

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)

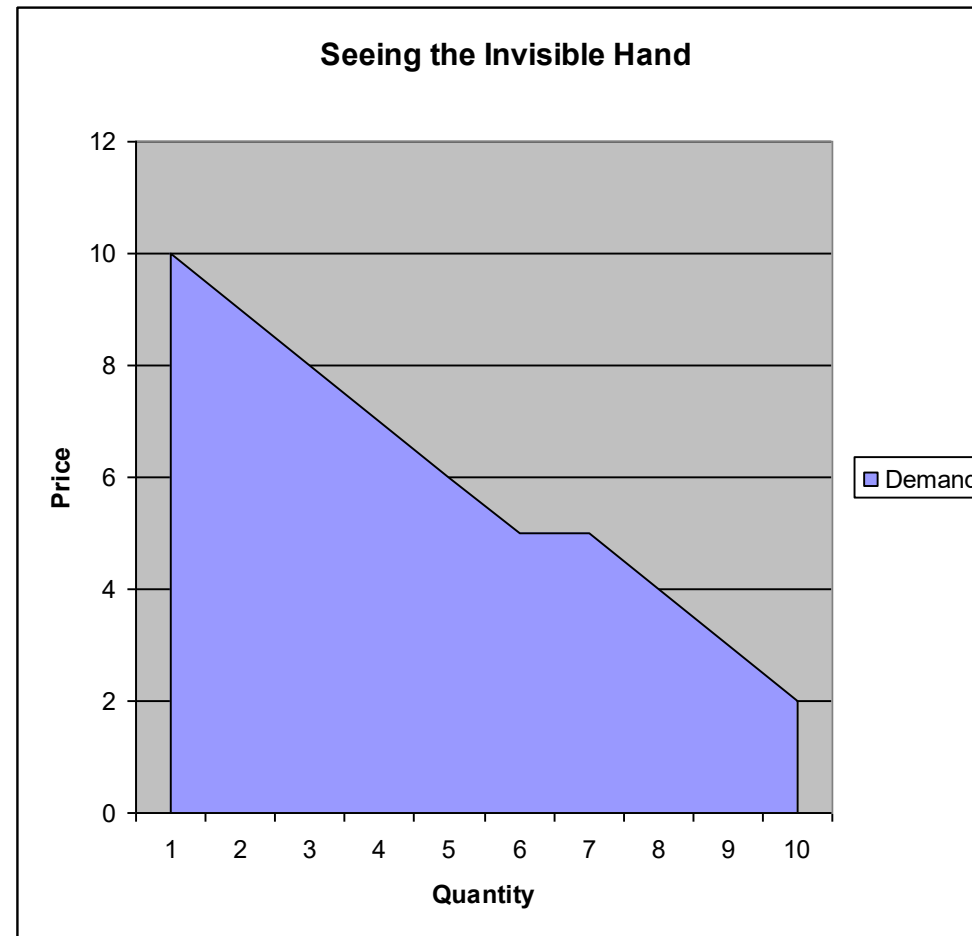
▶ Alvin E. Roth (AER!) (艾文·羅斯)

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

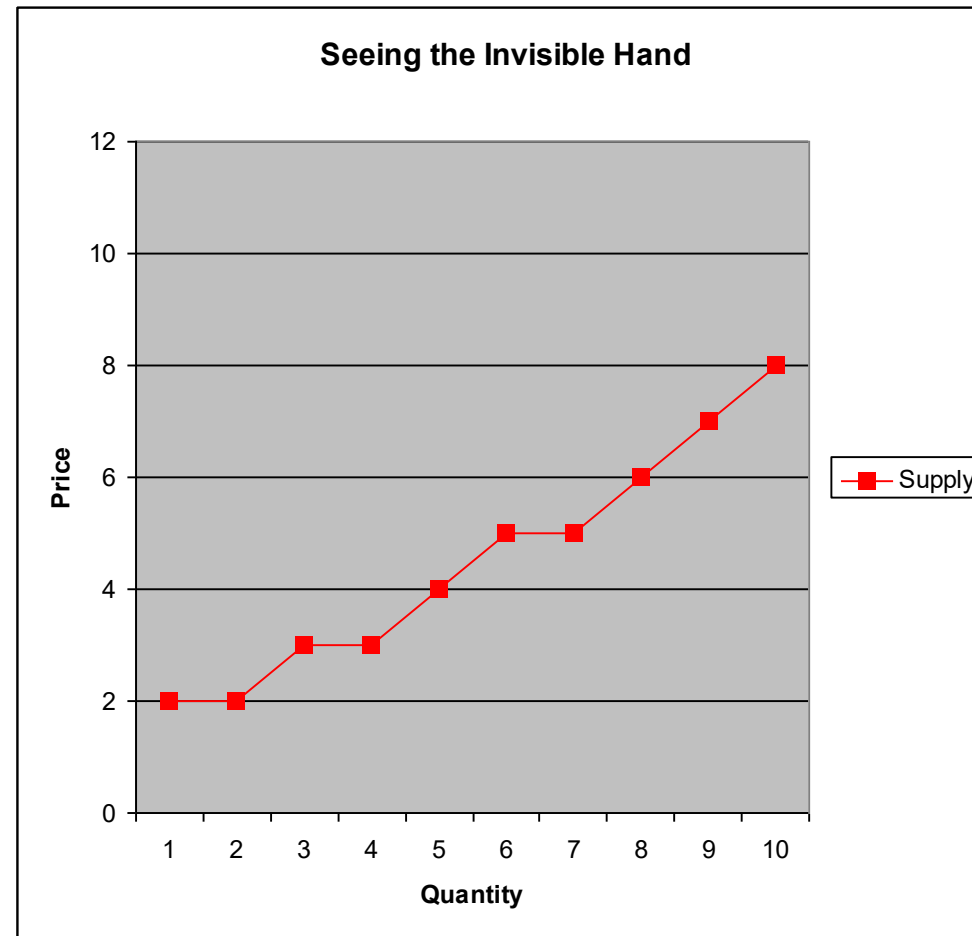
▶ Take this to the field (在「現場」設計穩定配對分發制度)

