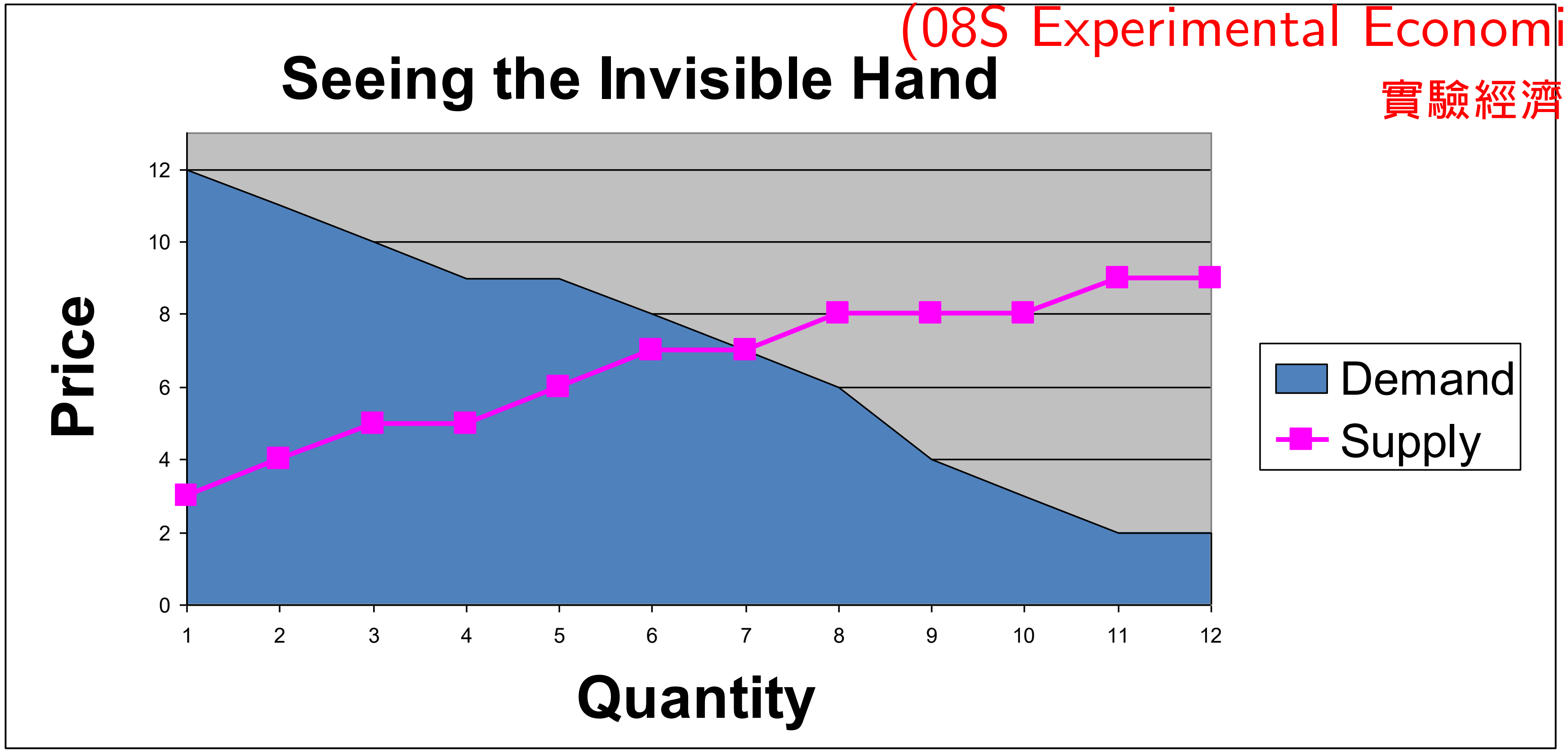
- Prices (成交價格)
  - 07F Economics I 經濟學—
- Pit Market (交易坑市場)
  - A: 6, 6, 6, 8, 5, 6, 6
  - B: 5, 5, 4, 6, 6, 6, 7
- Double Auction (雙邊喊價市場)
  - A: 5, 5, 5, 5, 5
  - B: 5, 5, 6, 6, 6
  - C: 4, 5, 5, 6, 5, 5

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

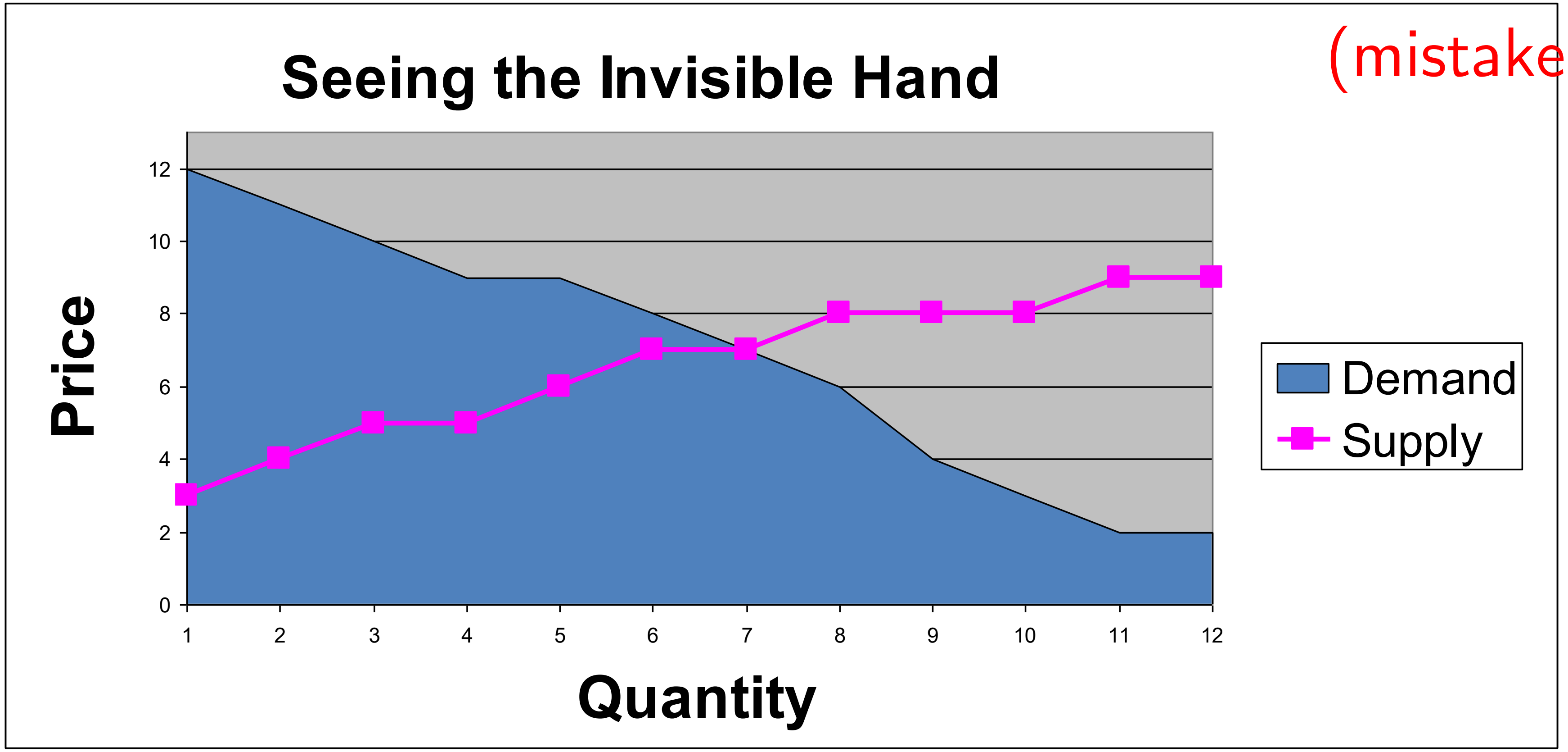


(08S Experimental Economics 實驗經濟學)

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?)

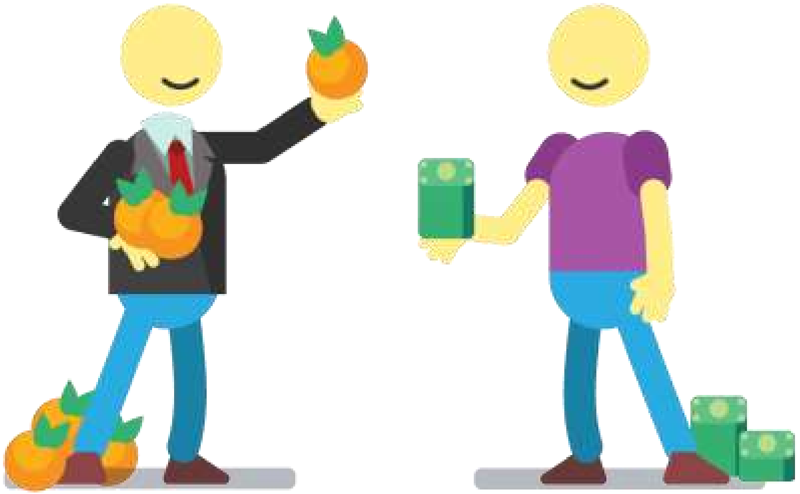


Game Instructions

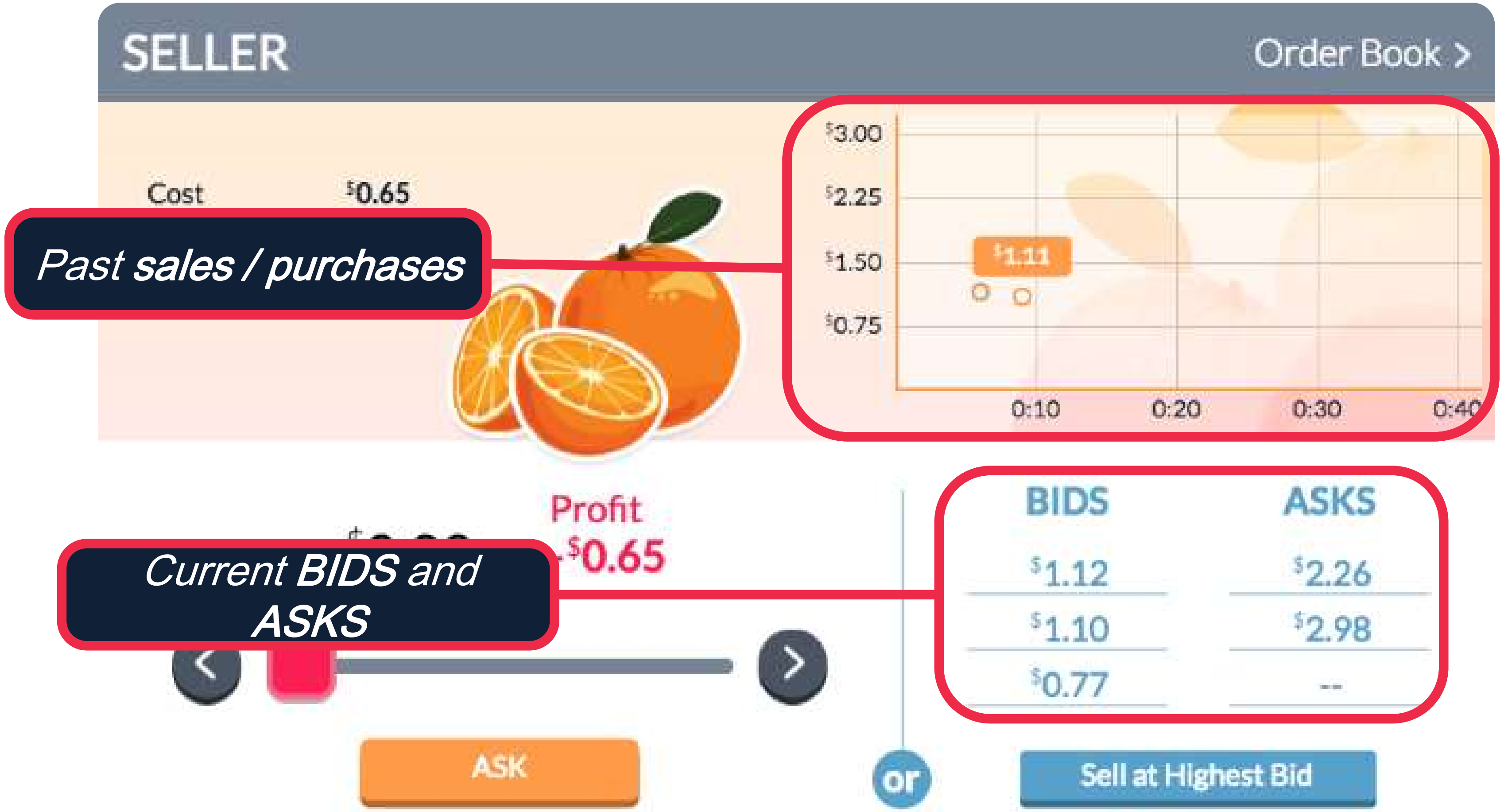
Groups of 5 sellers and 5 buyers.
Trade to maximize your profits!

Orange producer,
selling oranges

Hungry consumer,
buying oranges



Bids are offers to buy


SELLER
Order Book >
$3.00
$2.25
$1.50
$0.75
$1.11
0:10
0:20
0:30
0:40
ASK
or
Sell at Highest Bid

Past sales / purchases

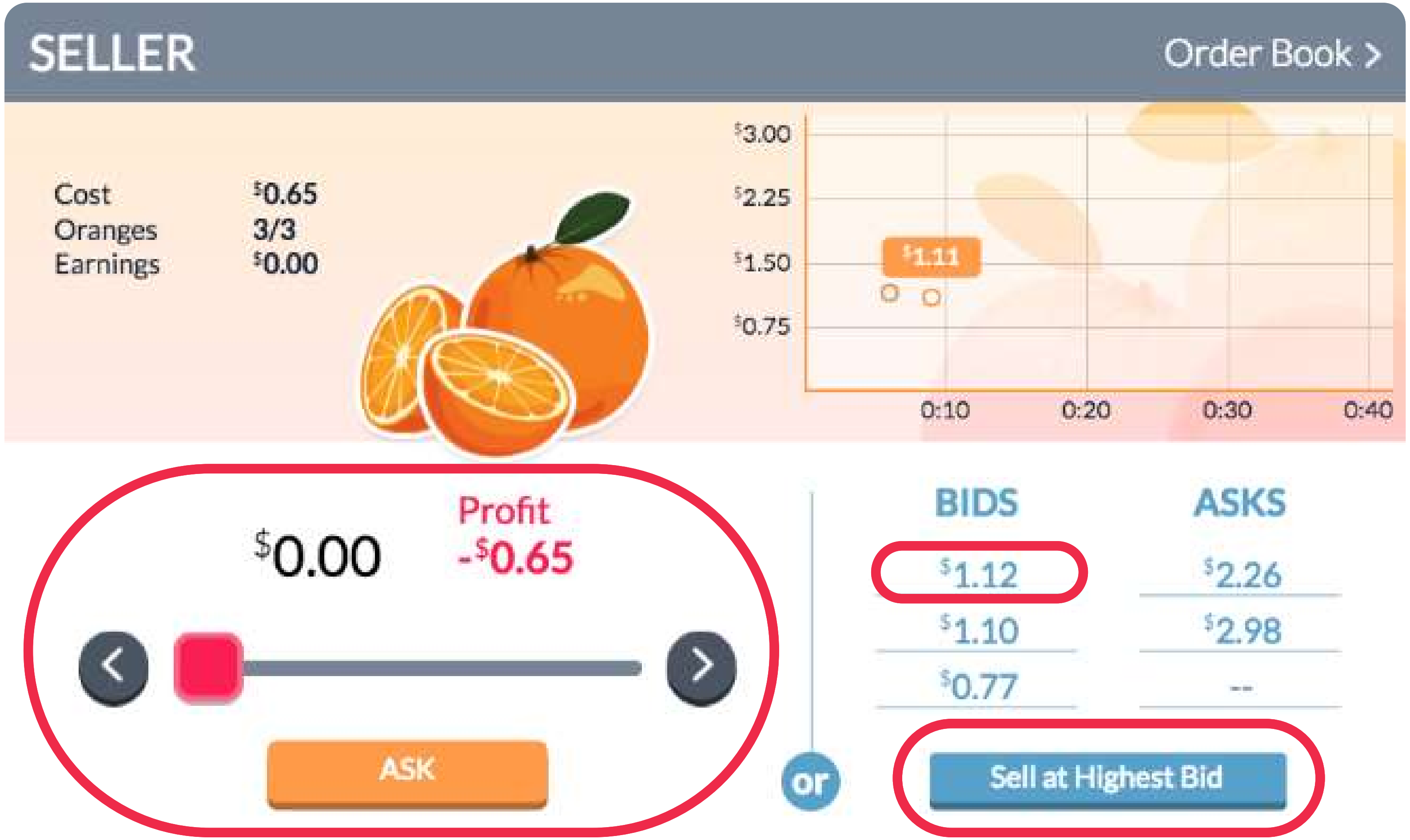
Cost $0.65

Profit $0.65

Current BIDS and ASKS

BIDS	ASKS
$1.12	$2.26
$1.10	$2.98
$0.77	--

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


SELLER
Order Book >
$3.00
$2.25
$1.50
$0.75
$1.11
0:10
0:20
0:30
0:40
ASK
or
Sell at Highest Bid

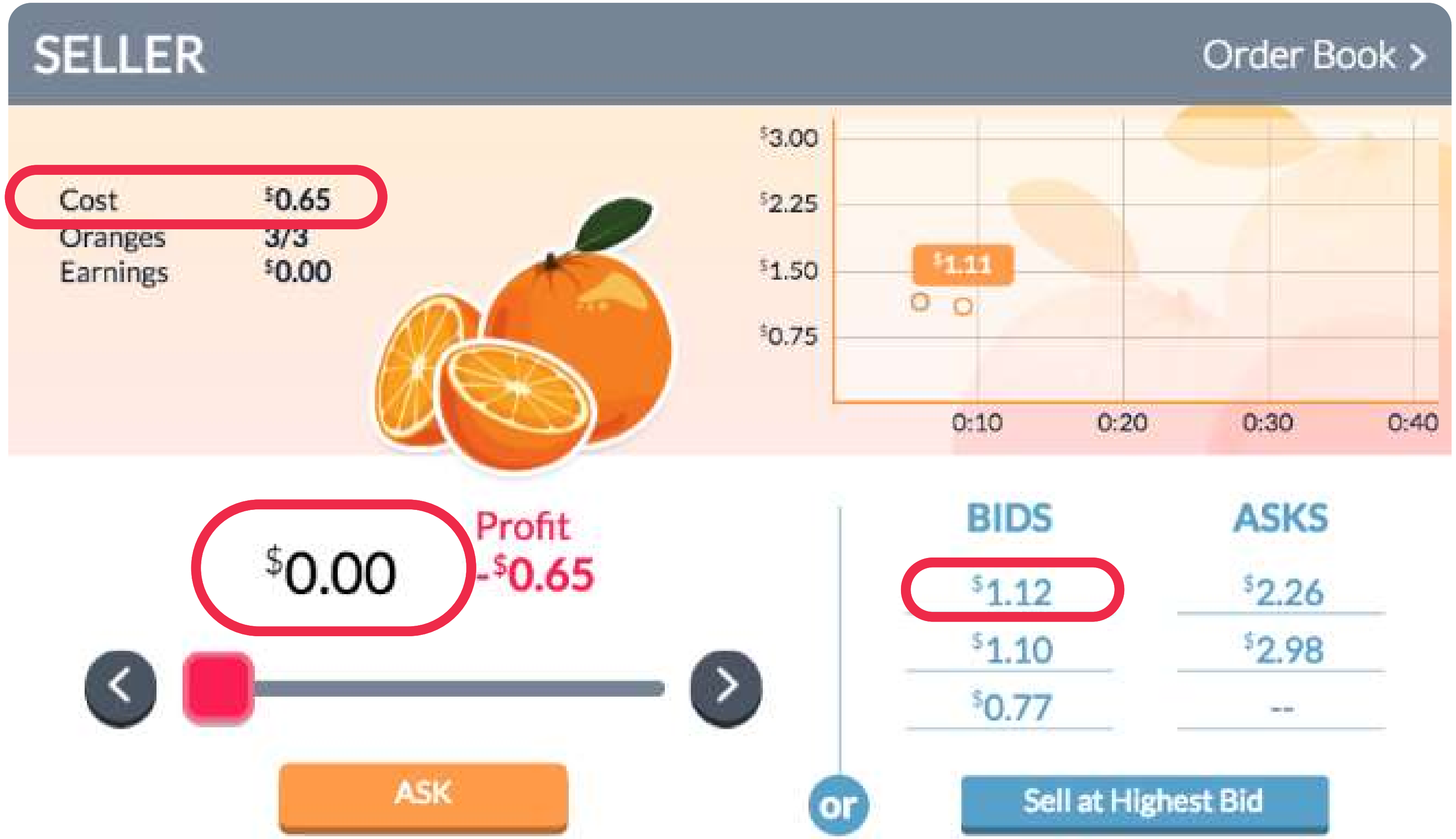
Cost	$0.65
Oranges	3/3
Earnings	$0.00

$0.00

Profit -$0.65

BIDS	ASKS
$1.12	$2.26
$1.10	$2.98
$0.77	--

Seller’s Profit = Sale Price – Cost of Production


SELLER
Order Book >
$3.00
$2.25
$1.50
$0.75
$1.11
0:10
0:20
0:30
0:40
ASK
or
Sell at Highest Bid