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

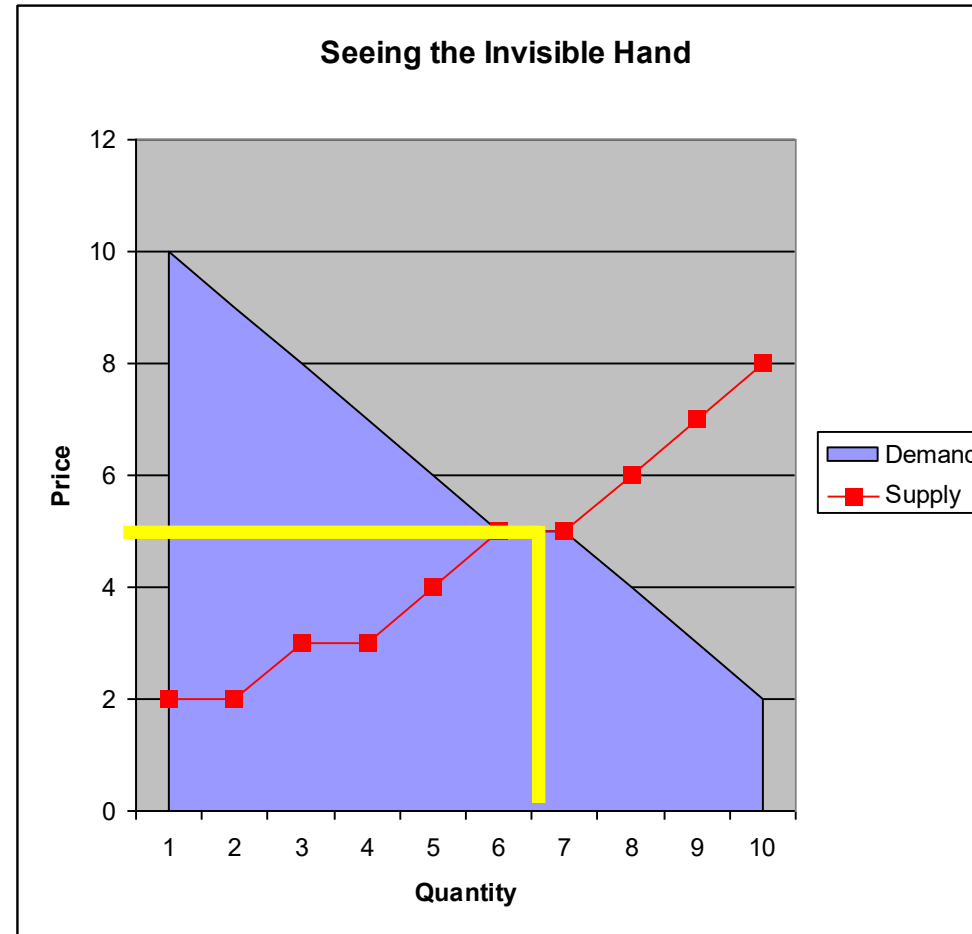
Seeing the Invisible Hand (發現看不見的手)



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 I
- 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

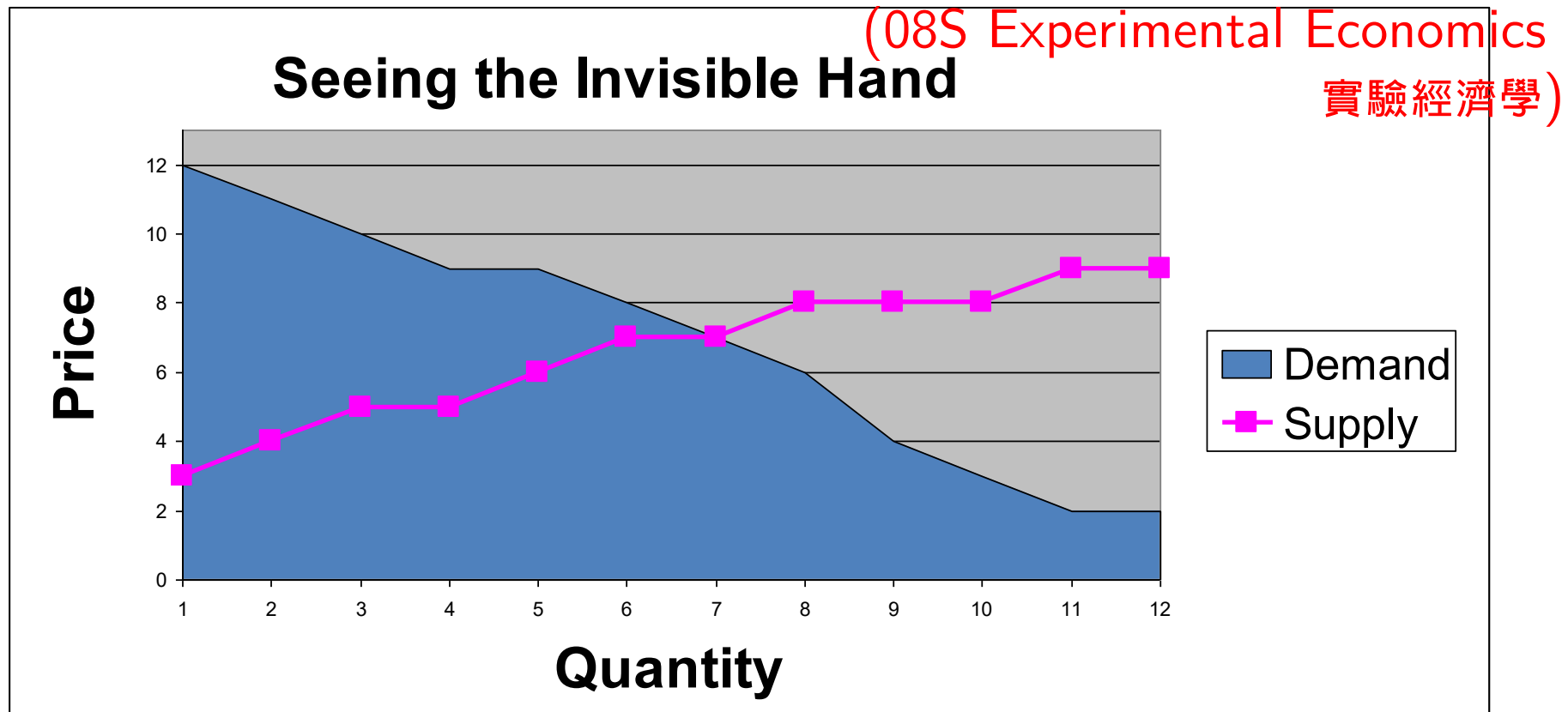


Seeing the Invisible Hand (發現看不見的手)