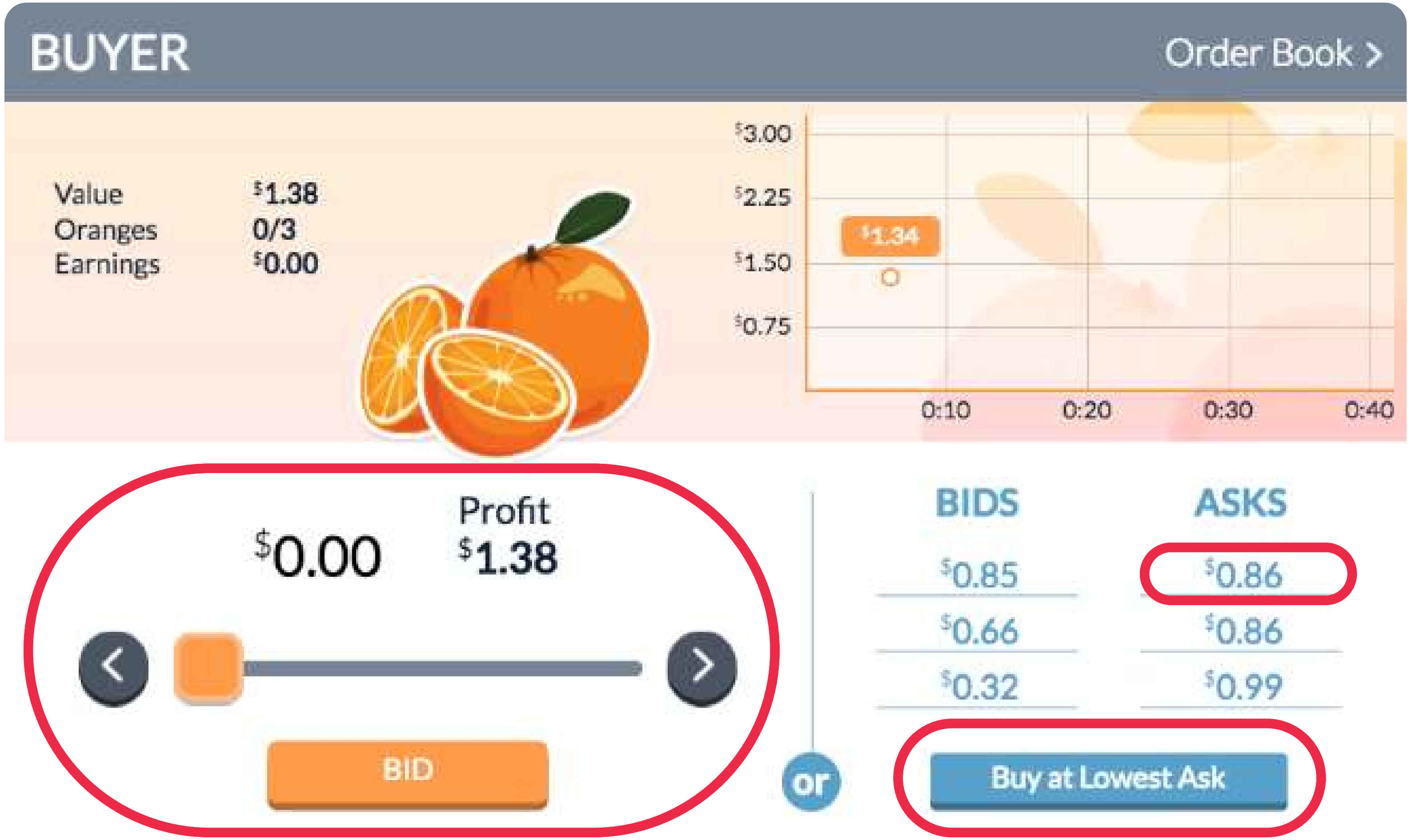
Cost $0.65
Oranges 3/3
Earnings $0.00

$0.00

Profit
-$0.65

BIDS	ASKS
$1.12	$2.26
$1.10	$2.98
$0.77	--

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



BUYER

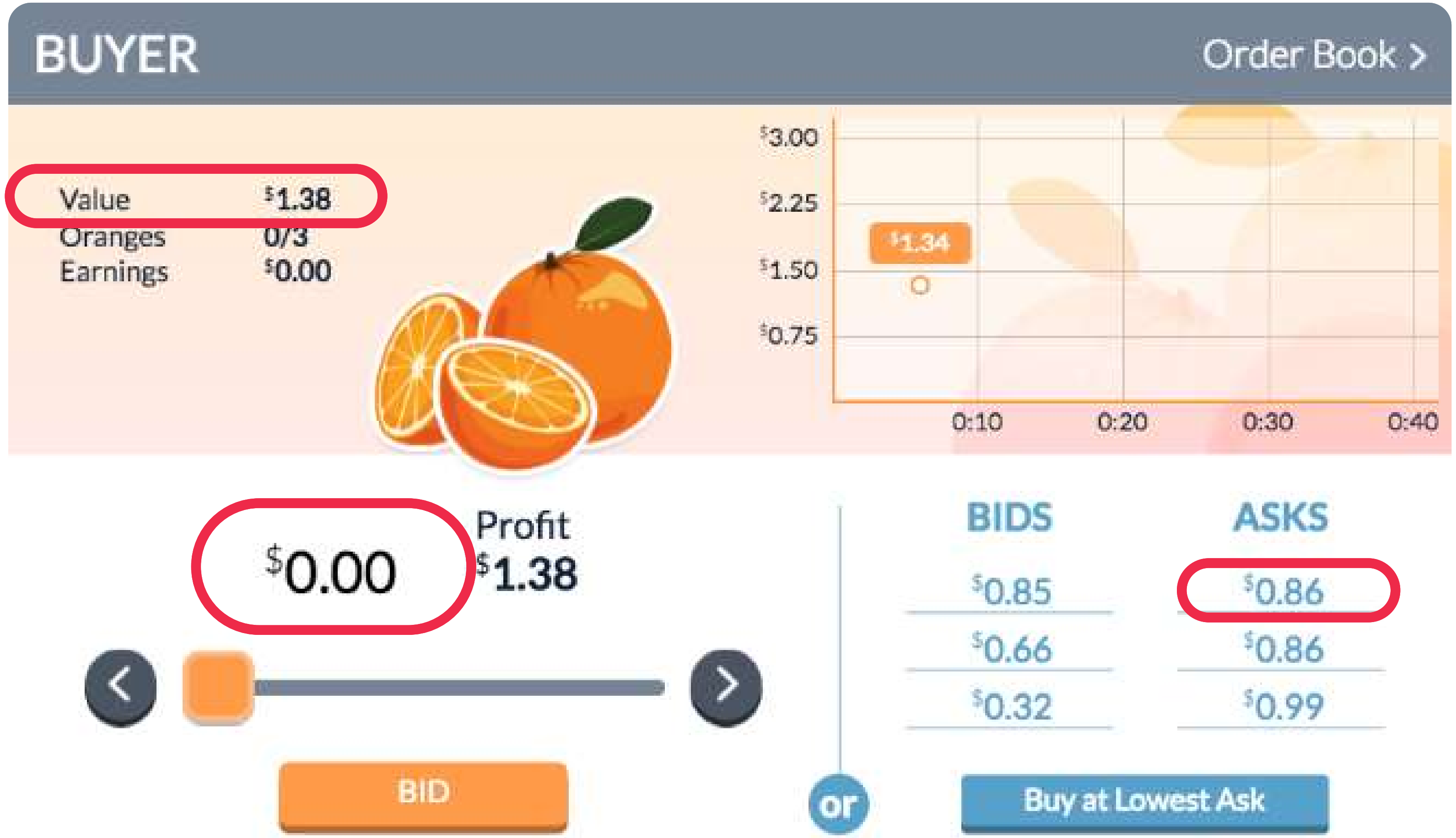
Value $1.38
Oranges 0/3
Earnings $0.00

BIDS	ASKS
$0.85	$0.86
$0.66	$0.86
$0.32	$0.99

$0.00 Profit $1.38

Order Book >
$3.00
$2.25
$1.50
$0.75
$1.34
0:10
0:20
0:30
0:40
BID
or
Buy at Lowest Ask

Buyer's Profit = Value of consumption – Purchase Price



BUYER
Order Book >
$3.00
$2.25
$1.50
$0.75
$1.34
0:10
0:20
0:30
0:40
BID
or
Buy at Lowest Ask

Value	$1.38
Oranges	0/3
Earnings	$0.00

$0.00

Profit
$1.38

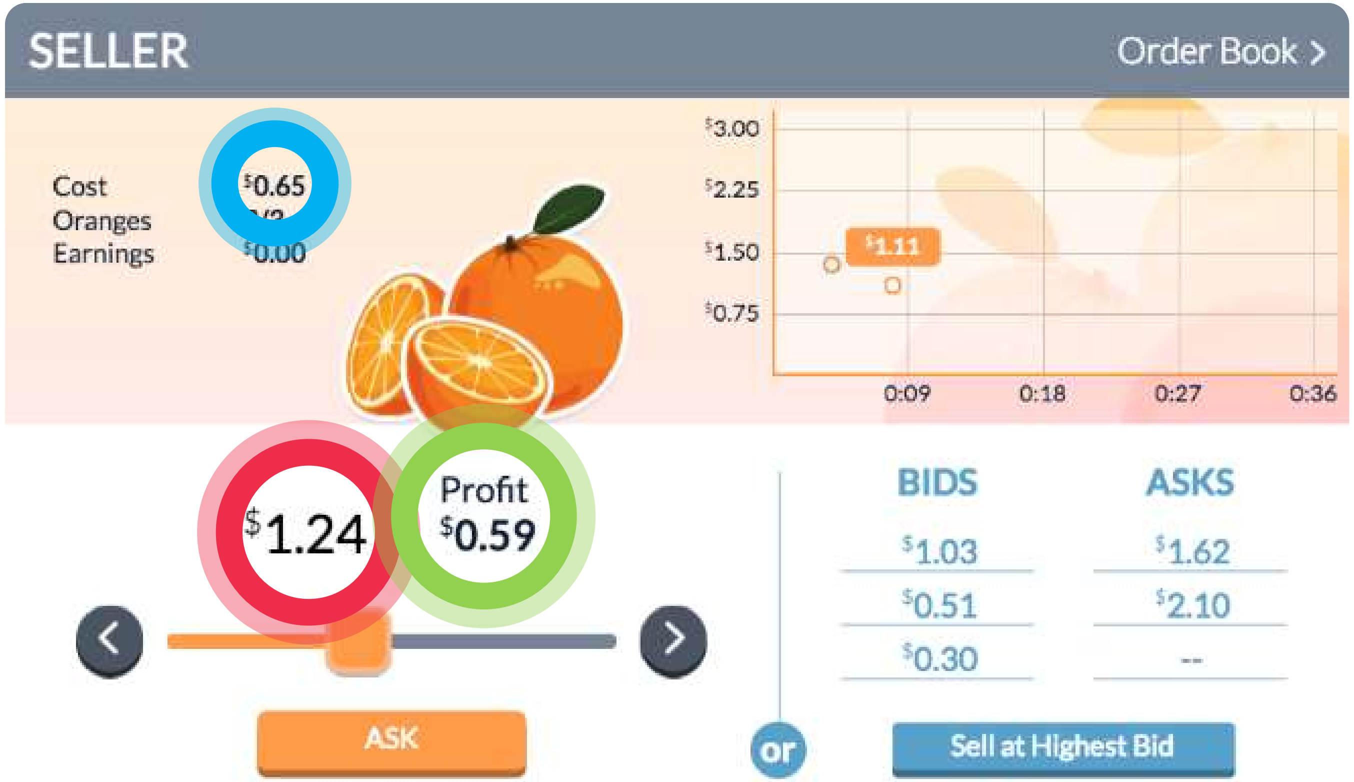
BIDS	ASKS
$0.85	$0.86
$0.66	$0.86
$0.32	$0.99

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 lower than the highest outstanding Bid

ASK

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


SELLER
Order Book >
$3.00
$2.25
$1.50
$0.75
$1.11
0:09
0:18
0:27
0:36
ASK
or
Sell at Highest Bid

Cost $0.65
Oranges ?/2
Earnings $0.00

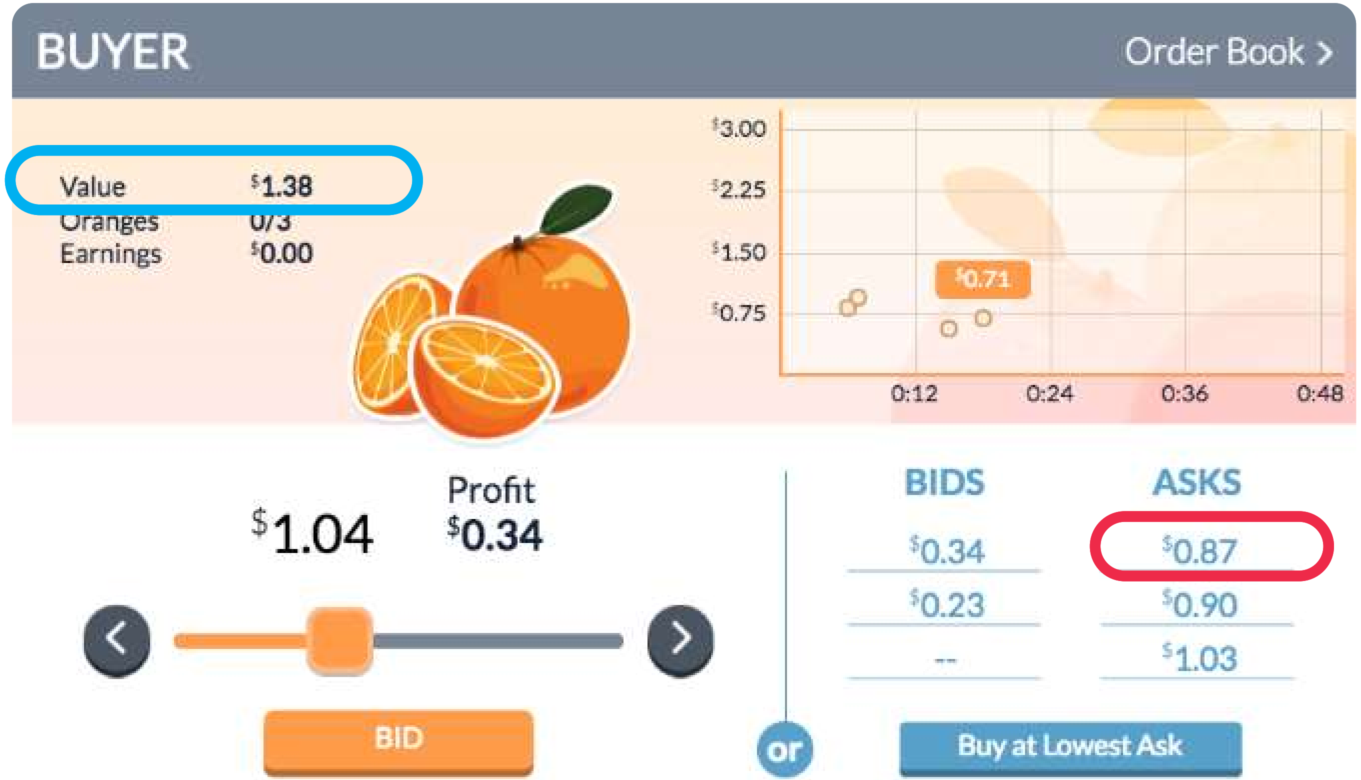
$1.24

Profit $0.59

BIDS	ASKS
$1.03	$1.62
$0.51	$2.10
$0.30	--

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

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



BUYER

Value $1.38
Oranges 0/3
Earnings $0.00

$1.04

Profit
$0.34

BIDS	ASKS
$0.34	$0.87
$0.23	$0.90
--	$1.03

Order Book >
$3.00
$2.25
$1.50
$0.75
$0.71
0:12
0:24
0:36
0:48
BID
or
Buy at Lowest Ask

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

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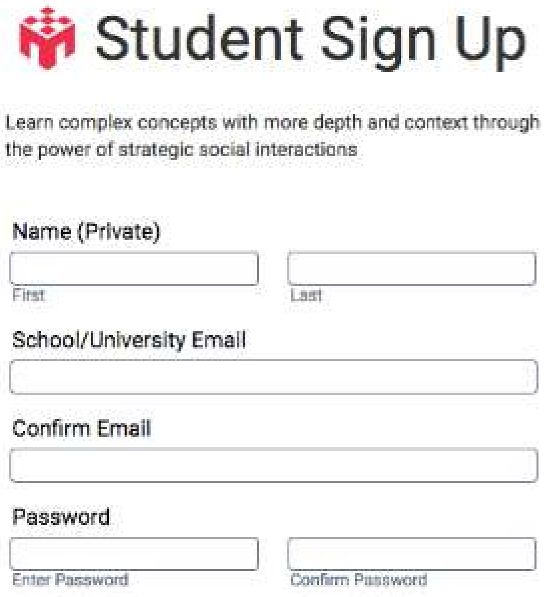


Student Sign Up

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

Name (Private)

First

Last

School/University Email

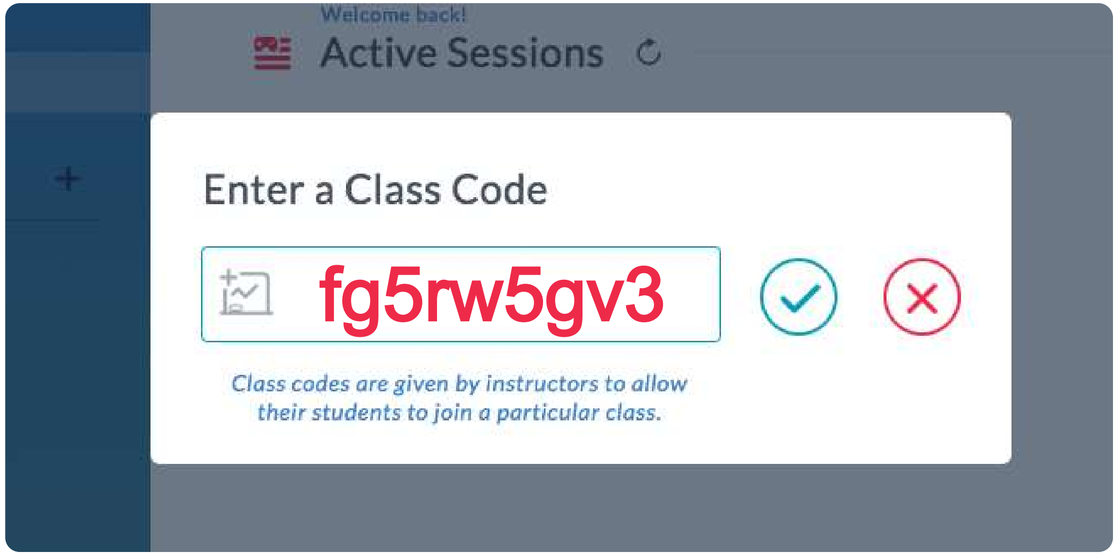
Confirm Email

Password

Enter Password

Confirm Password

2. Join the class



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fg5rw5gv3

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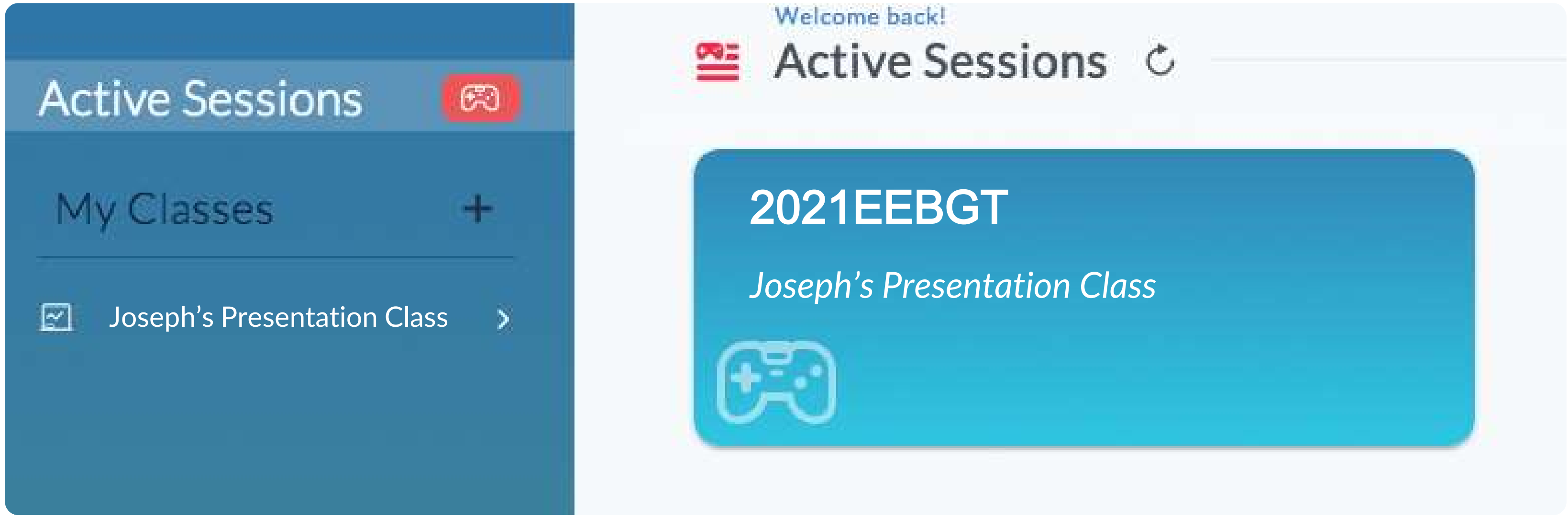


Active Sessions

My Classes +

Joseph’s Presentation Class ›

Welcome back!

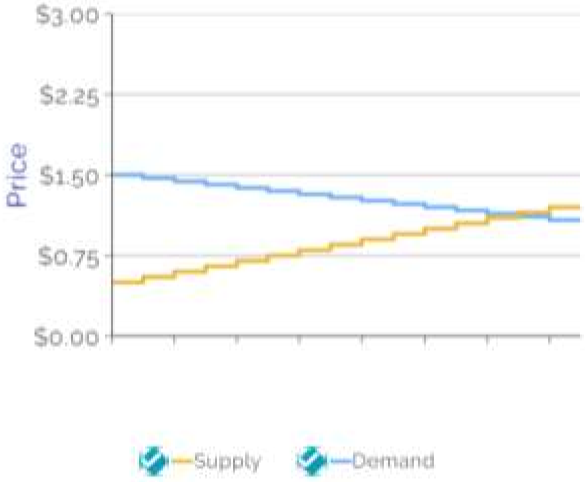
Active Sessions

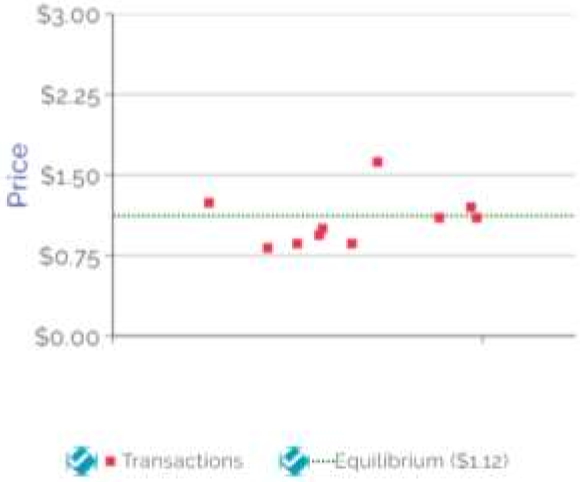
2021EEBGT

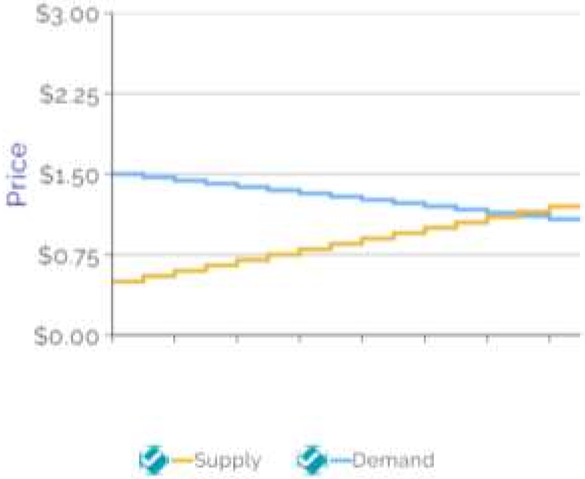
Joseph’s Presentation Class

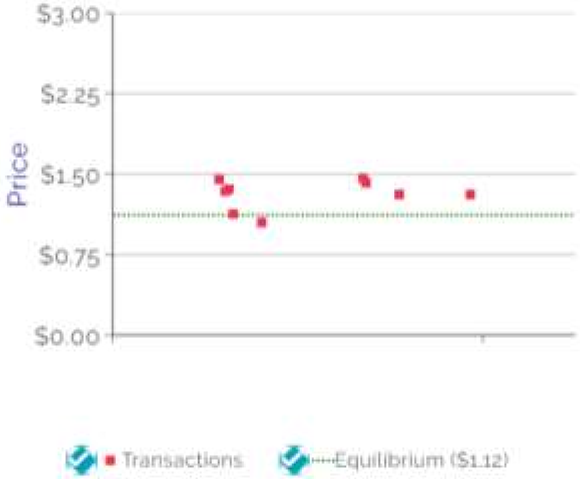
MobLab Double Auction:

EE-BGT 21S Results: Round 1



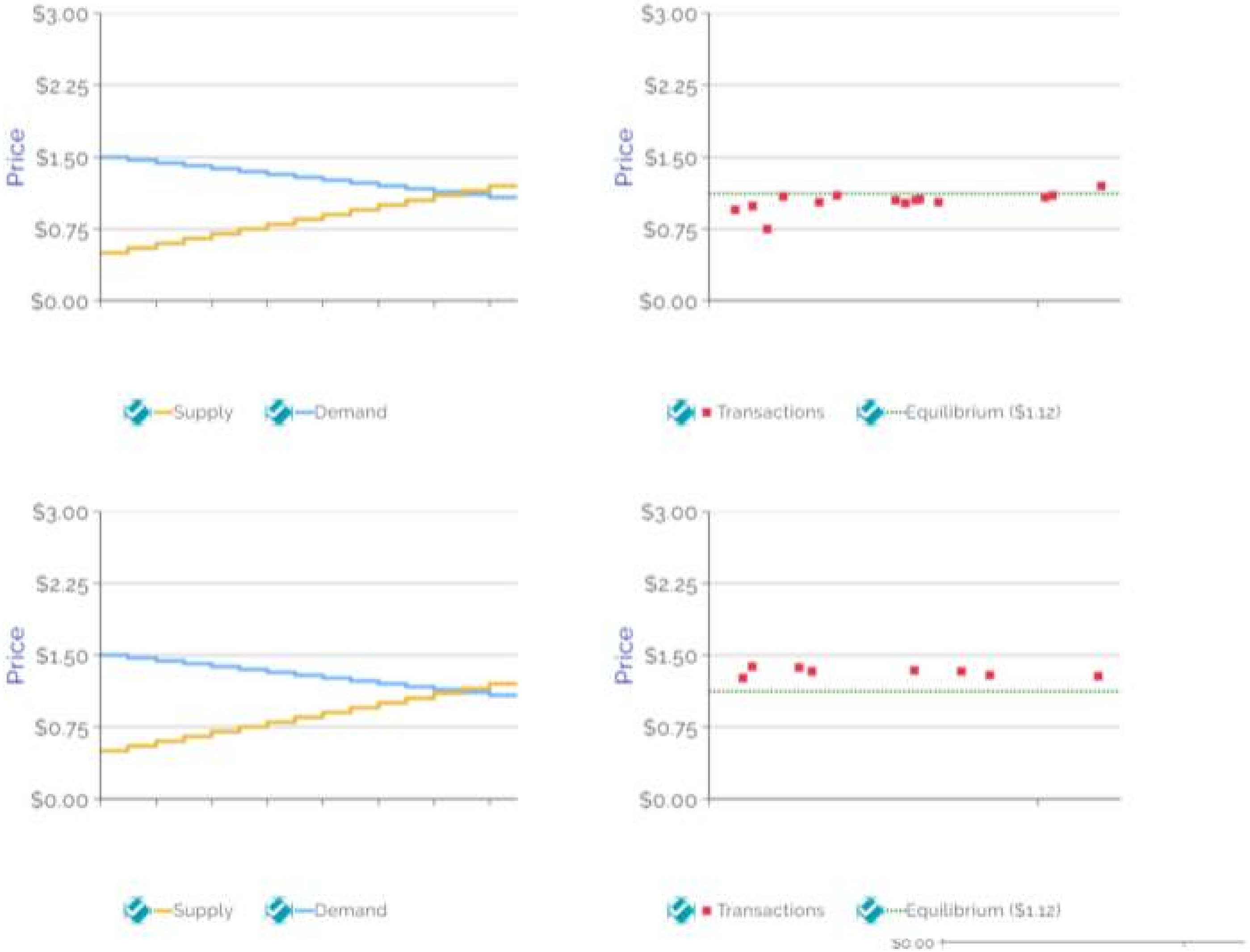




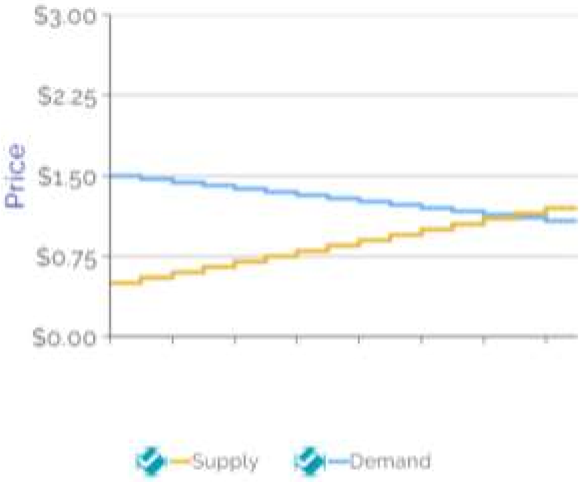


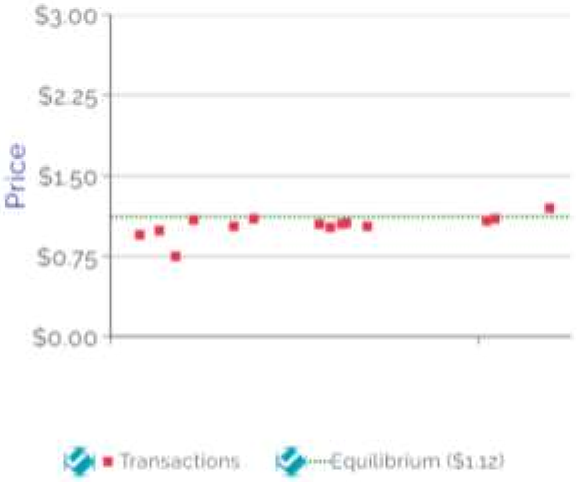
MobLab Double Auction:

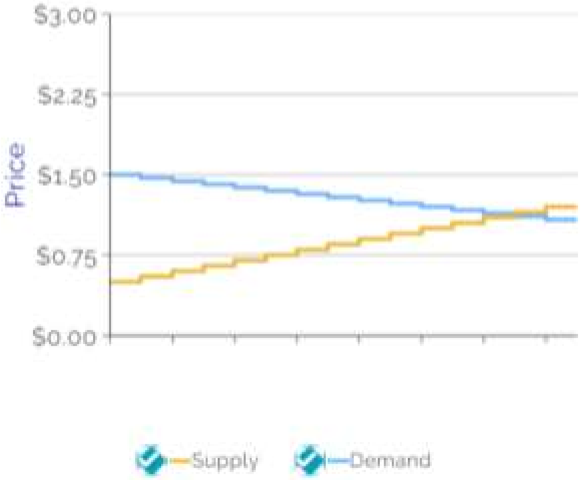
EE-BGT 21S Results: Round 2

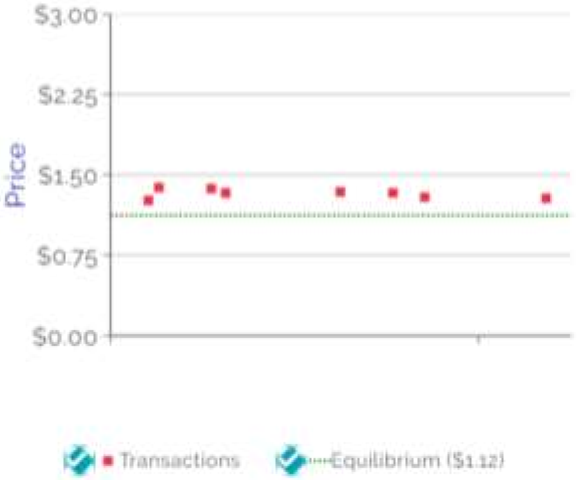


MobLab Double Auction:
EE-BGT 21S Results: Round 3



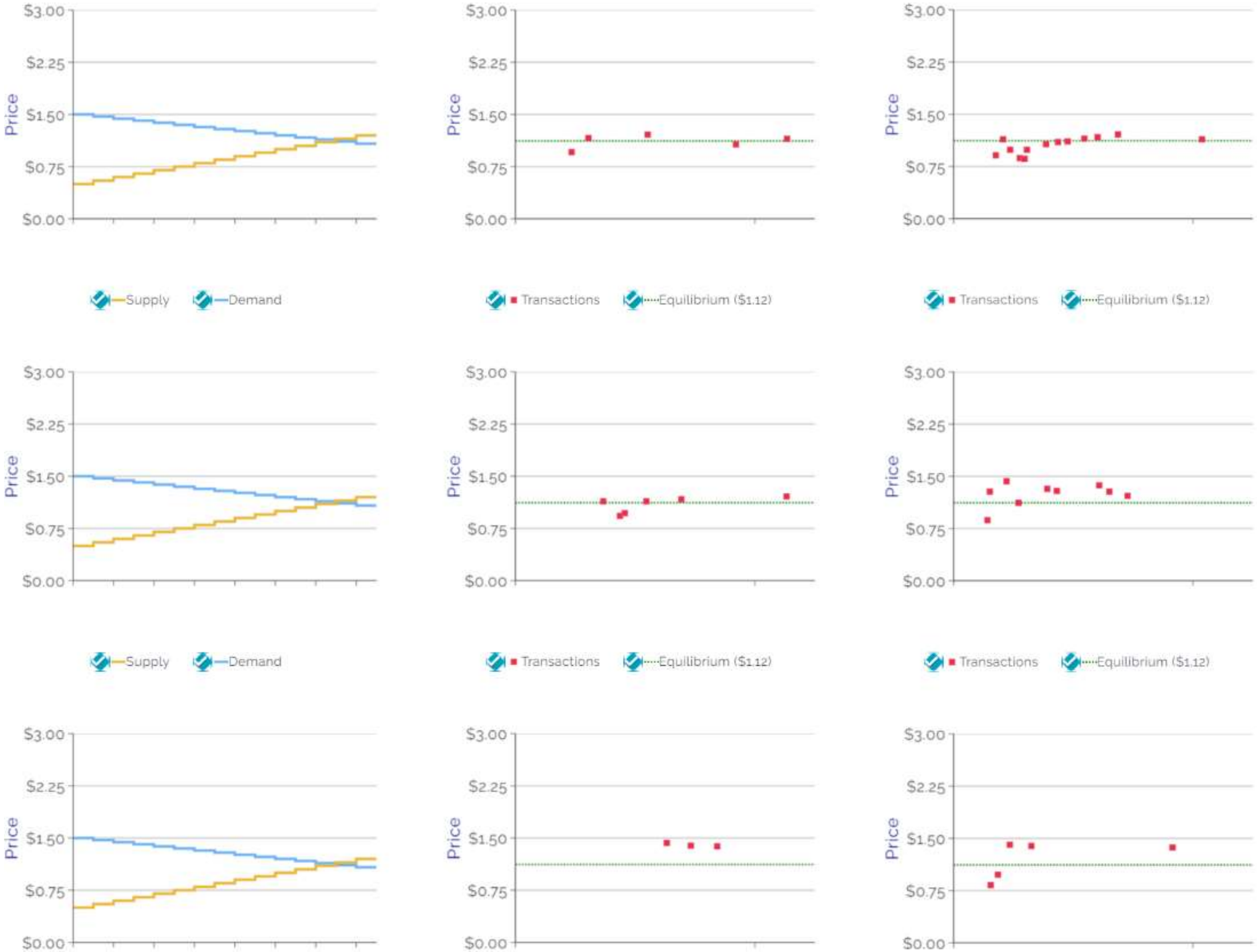






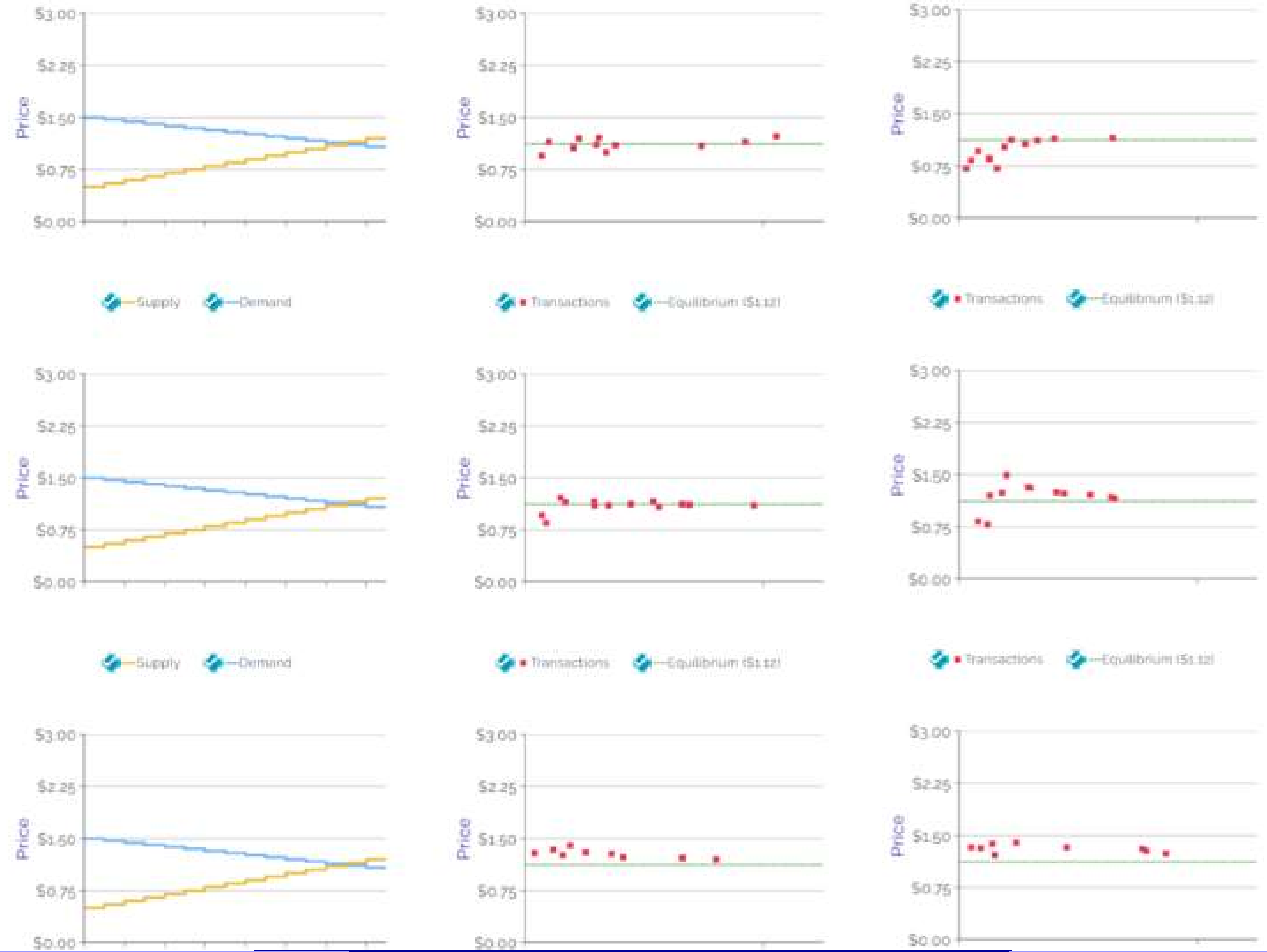
MobLab Double Auction:

CCU Results: Round 1



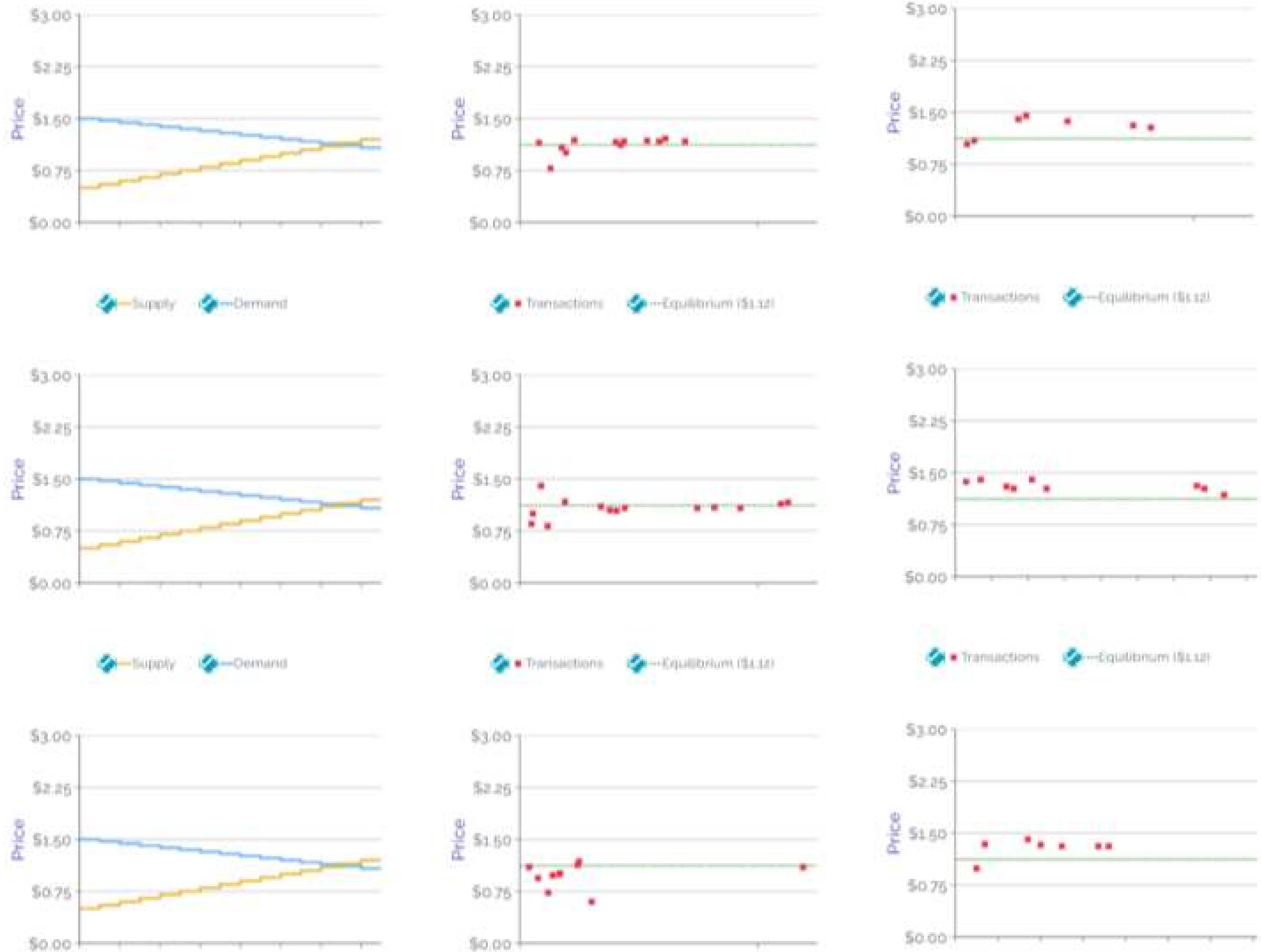
MobLab Double Auction:

CCU Results: Round 2



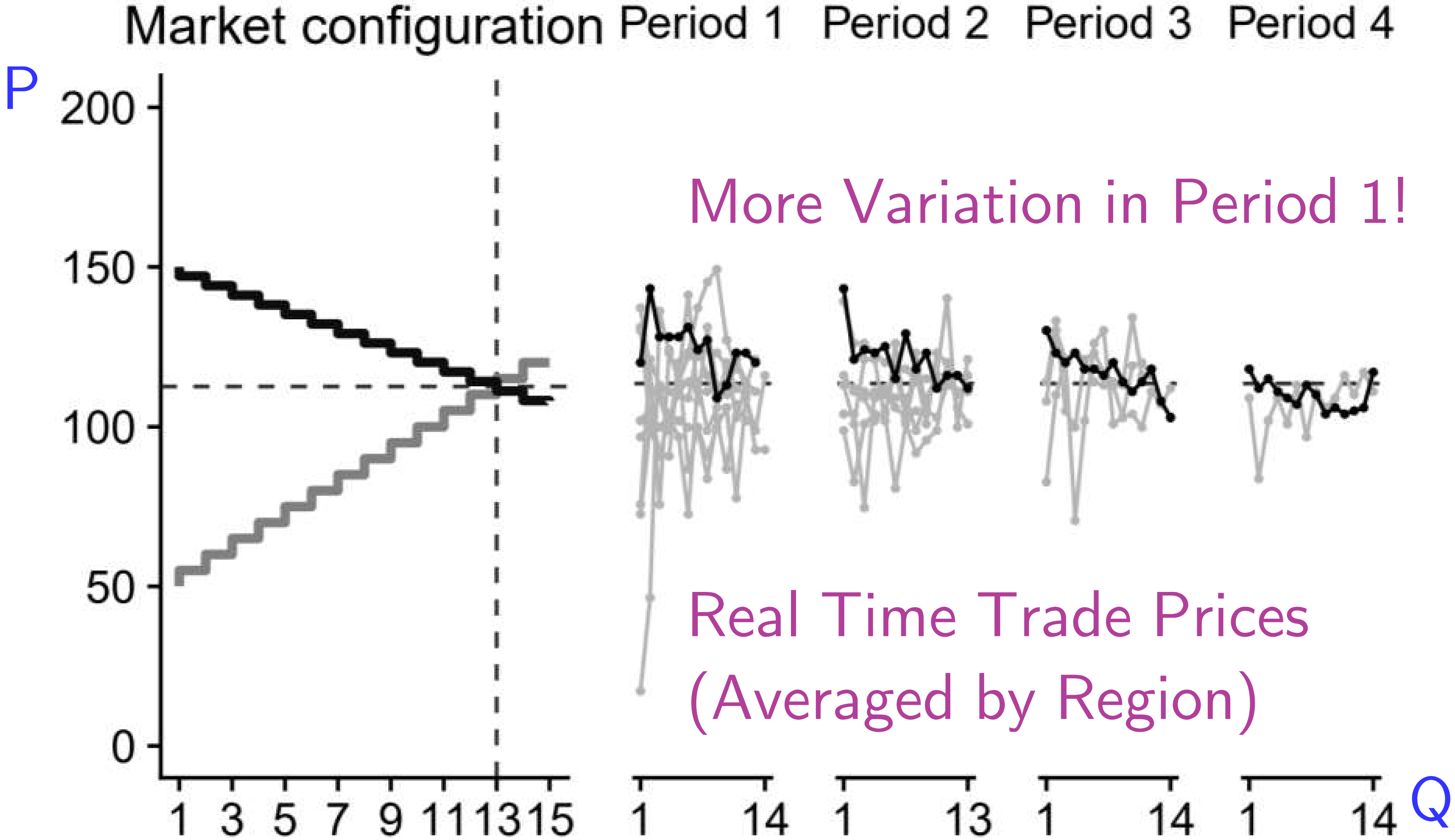
MobLab Double Auction:

CCU Results: Round 3



MobLab Double Auction: Lin et al. (2020)

Prices Converge to Competitive Equilibrium



More Variation in Period 1!

Real Time Trade Prices
(Averaged by Region)

MobLab Double Auction:

Summary Statistics

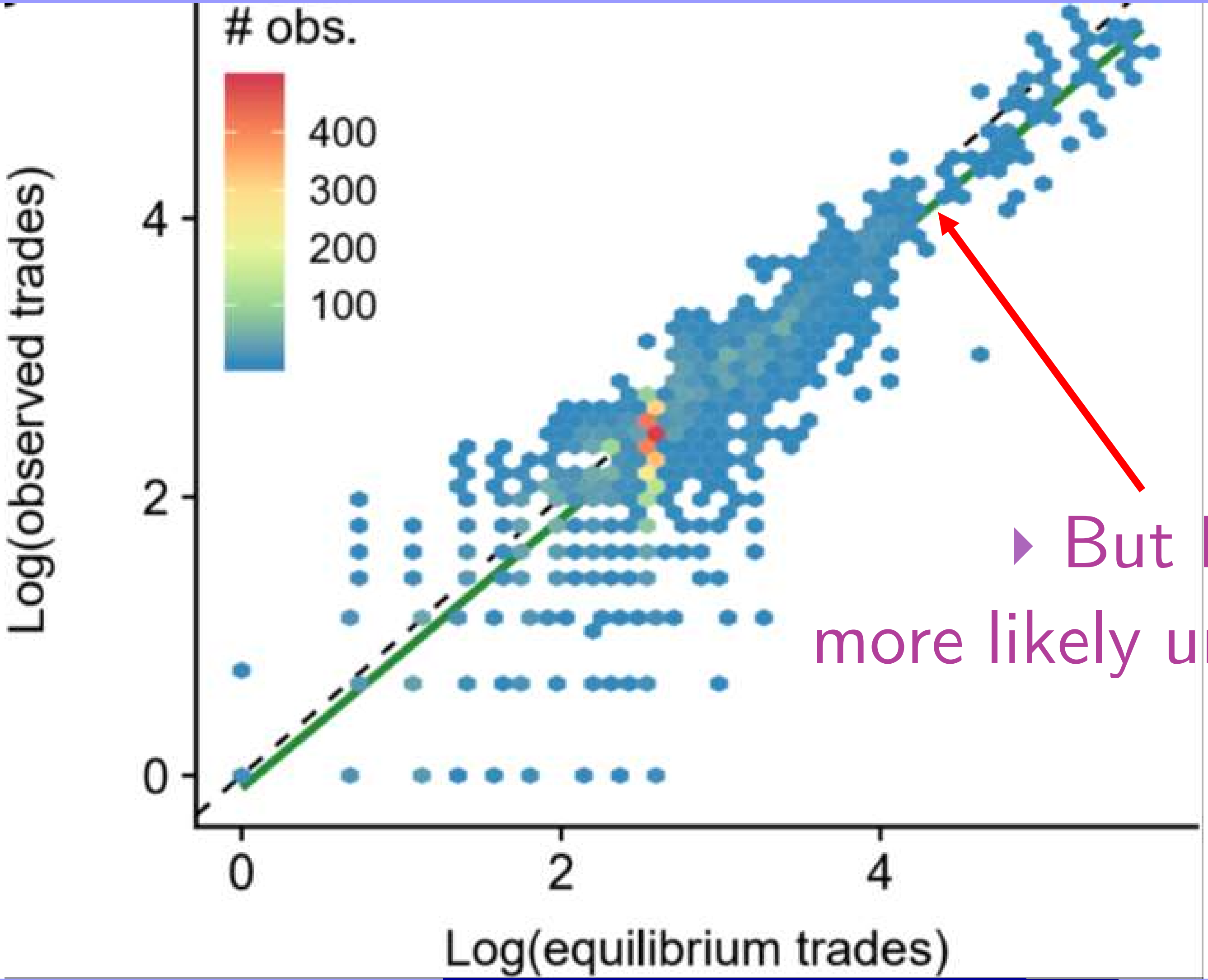
	Mean	(s. d.)
Double Auction	(5,809 Markets)	
MED δ - Accuracy	0.070	(0.280)
Smith's α - Fluctuation	0.279	(0.294)
Efficiency	81.5%	(25.8%)

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:

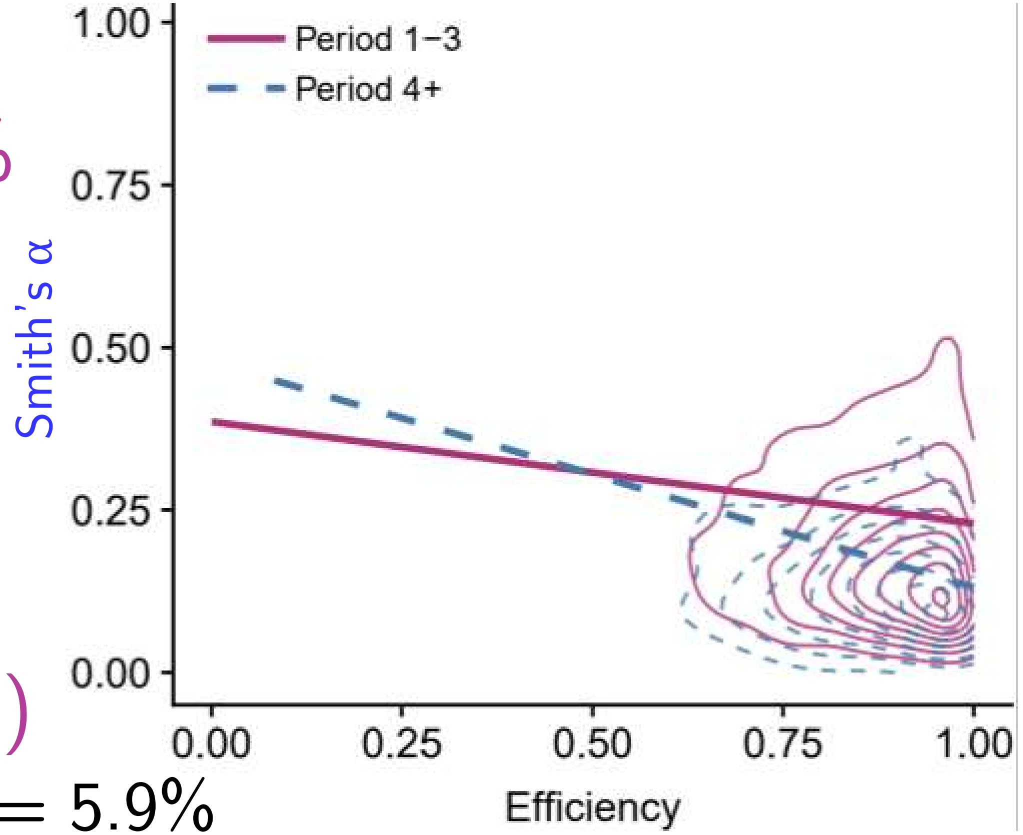
Trade Volume Close to CE!