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

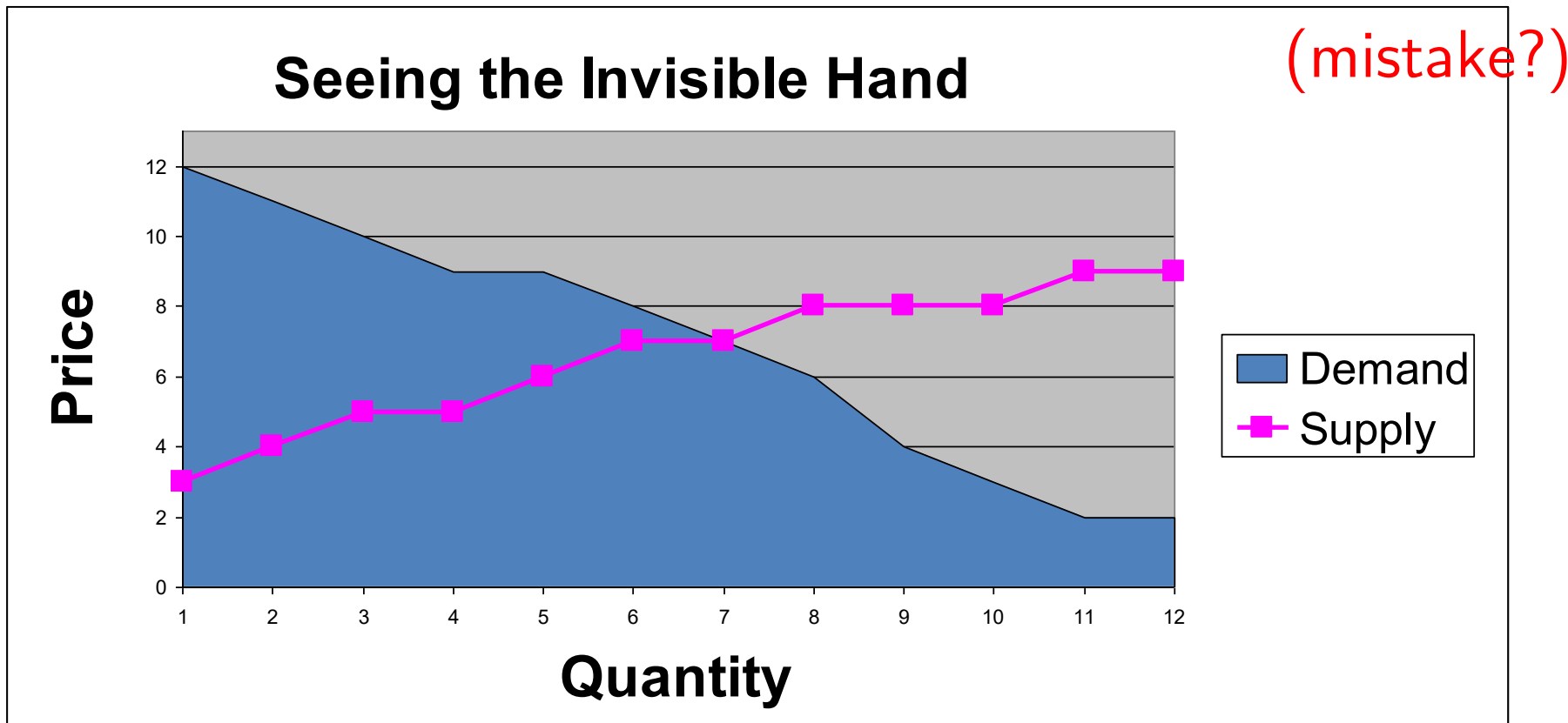
Seeing the Invisible Hand (發現看不見的手)

- 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

SELLER Order Book >

Cost \$0.65

Past sales / purchases



Profit
\$0.65

Current BIDS and ASKS


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

ASK or Sell at Highest Bid

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

SELLER Order Book >

Cost \$0.65
Oranges 3/3
Earnings \$0.00



\$3.00
\$2.25
\$1.50
\$0.75

0:10 0:20 0:30 0:40

\$1.11

\$0.00 Profit -\$0.65

< [Slider] >

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

SELLER Order Book >

Cost	\$0.65
Oranges	3/3
Earnings	\$0.00



Profit
\$0.00 -\$0.65

BIDS **ASKS**


\$1.12	\$2.26
\$1.10	\$2.98
\$0.77	--

ASK or Sell at Highest Bid

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

BUYER Order Book >

Value \$1.38
Oranges 0/3
Earnings \$0.00



\$3.00
\$2.25
\$1.50
\$0.75

0:10 0:20 0:30 0:40

\$1.34

\$0.00 Profit \$1.38

< [Slider] >

BID

or



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

Buy at Lowest Ask

Buyer's Profit = Value of consumption - Purchase Price

BUYER Order Book >

Value	\$1.38
Oranges	0/3
Earnings	\$0.00



Profit \$1.38

\$0.00

BIDS

\$0.85
\$0.66
\$0.32

ASKS

\$0.86
\$0.86
\$0.99

BID or **Buy at Lowest Ask**

When does a transaction occur?

- Someone uses

Buy at Lowest Ask

Sell at Highest Bid

- A Buyer places a

BID

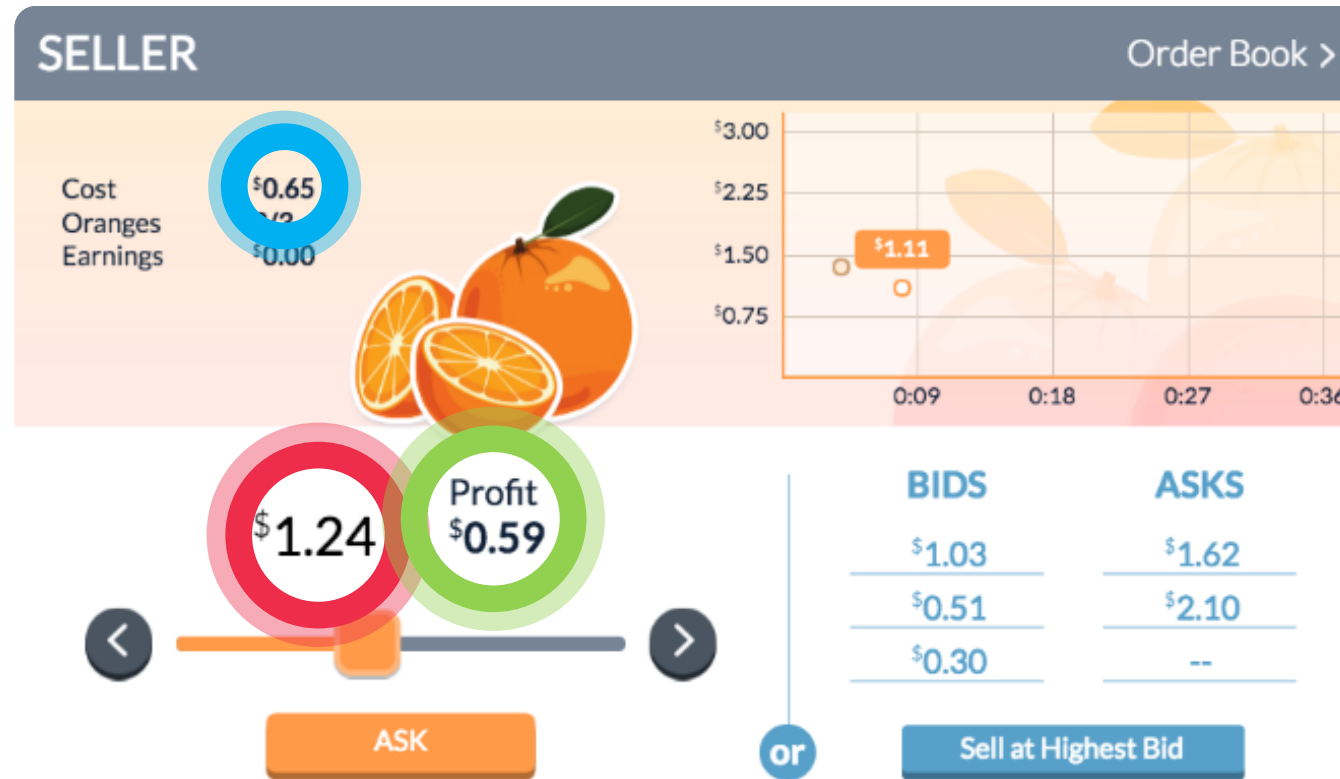
than the lowest outstanding Ask

- A Seller places an

lower than the highest outstanding Bid

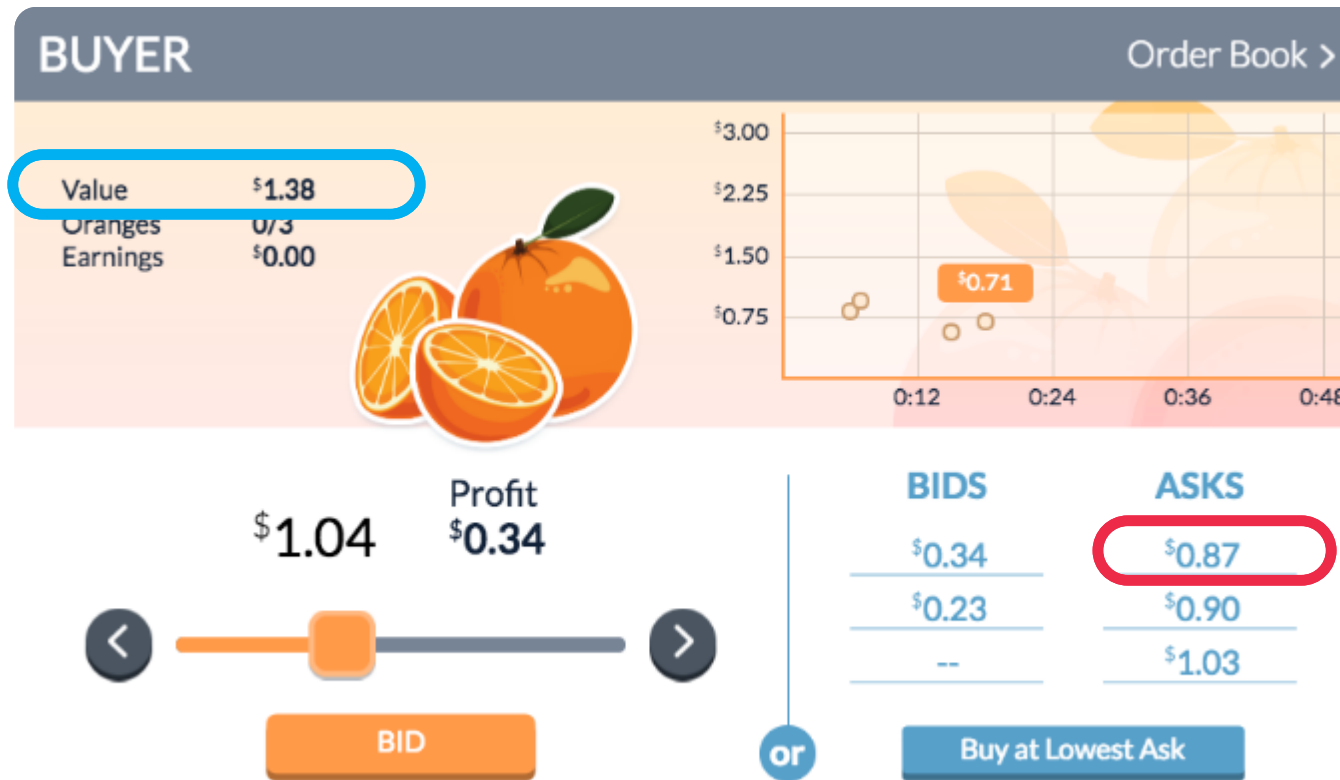
ASK

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



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

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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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!