- 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 α = 5.9%
    - Efficiency: around 95.89%

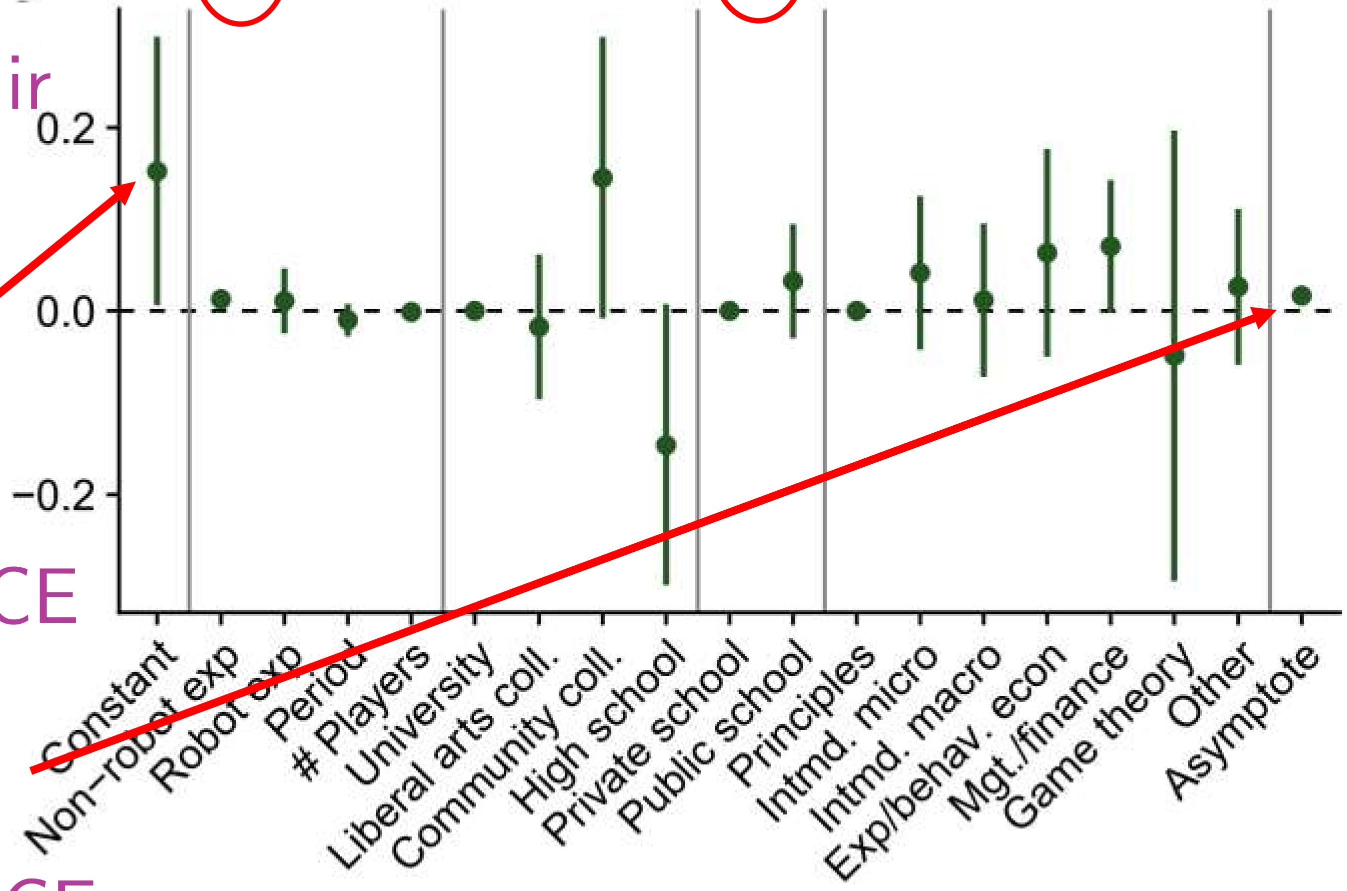


MobLab Double Auction:

Within-Period Price Convergence to CE

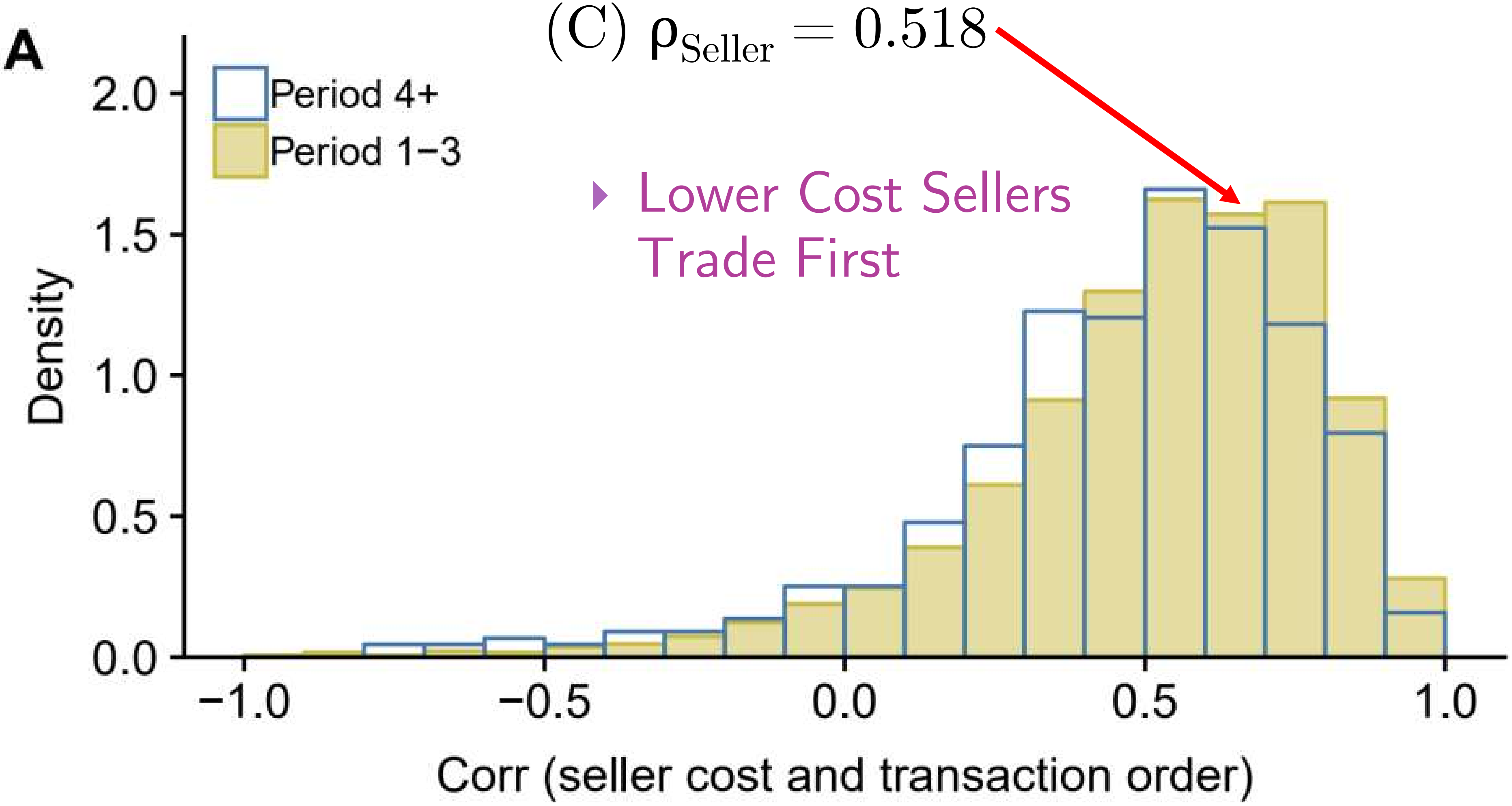
$$y_{it} = (1/t)\mathbb{X}_i \cdot \boxed{\beta_1} + (1-1/t)\boxed{\beta_2} + \epsilon_{it},$$

- 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)

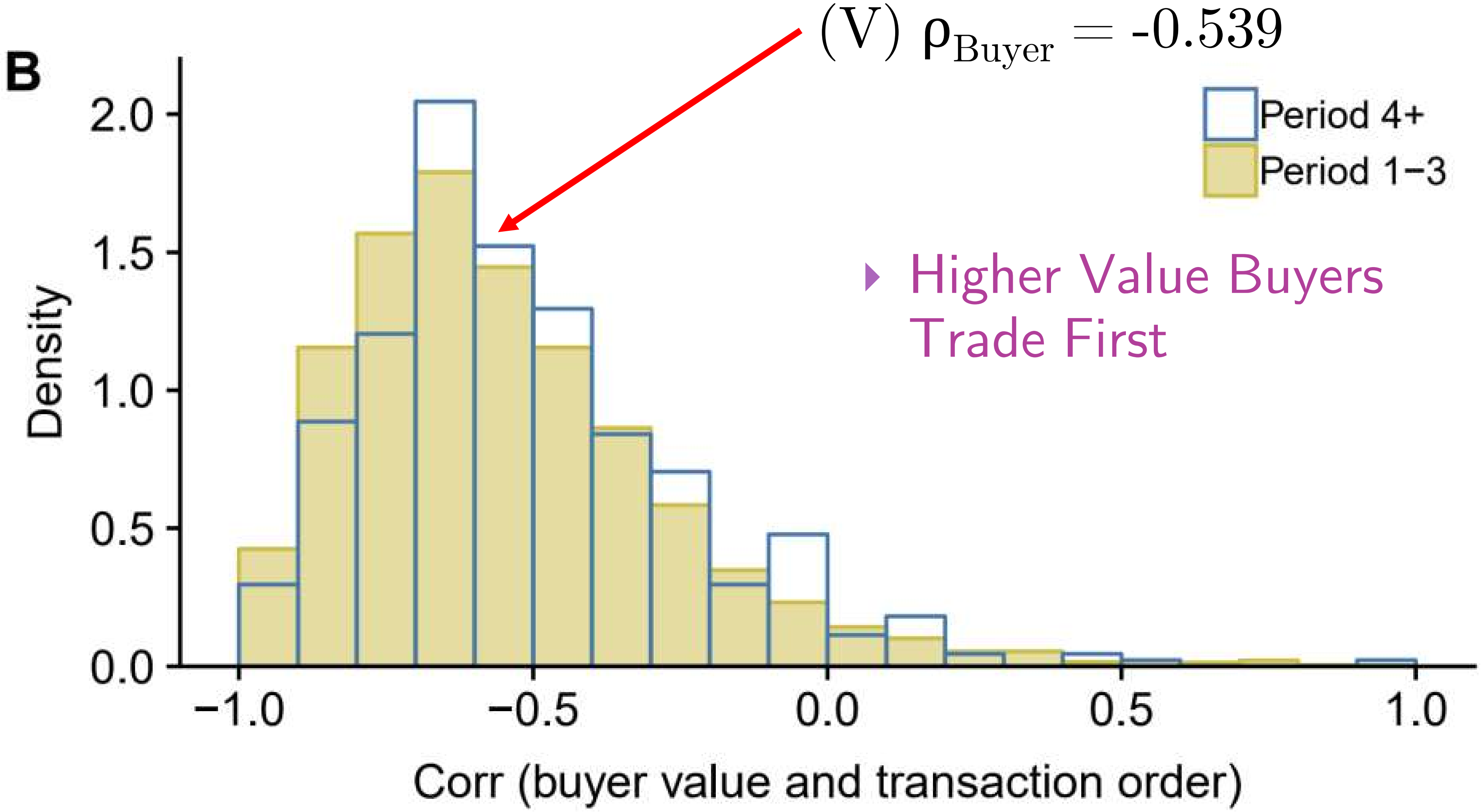


(C) $\rho_{\text{Seller}} = 0.518$

- Lower Cost Sellers Trade First

MobLab Double Auction: Buyer Rank-Order

Correlation(Transaction Order, Buyer Value)

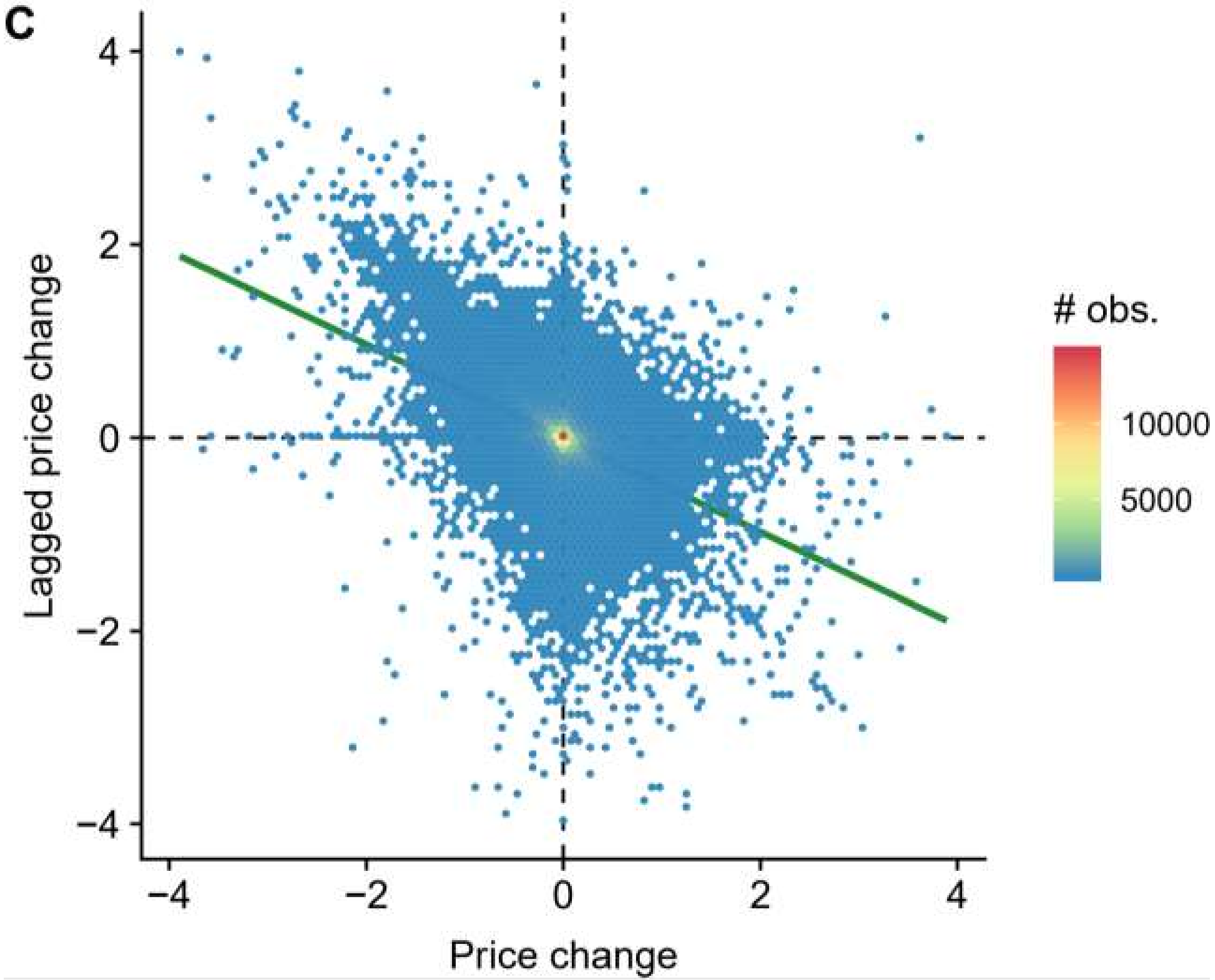


(V) $\rho_{\text{Buyer}} = -0.539$

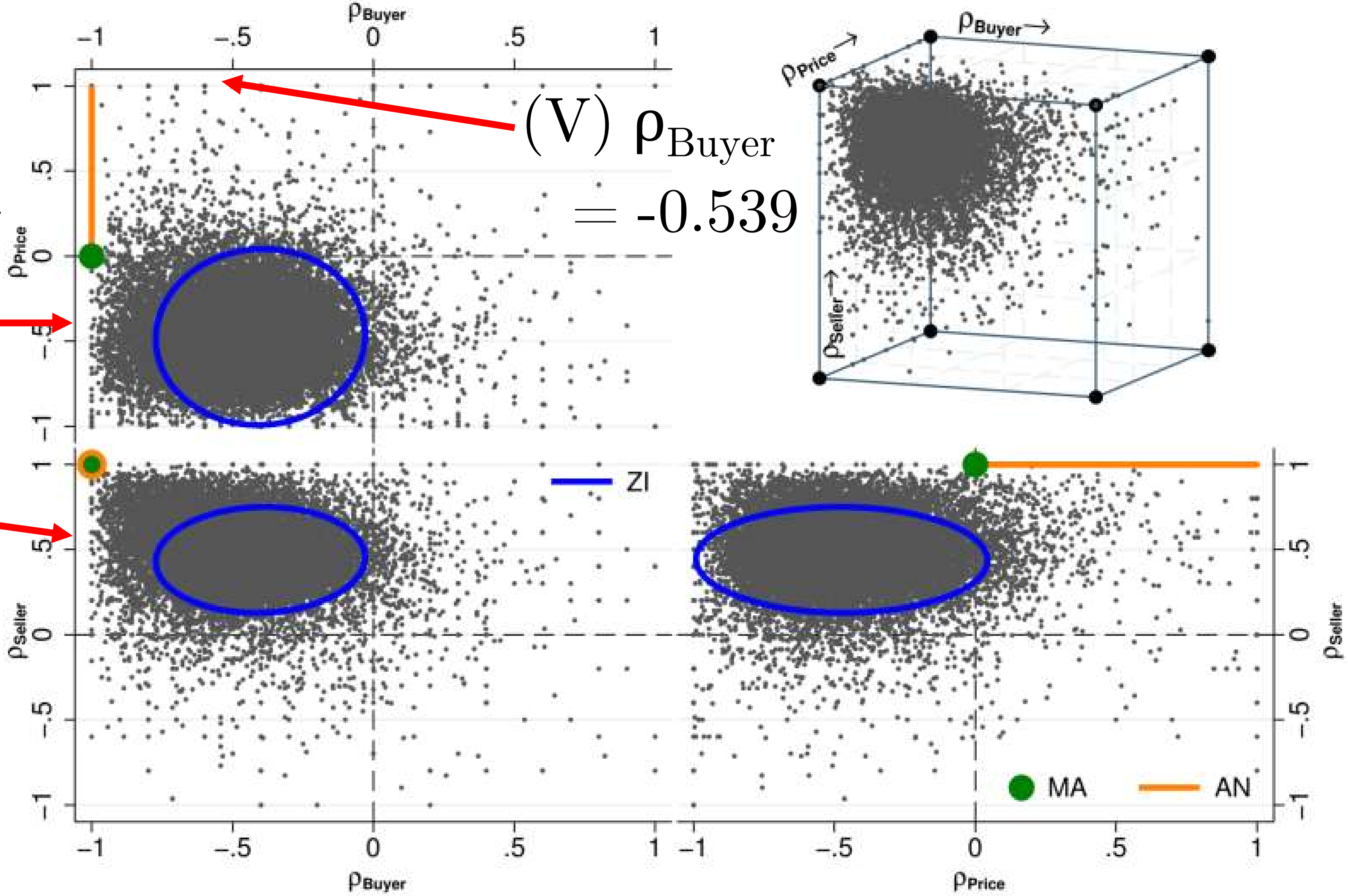
- Higher Value Buyers Trade First

MobLab Double Auction:

Price Change Autocorrelation = -0.457



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



$\rho_{\text{Price}} =$ -0.457

(P)

(V) $\rho_{\text{Buyer}} =$ -0.539

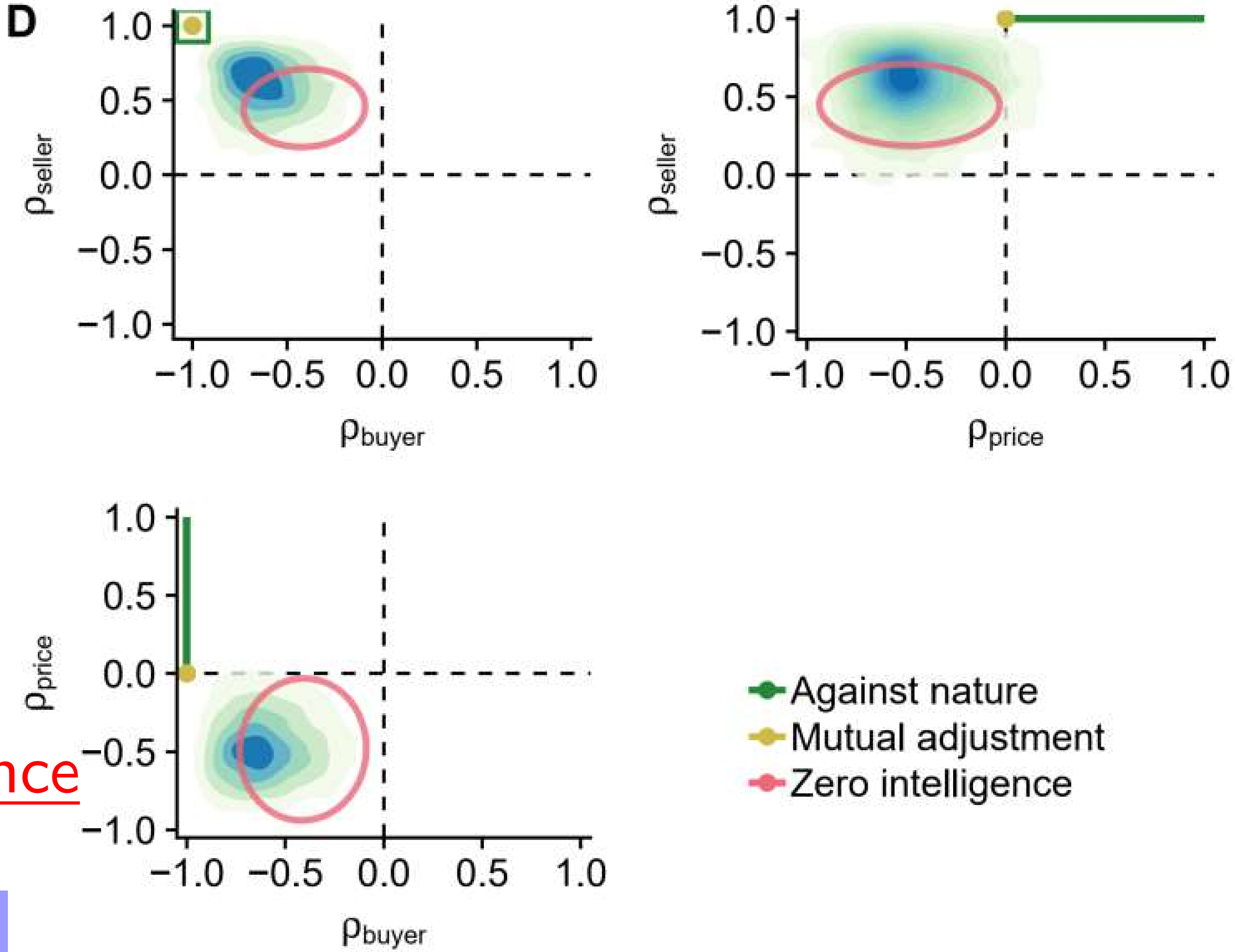
(C)