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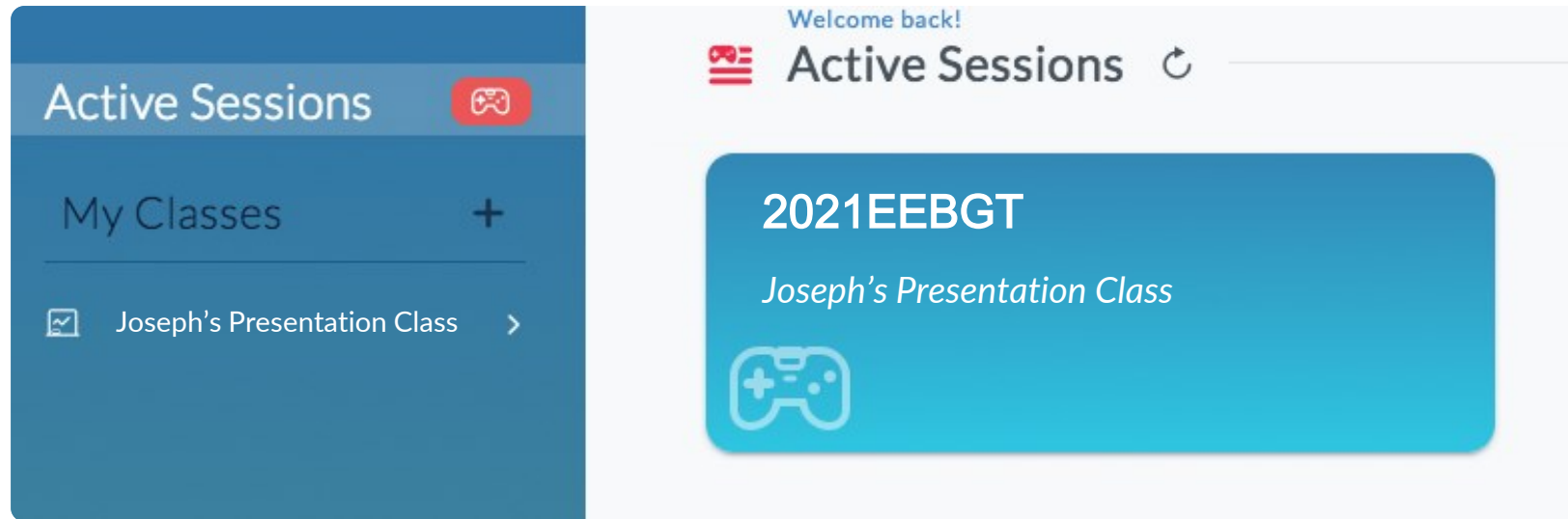
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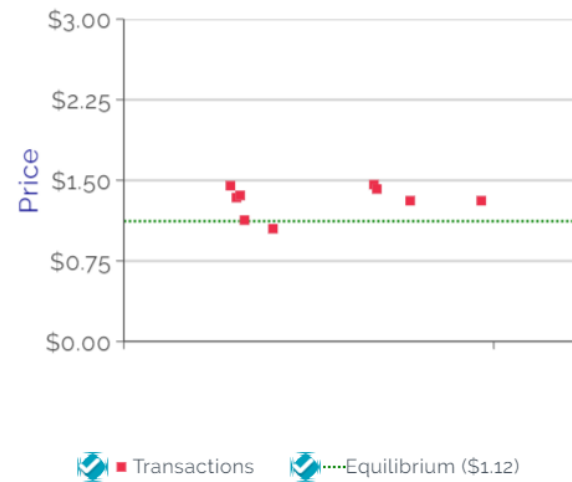
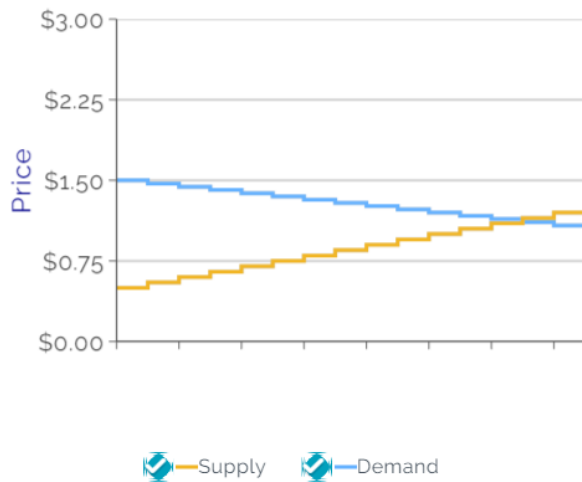
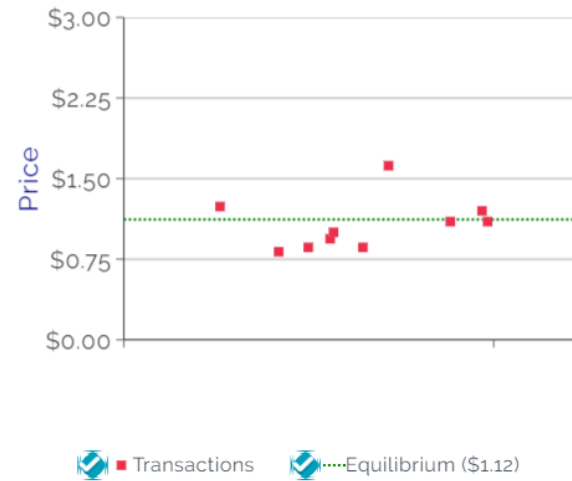
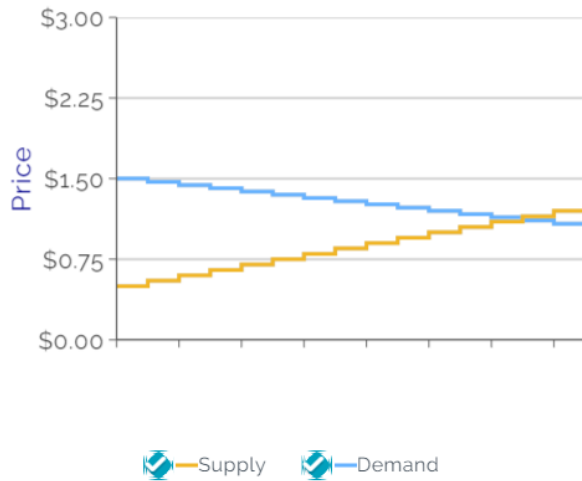
Class codes are given by instructors to allow their students to join a particular class.

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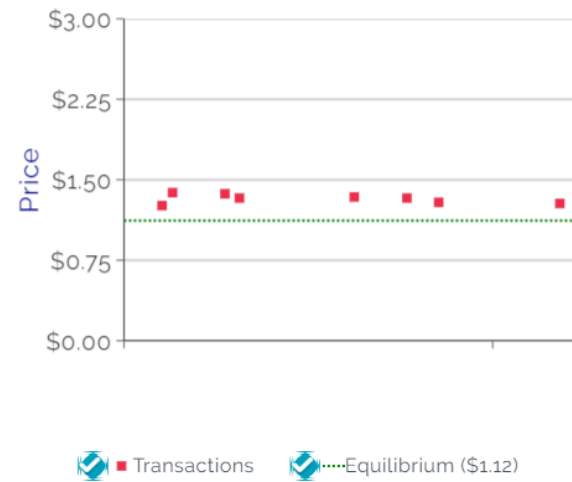
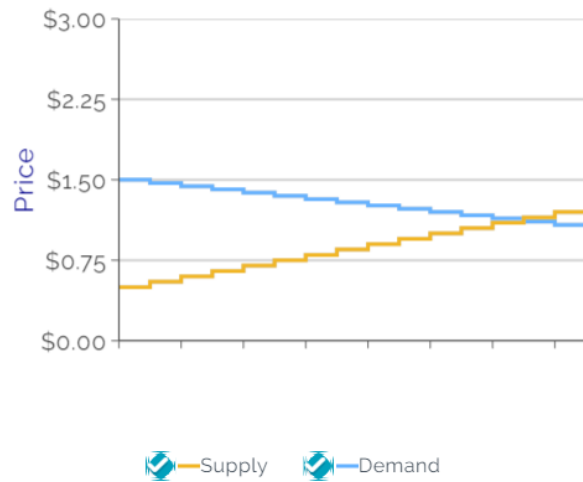
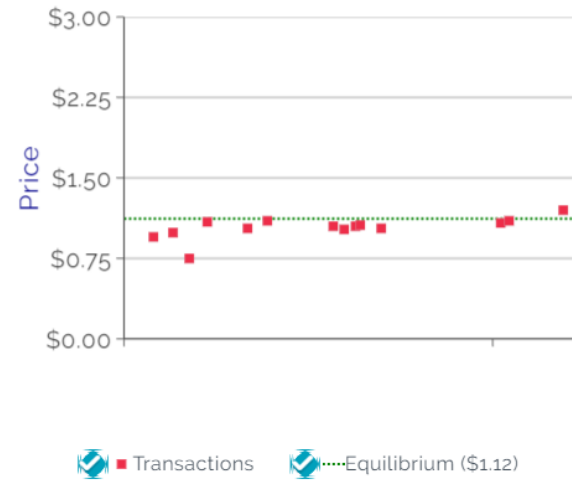
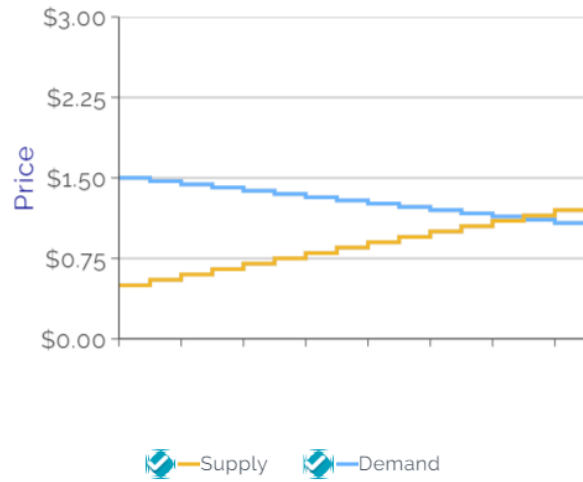
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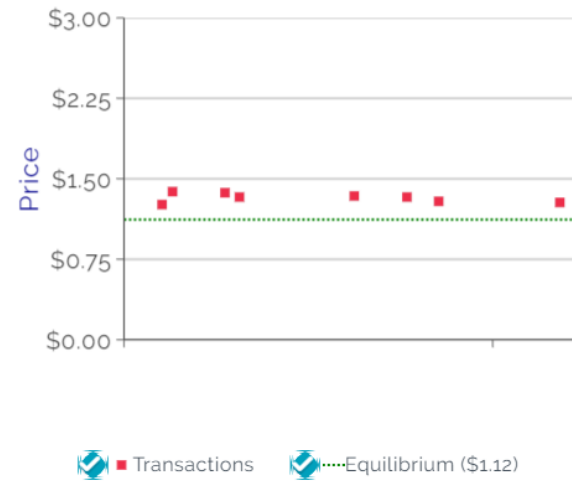
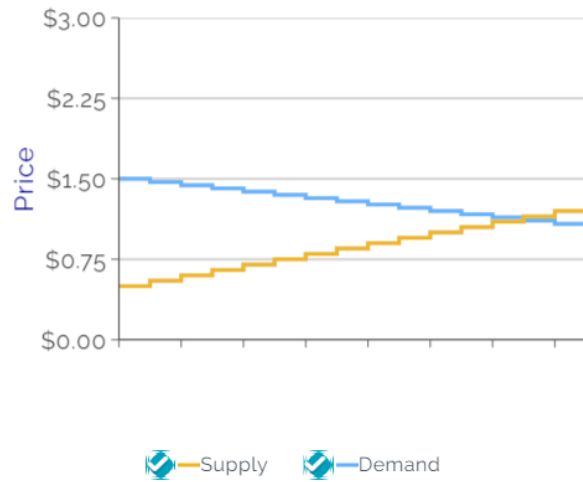
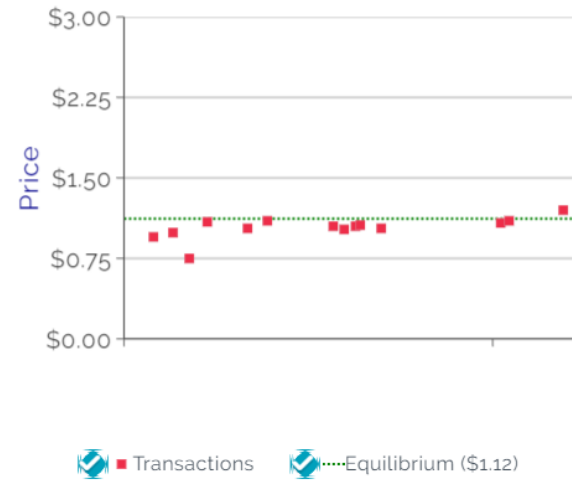
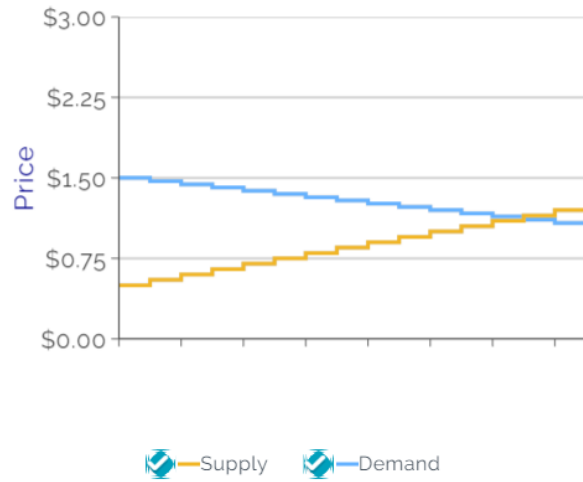
MobLab Double Auction: EE-BGT 21S Results: Round 1