$\rho_{\text{Seller}} =$ 0.518

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

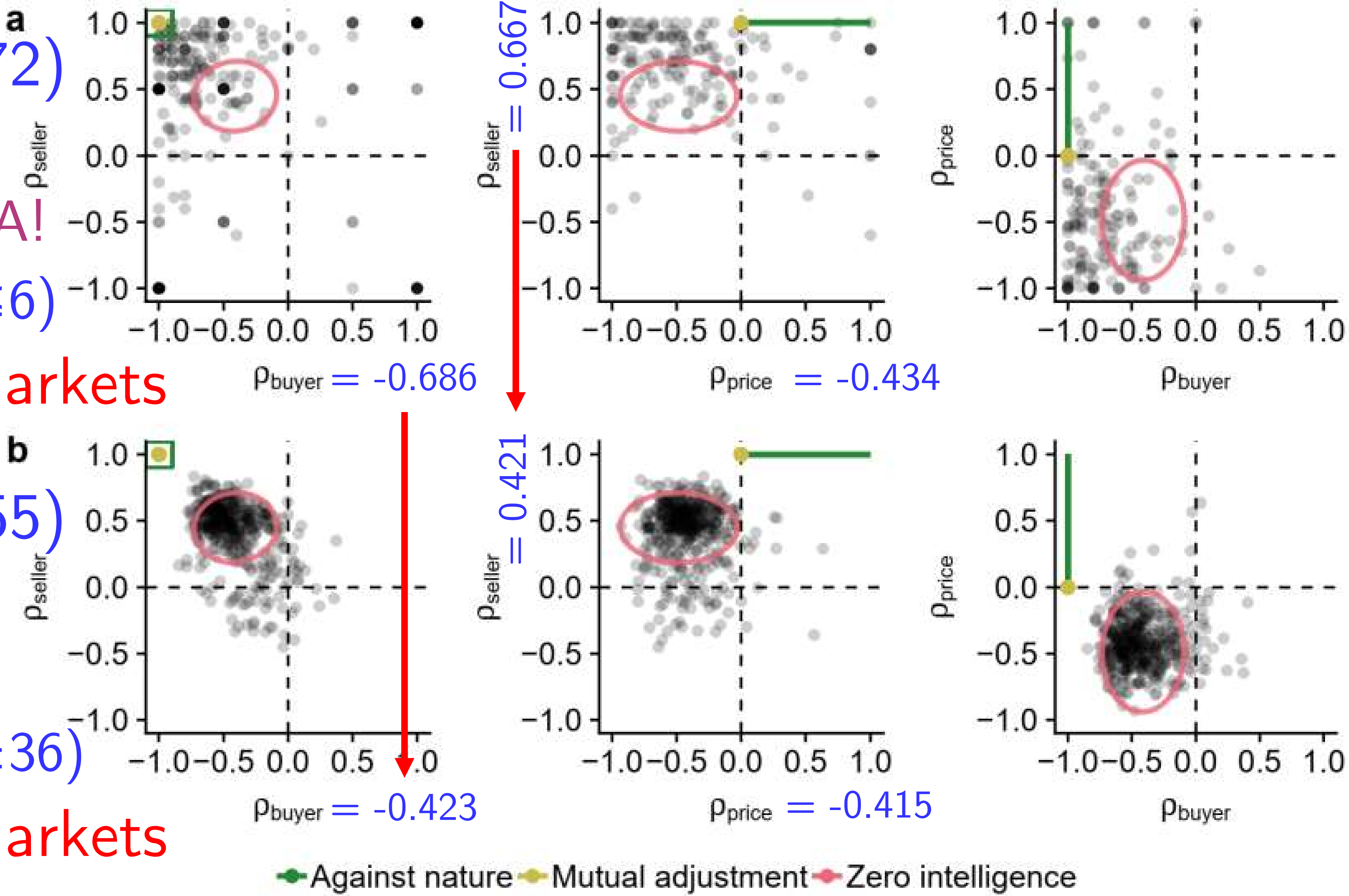
(N = 455)

Favor

ZI!

(traders≥36)

Large markets



ρ_{buyer} = -0.686

ρ_{seller} = 0.667

ρ_{price} = -0.434

ρ_{buyer} = -0.423

ρ_{seller} = 0.421

ρ_{price} = -0.415

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

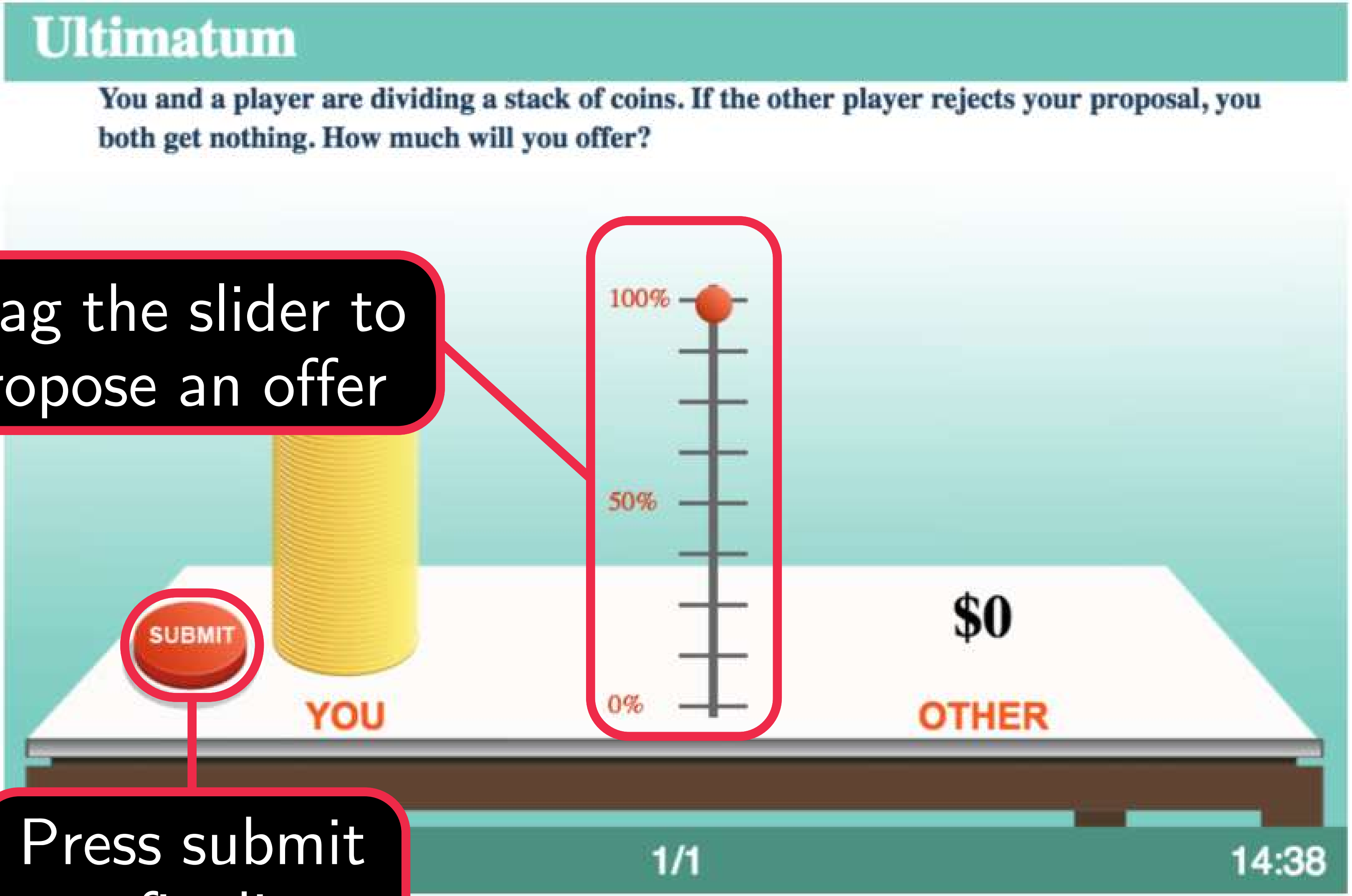
1. Ultimatum Bargaining (最後通牒談判實驗)
2. Beauty Contests (選美結果預測實驗)
3. Continental Divide (產業發展分水嶺實驗)
   - How BGT can explain what people do more accurately by
   - Extending GT to include social preferences (fairness), limited strategic thinking, and learning. (為了更準確預測人們的行為，行為賽局論如何把社會(公平)偏好、有限理性思考和學習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?

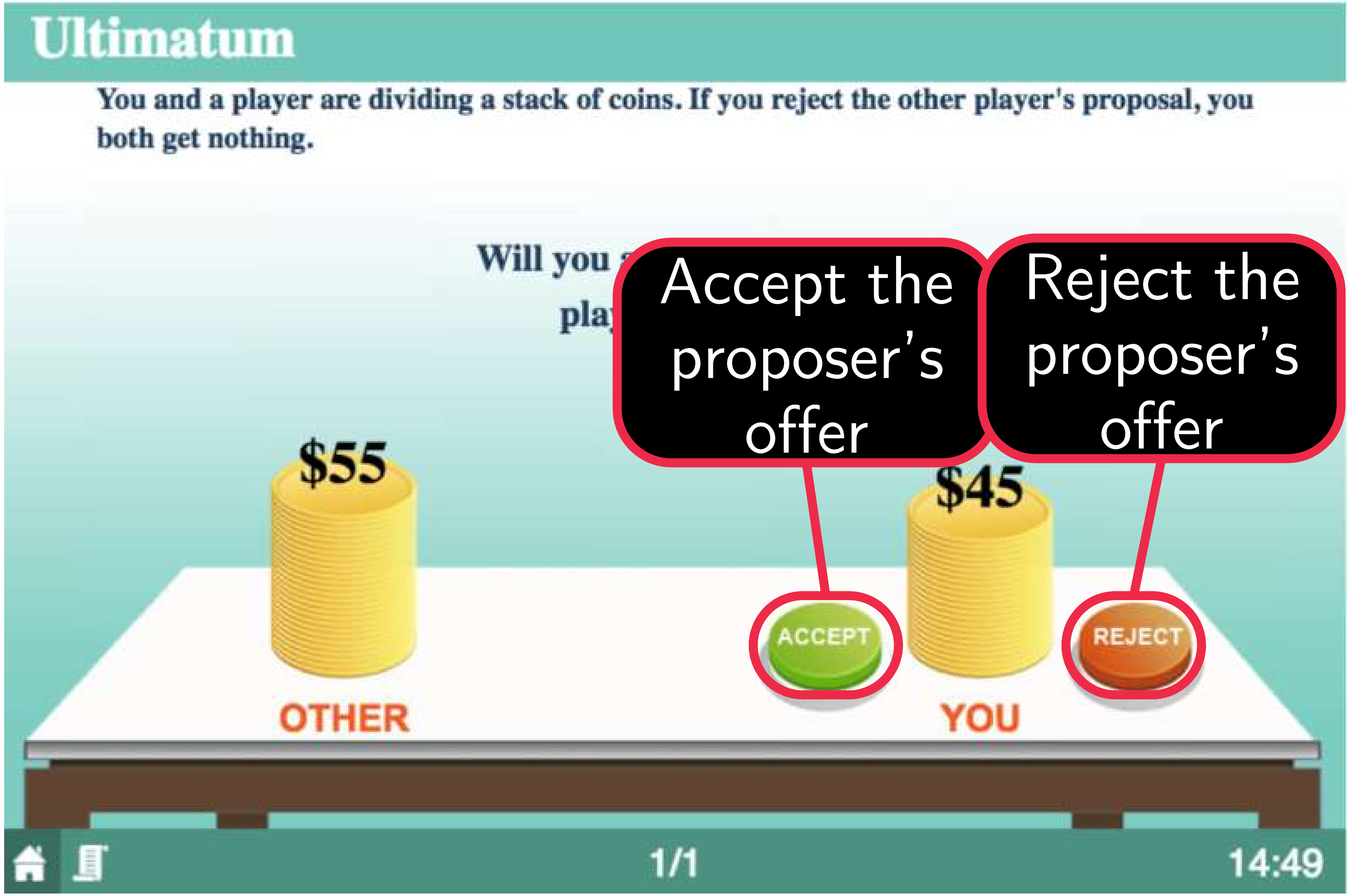
100%
50%
0%
$0
SUBMIT
YOU
OTHER
1/1
14:38

Drag the slider to propose an offer

Press submit to finalize

MobLab Ultimatum Game:

Respondent



Ultimatum

You and a player are dividing a stack of coins. If you reject the other player's proposal, you both get nothing.

Will you s

play

$55
OTHER
$45
YOU
ACCEPT
REJECT
1/1
14:49

Accept the proposer's offer

Reject the proposer's offer

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)

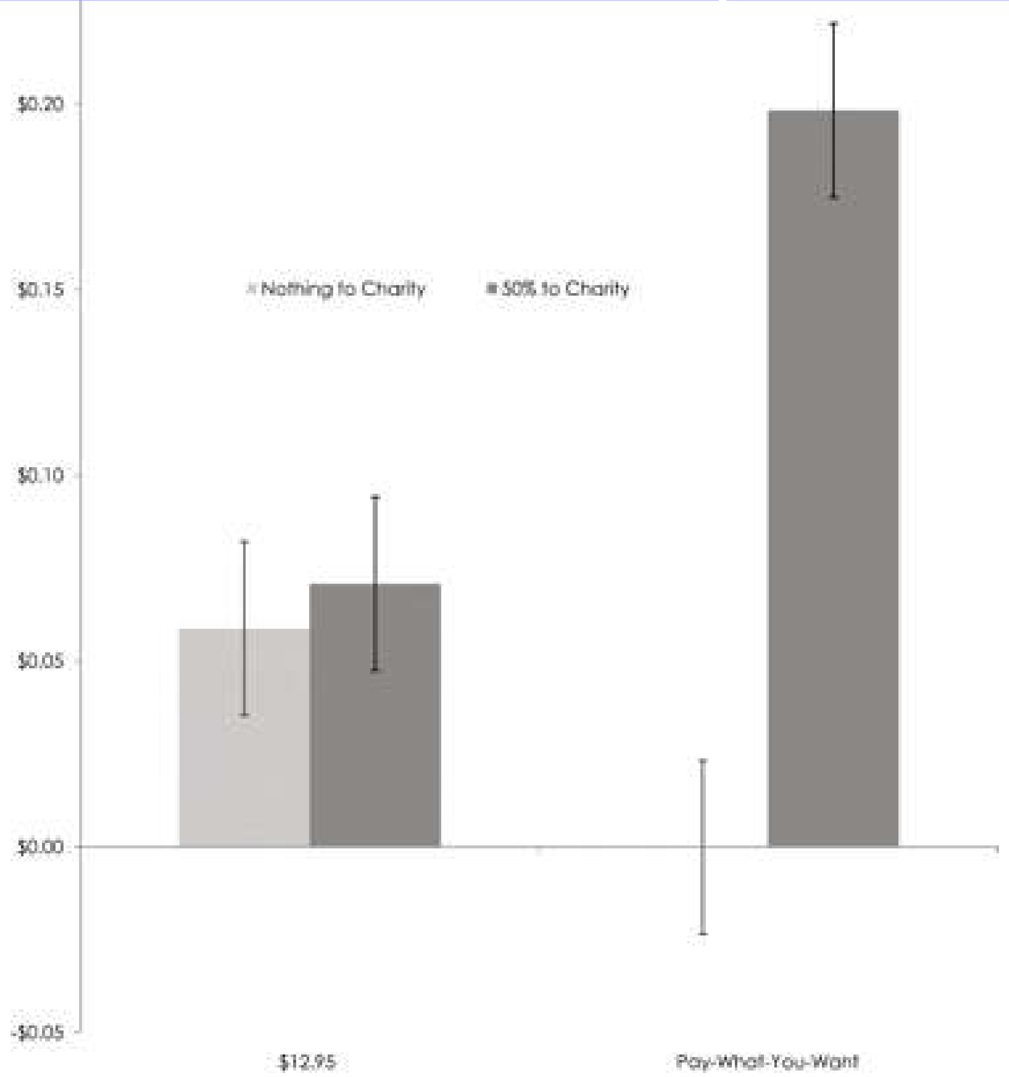
Disneyland Photo Field Experiment (還真的有攝影師開價的實驗)

- 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)

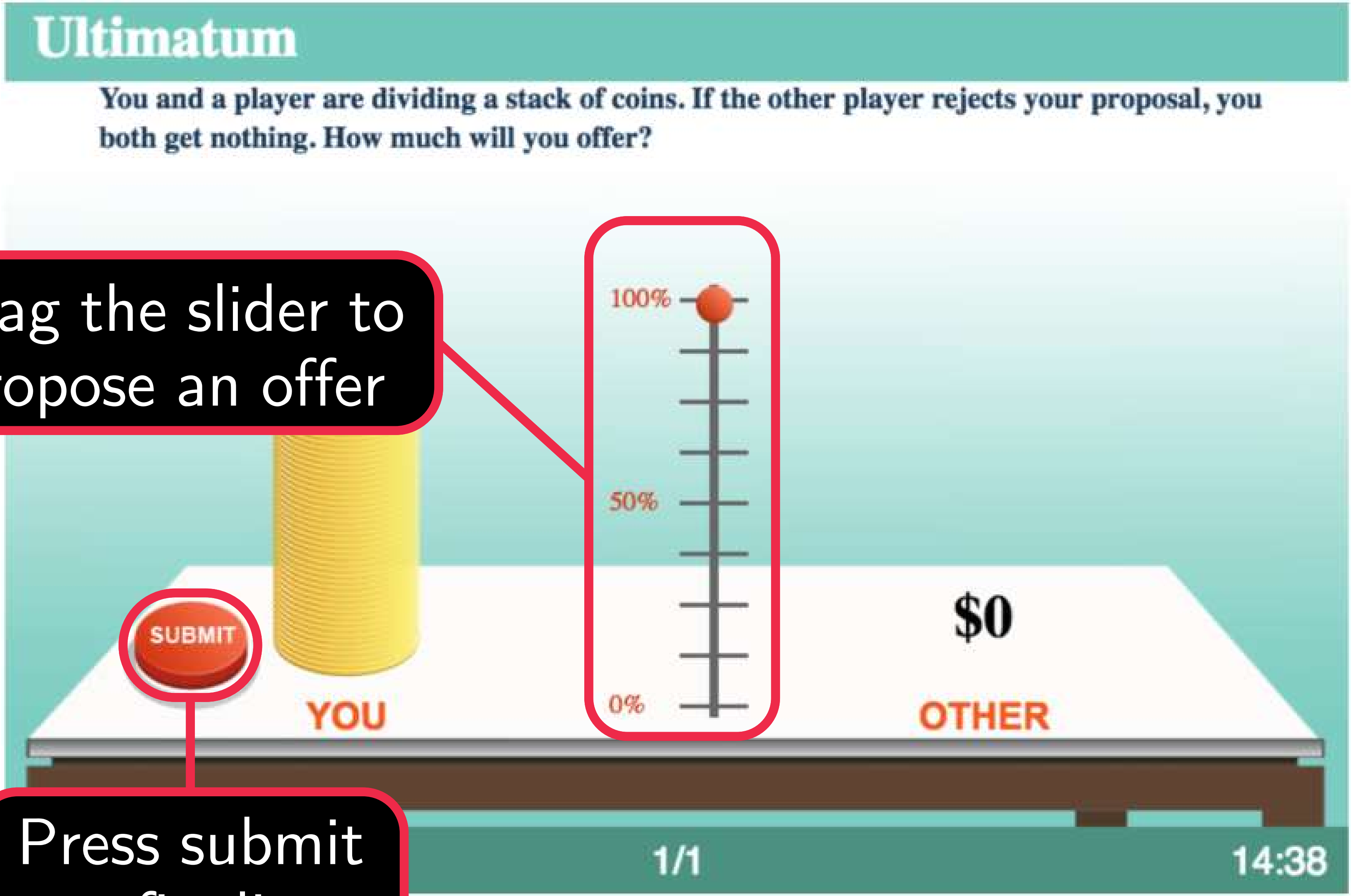
*Problem:

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



MobLab Ultimatum Game:

Proposer



Ultimatum

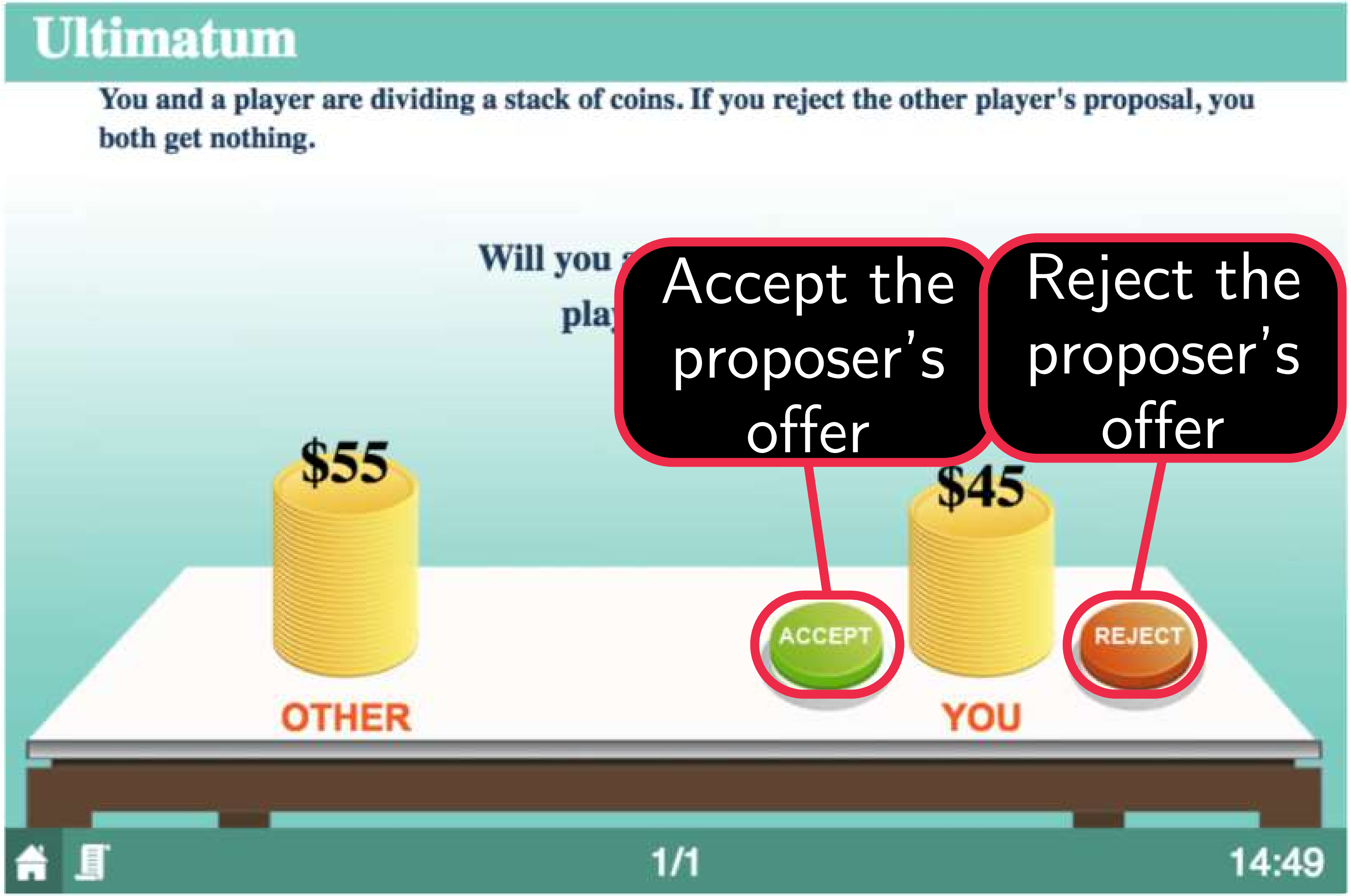
You and a player are dividing a stack of coins. If the other player rejects your proposal, you both get nothing. How much will you offer?

100%
50%
0%
SUBMIT
YOU
$0
OTHER
1/1
14:38

Drag the slider to propose an offer

Press submit to finalize

MobLab Ultimatum Game: Respondent



Ultimatum

You and a player are dividing a stack of coins. If you reject the other player's proposal, you both get nothing.

Will you
pla

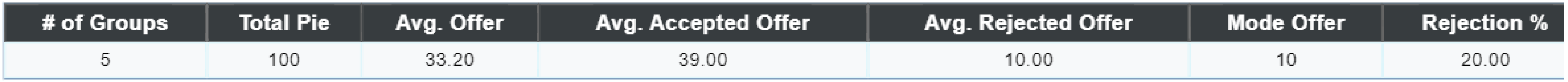
$55
OTHER
$45
YOU
ACCEPT
REJECT
1/1
14:49

Accept the proposer's offer

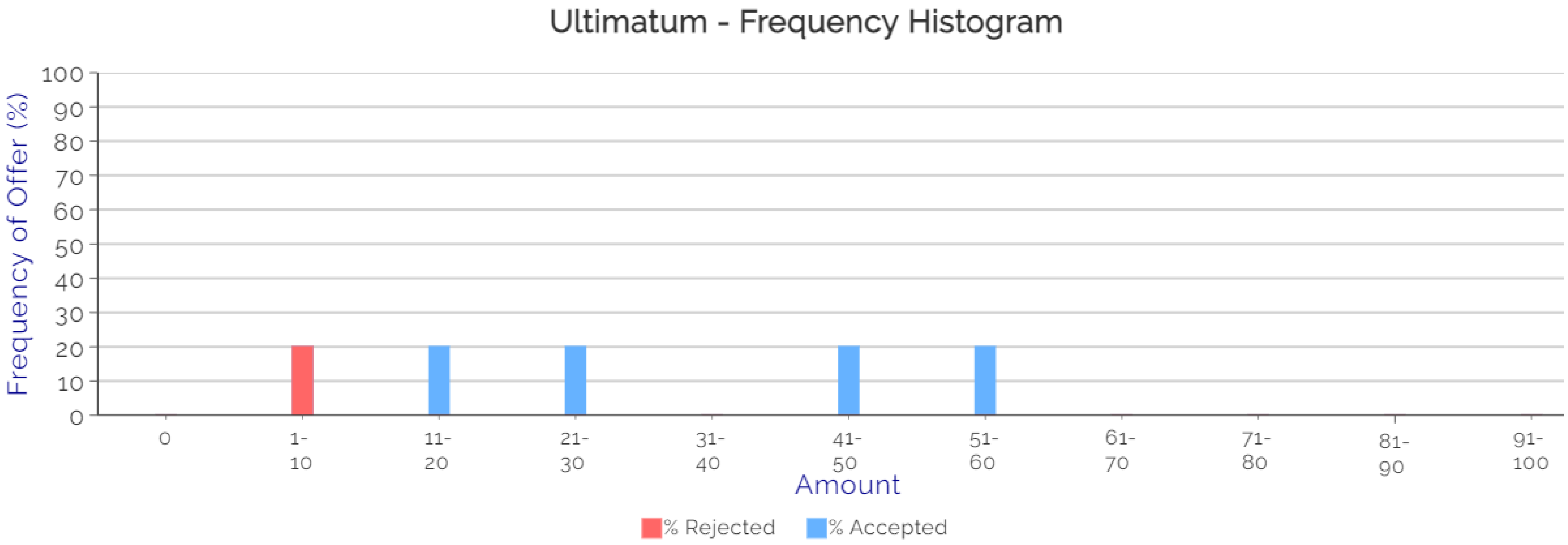
Reject the proposer's offer

MobLab Ultimatum Game:

EE-BGT 21S Results:

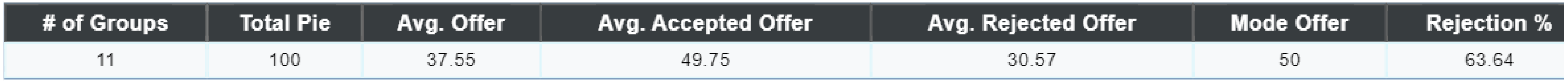


# of Groups	Total Pie	Avg. Offer	Avg. Accepted Offer	Avg. Rejected Offer	Mode Offer	Rejection %
5	100	33.20	39.00	10.00	10	20.00

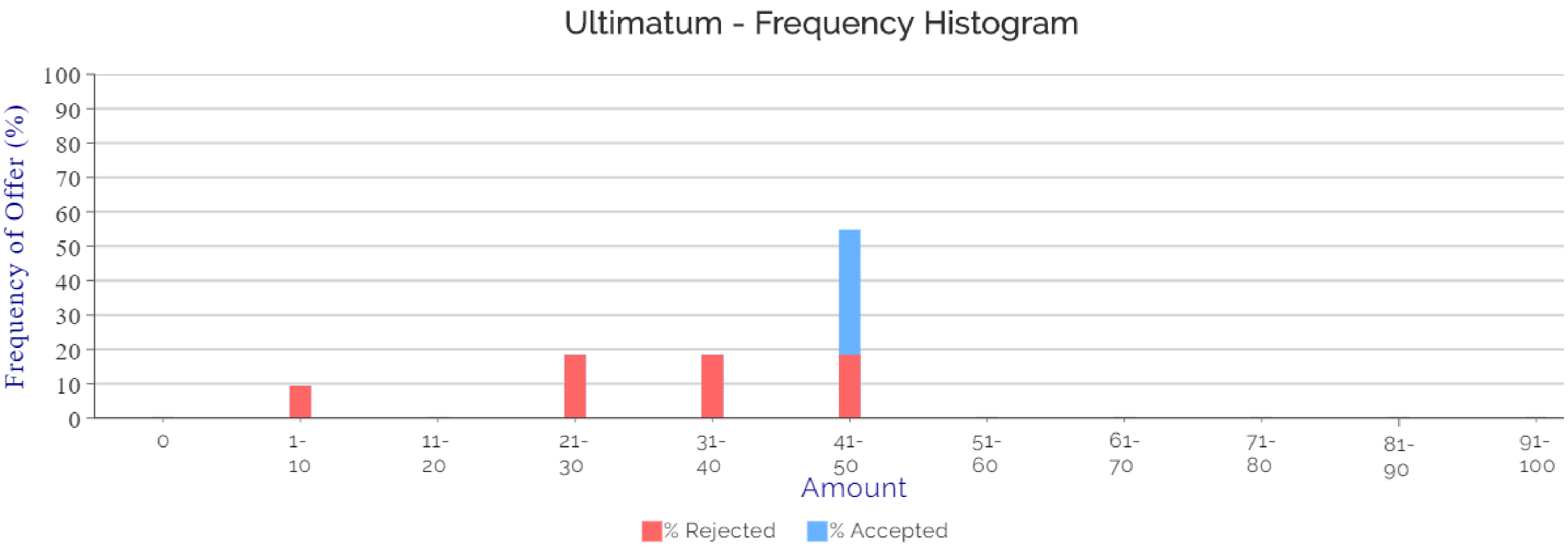


MobLab Ultimatum Game:

CCU Results:

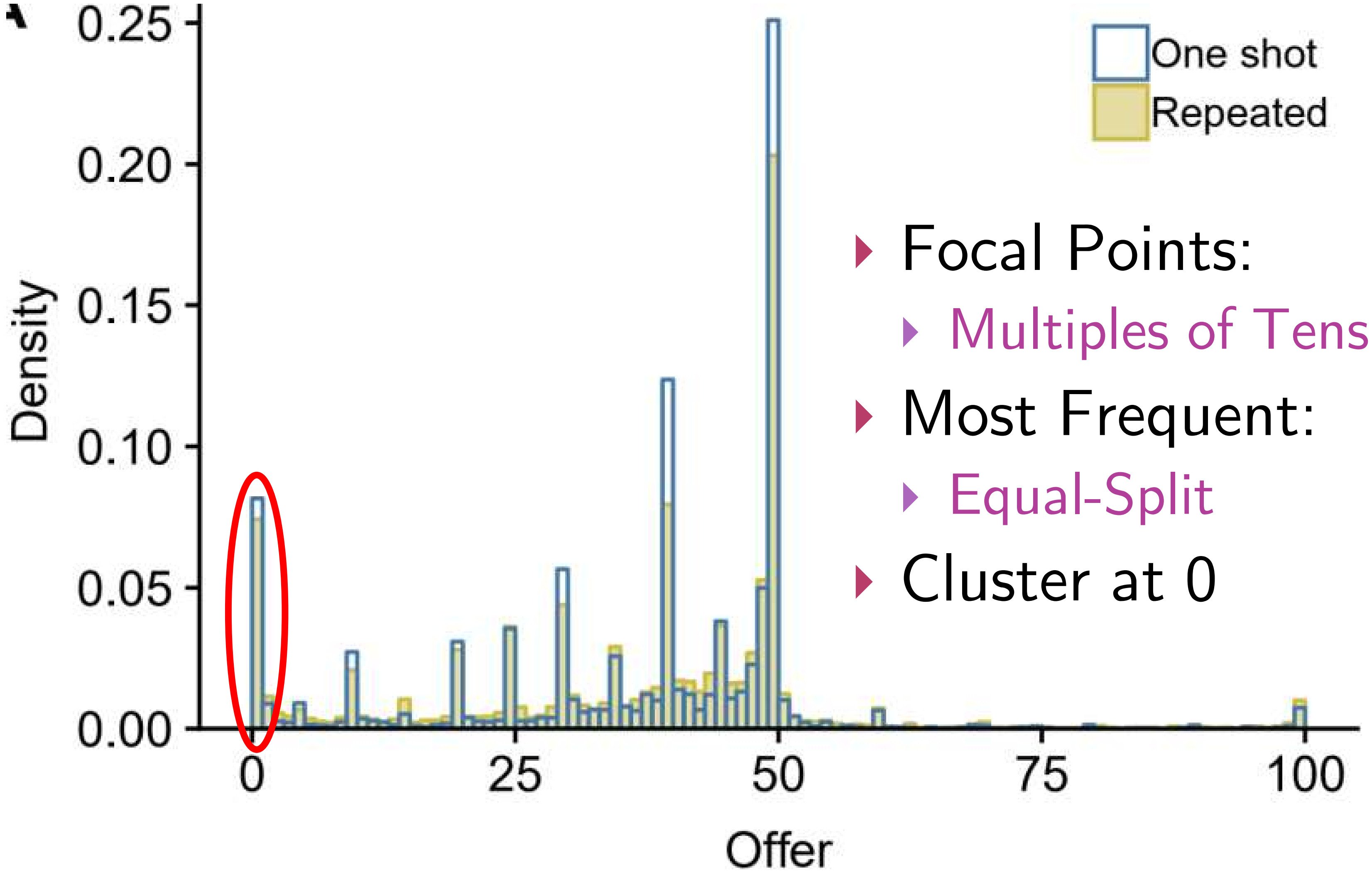


# of Groups	Total Pie	Avg. Offer	Avg. Accepted Offer	Avg. Rejected Offer	Mode Offer	Rejection %
11	100	37.55	49.75	30.57	50	63.64



MobLab Ultimatum Game:

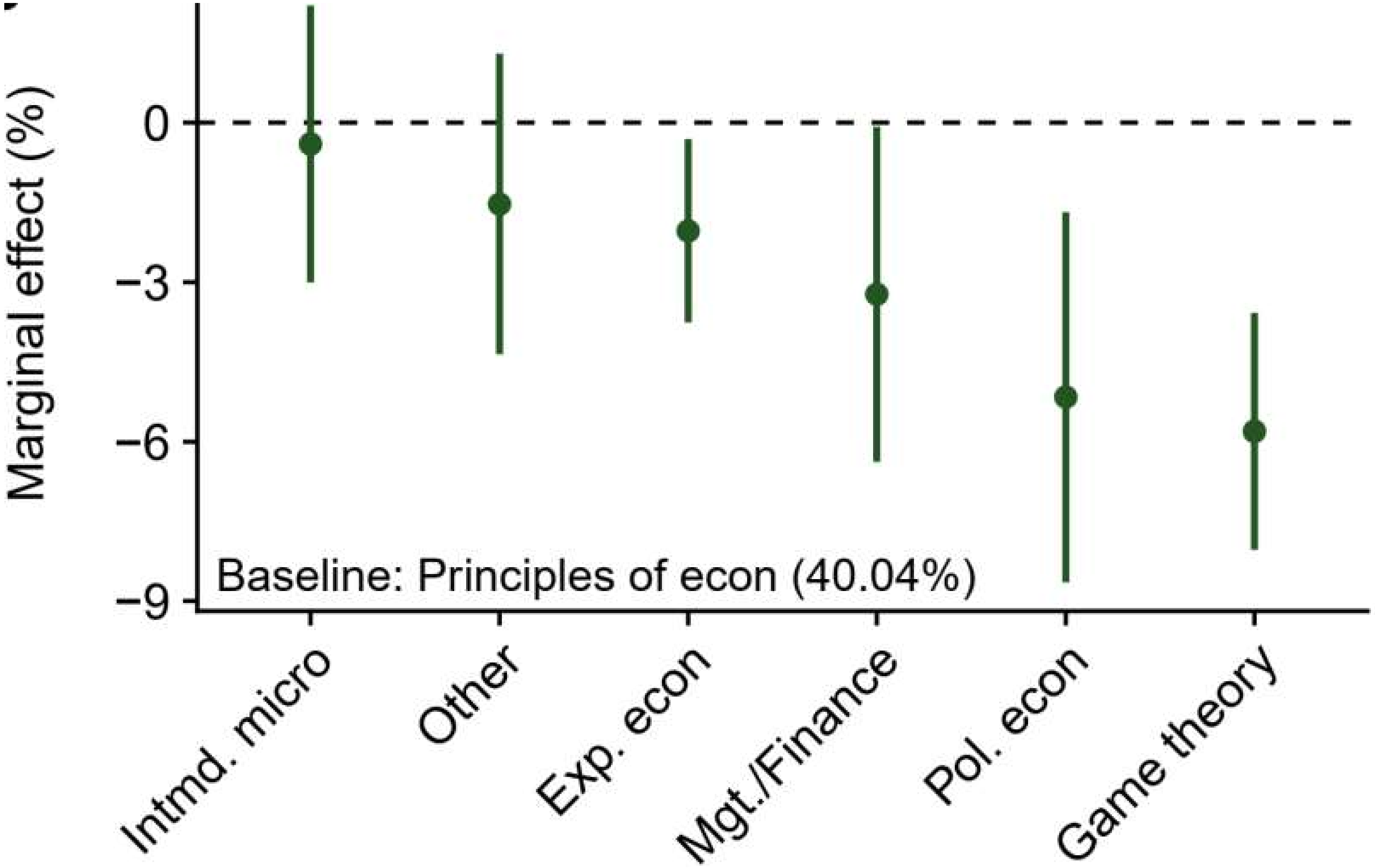
Proposal Offers



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

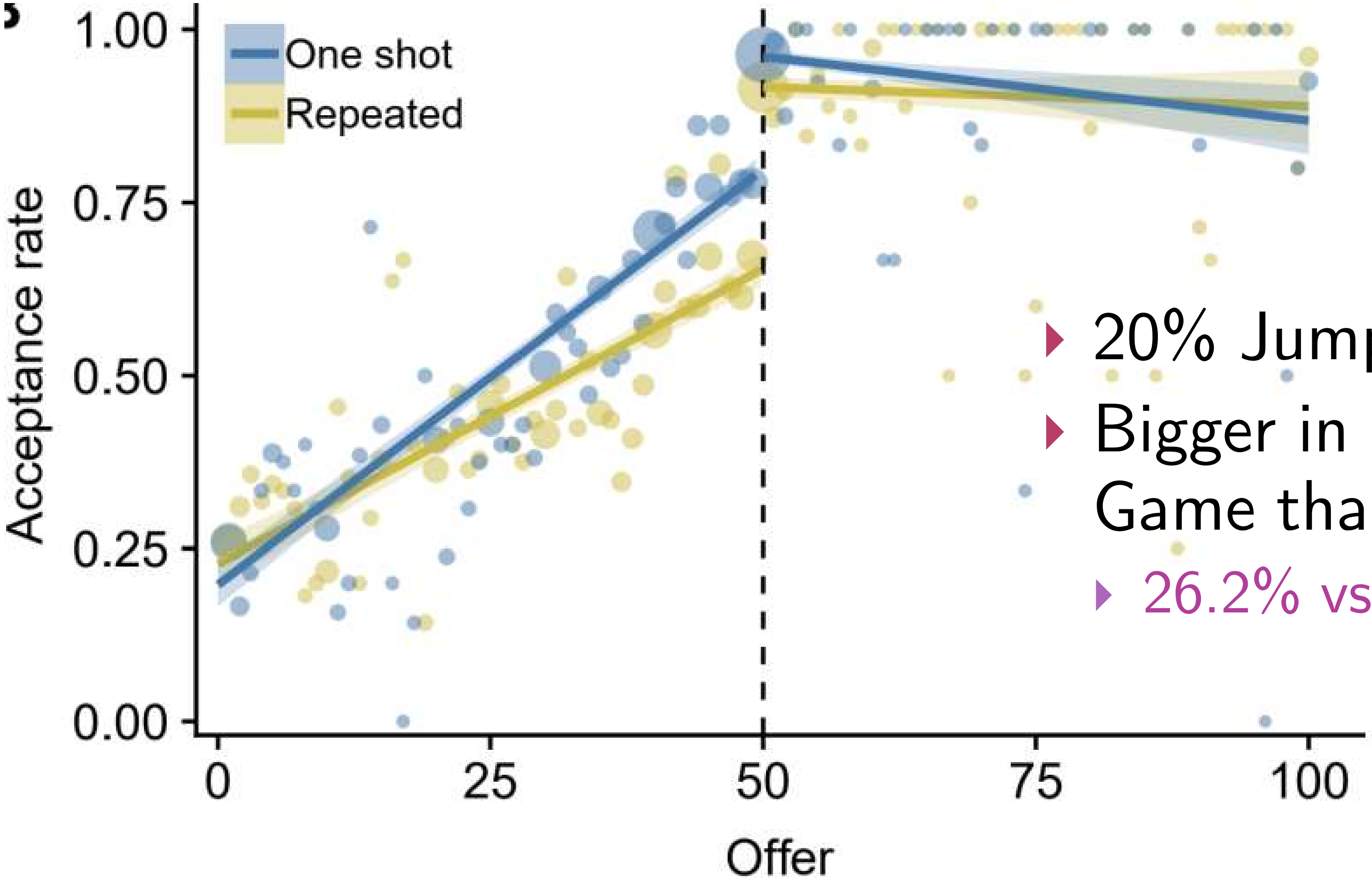
MobLab Ultimatum Game:

Proposal Offer - Class Effect



MobLab Ultimatum Game:

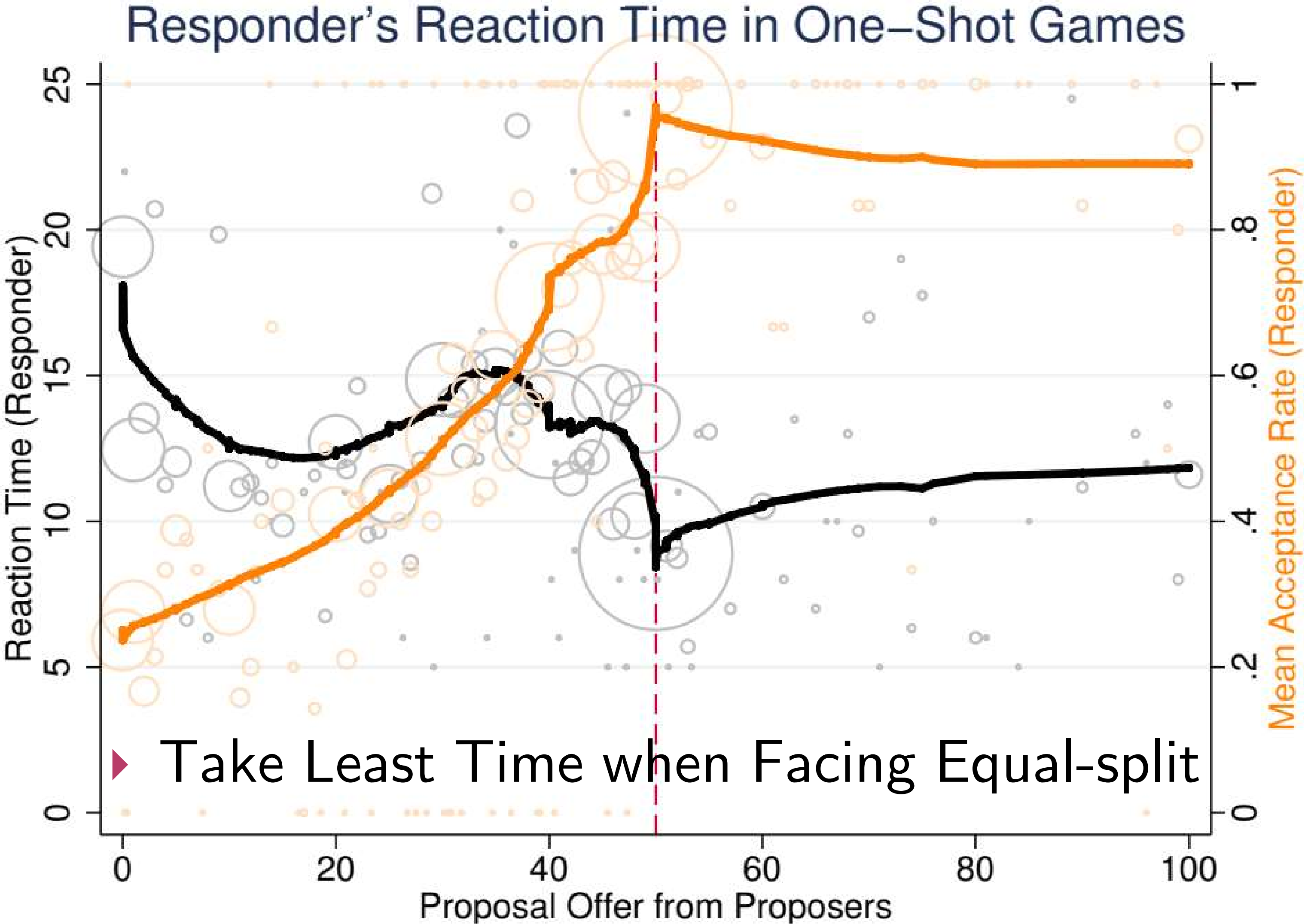
Acceptance Rate (Fit 2-part Regression)



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

MobLab Ultimatum Game:

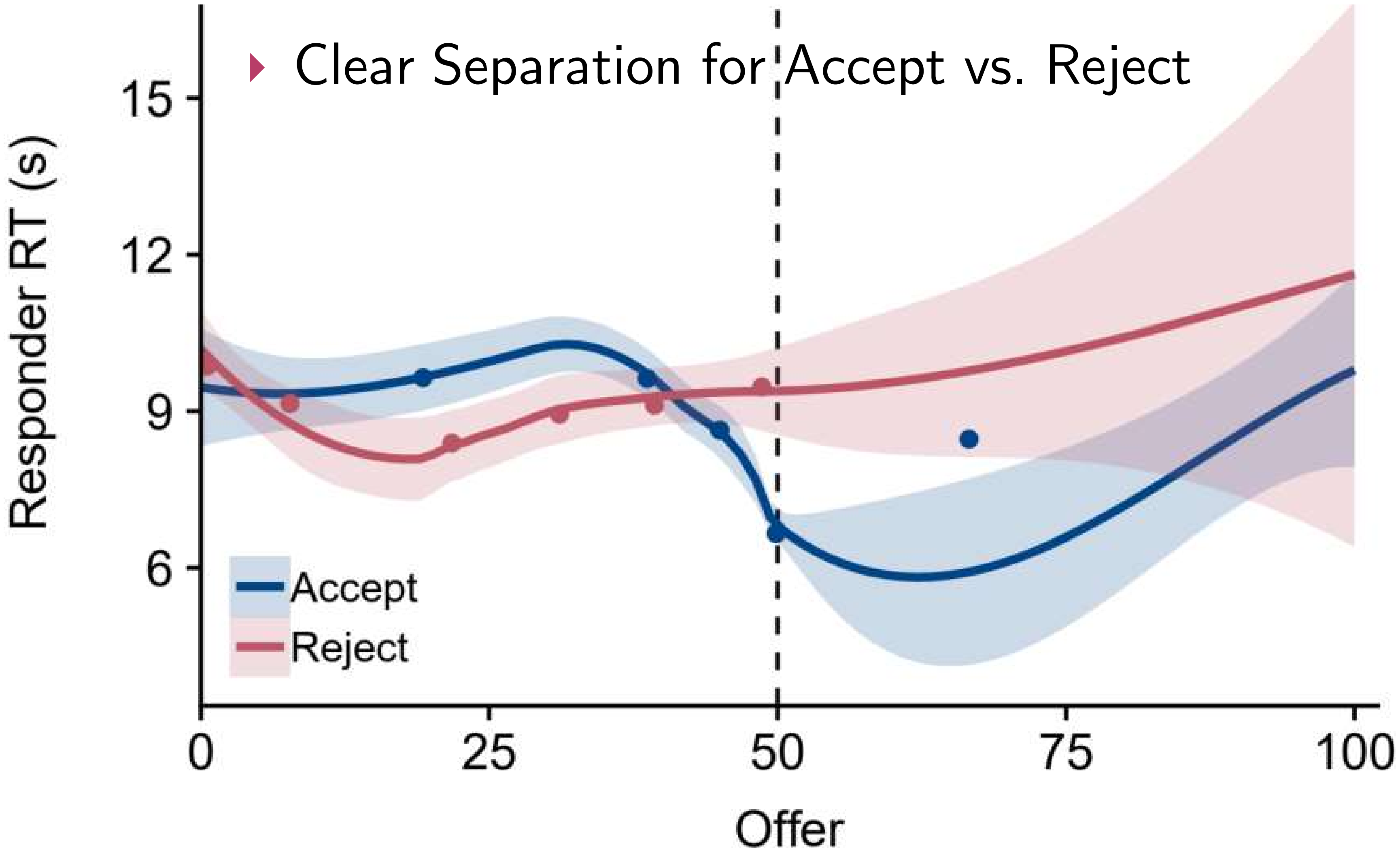
Acceptance Rate and Response Time



- Take Least Time when Facing Equal-split

MobLab Ultimatum Game:

Response Time



- Clear Separation for Accept vs. Reject

MobLab Ultimatum Game:

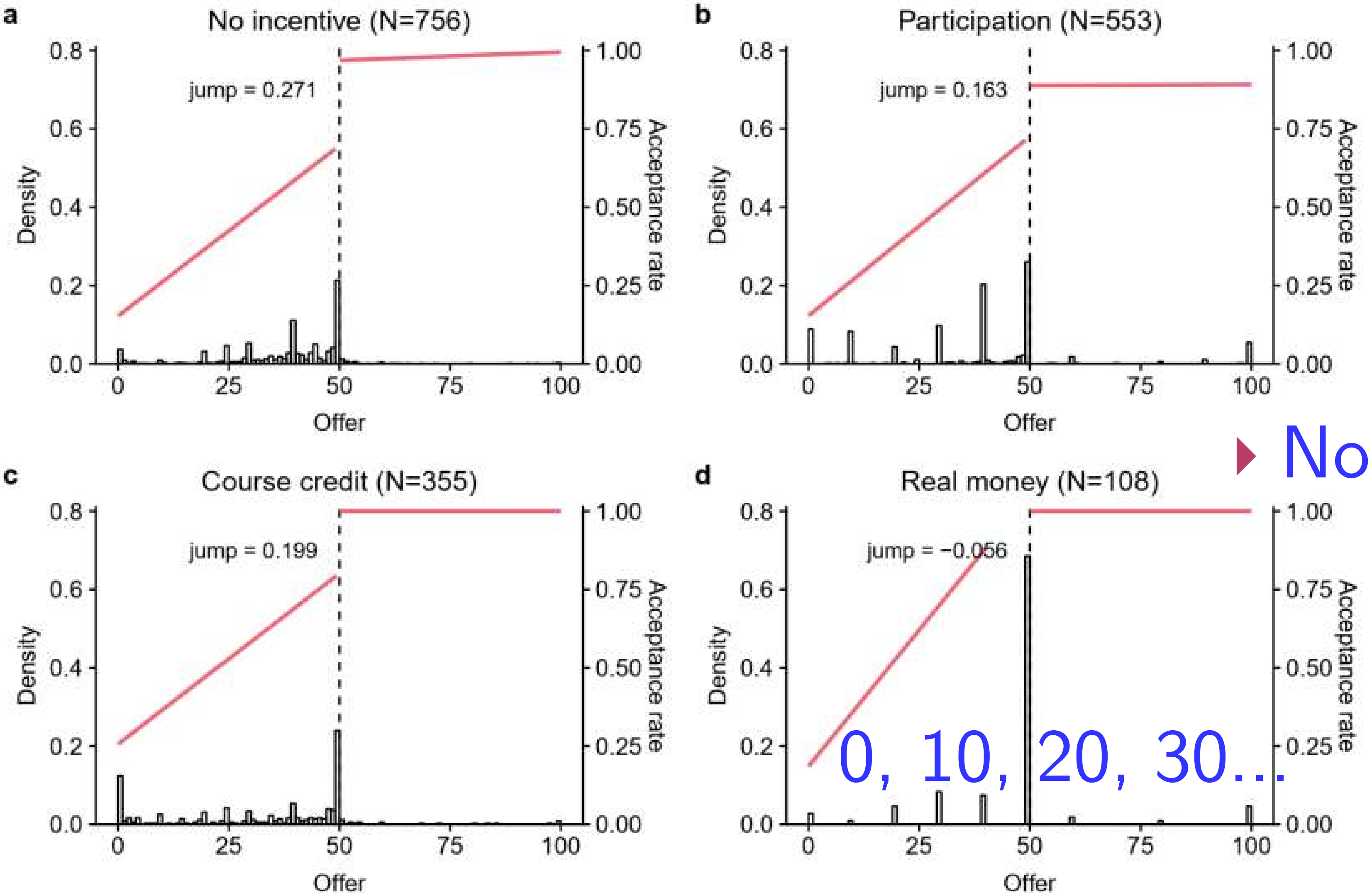
Robustness: Do Incentives Matter?

- Find Syllabi online (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%)

Exp/Beh Econ
@US-South
SLAC

MobLab Ultimatum Game:

Robustness: Do Incentives Matter?



0, 10, 20, 30…

- 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)

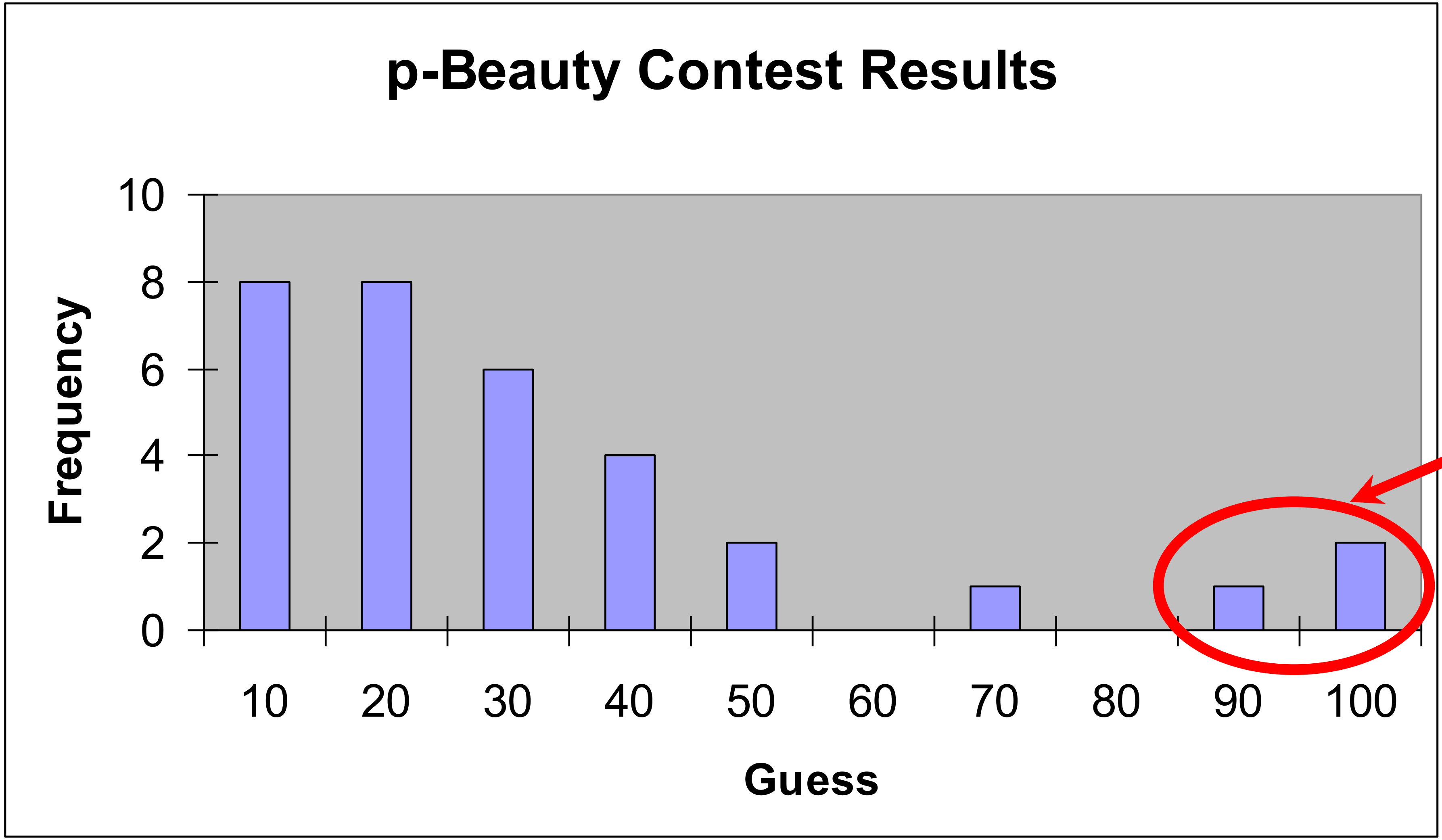
2. *p*-Beauty Contest (選美結果預測賽局)

- 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)



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. Conti

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. Conti

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

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- 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)
- 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: 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！