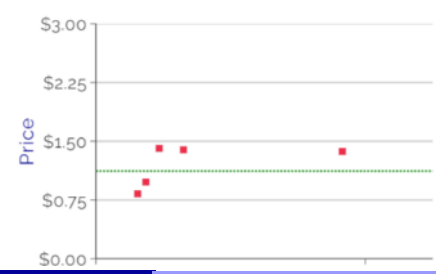
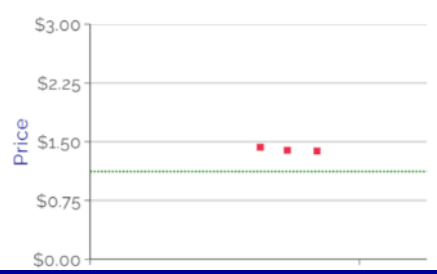
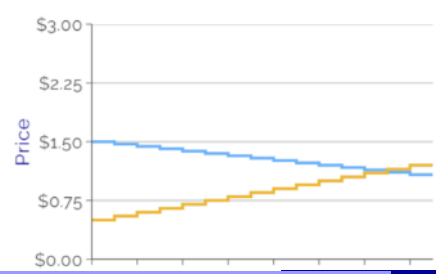
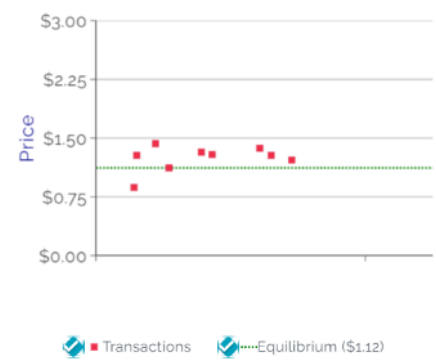
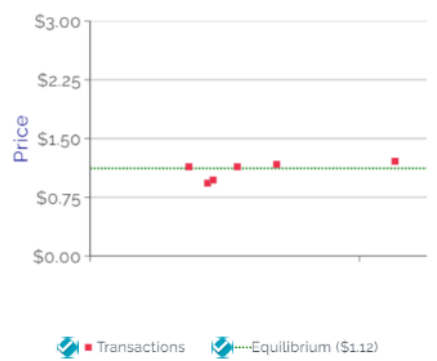
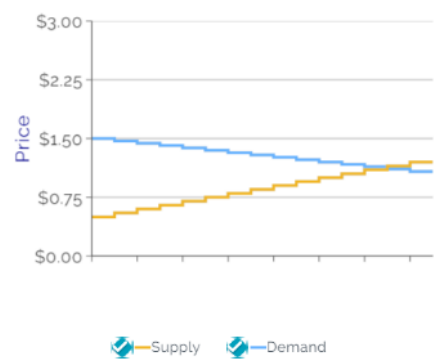
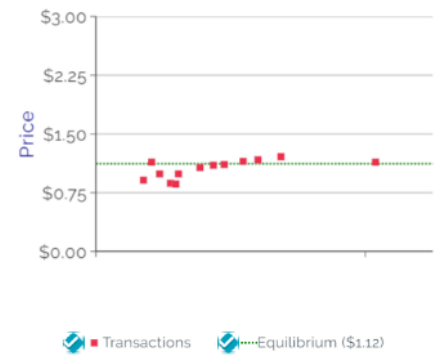
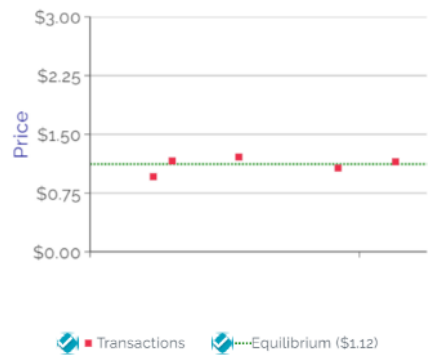
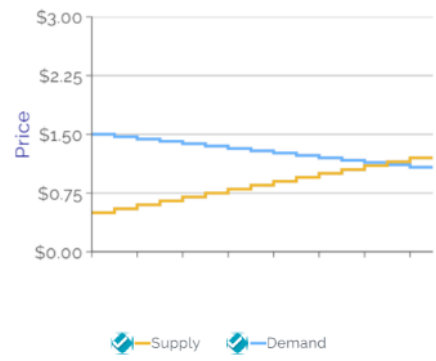
MobLab Double Auction: EE-BGT 21S Results: Round 2



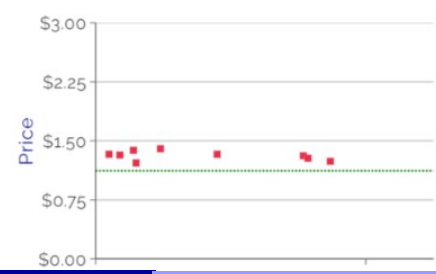
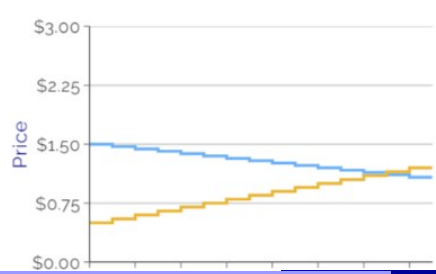
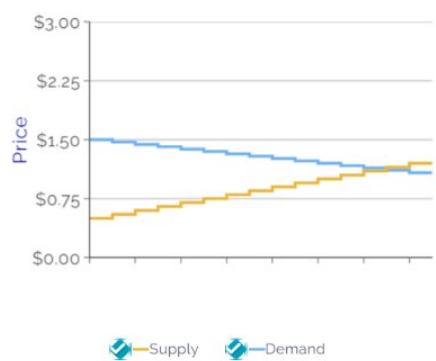
MobLab Double Auction: EE-BGT 21S Results: Round 3



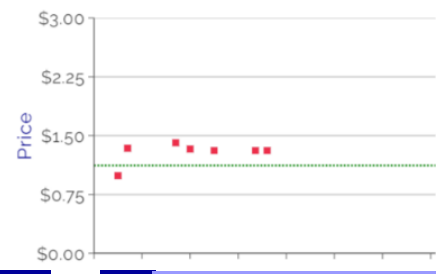
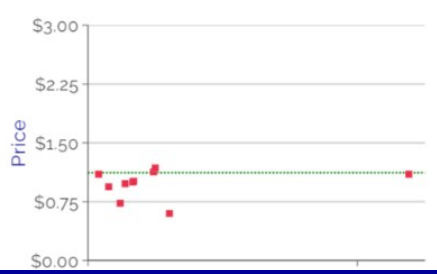
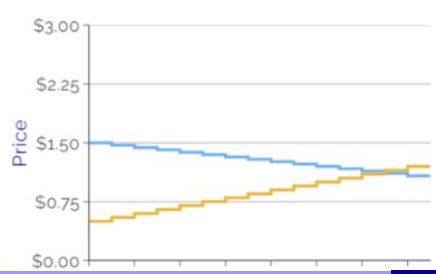
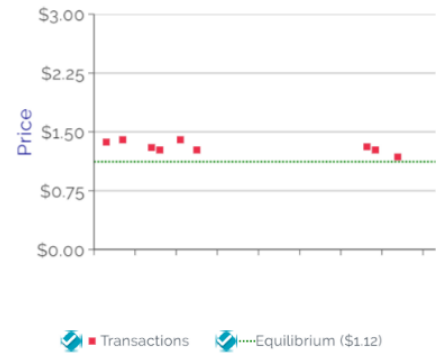
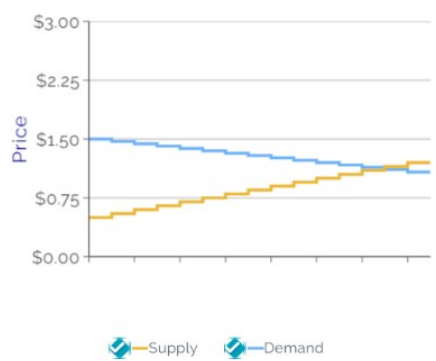
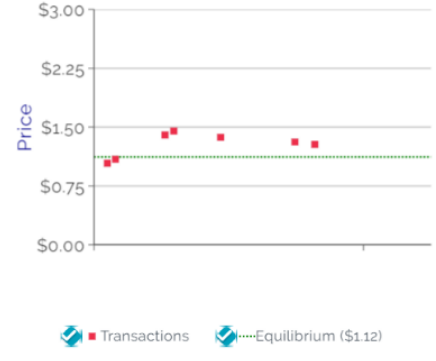
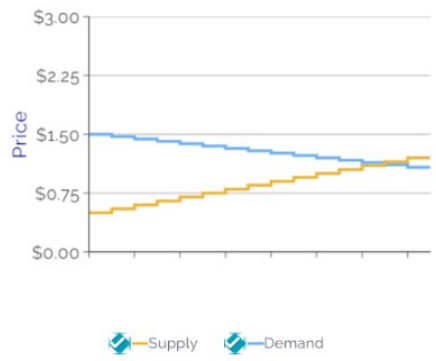
MobLab Double Auction: CCU Results: Round 1



MobLab Double Auction: CCU Results: Round 2

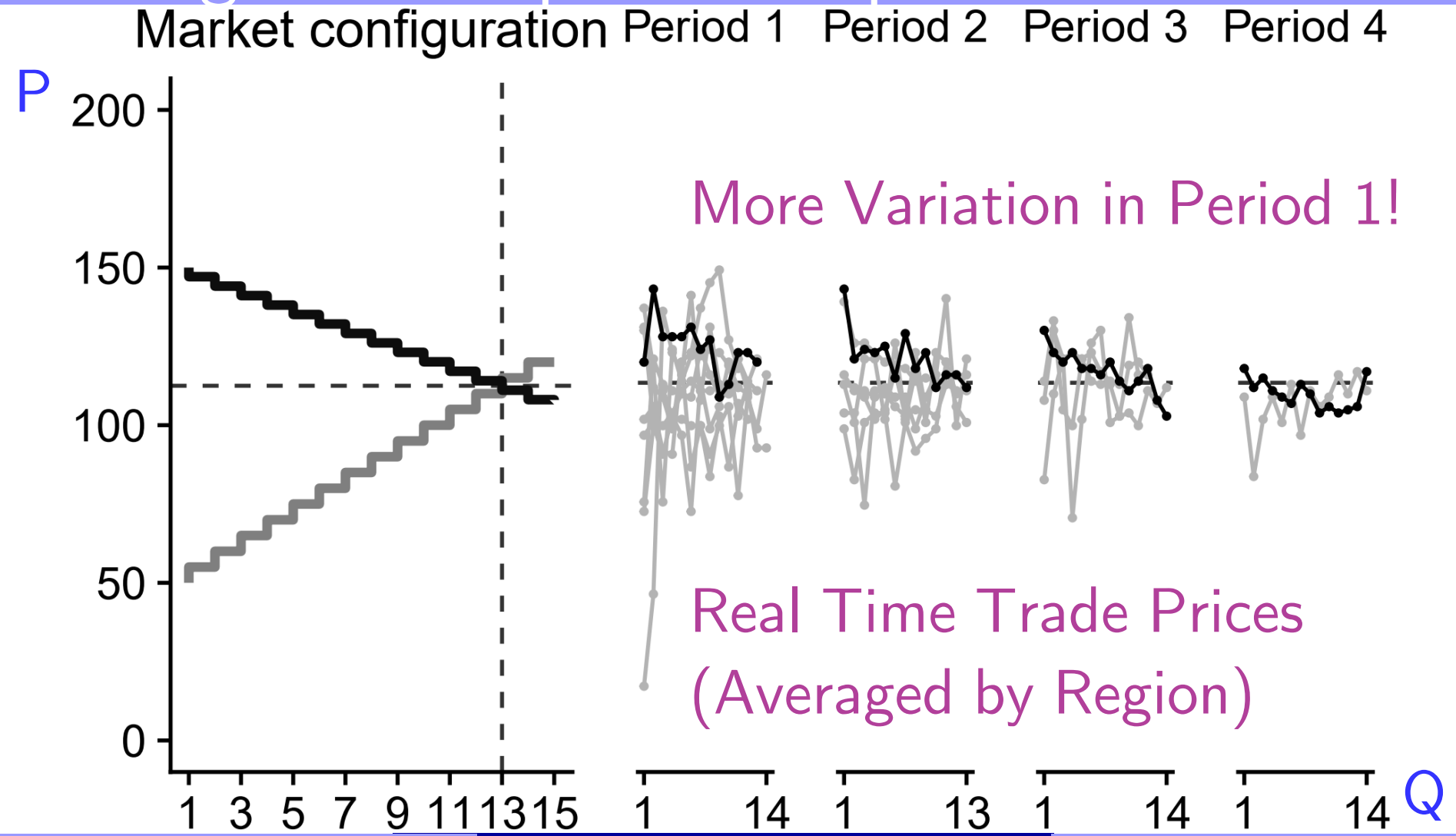


MobLab Double Auction: CCU Results: Round 3



MobLab Double Auction: Lin et al. (2020)

Prices Converge to Competitive Equilibrium



MobLab Double Auction:

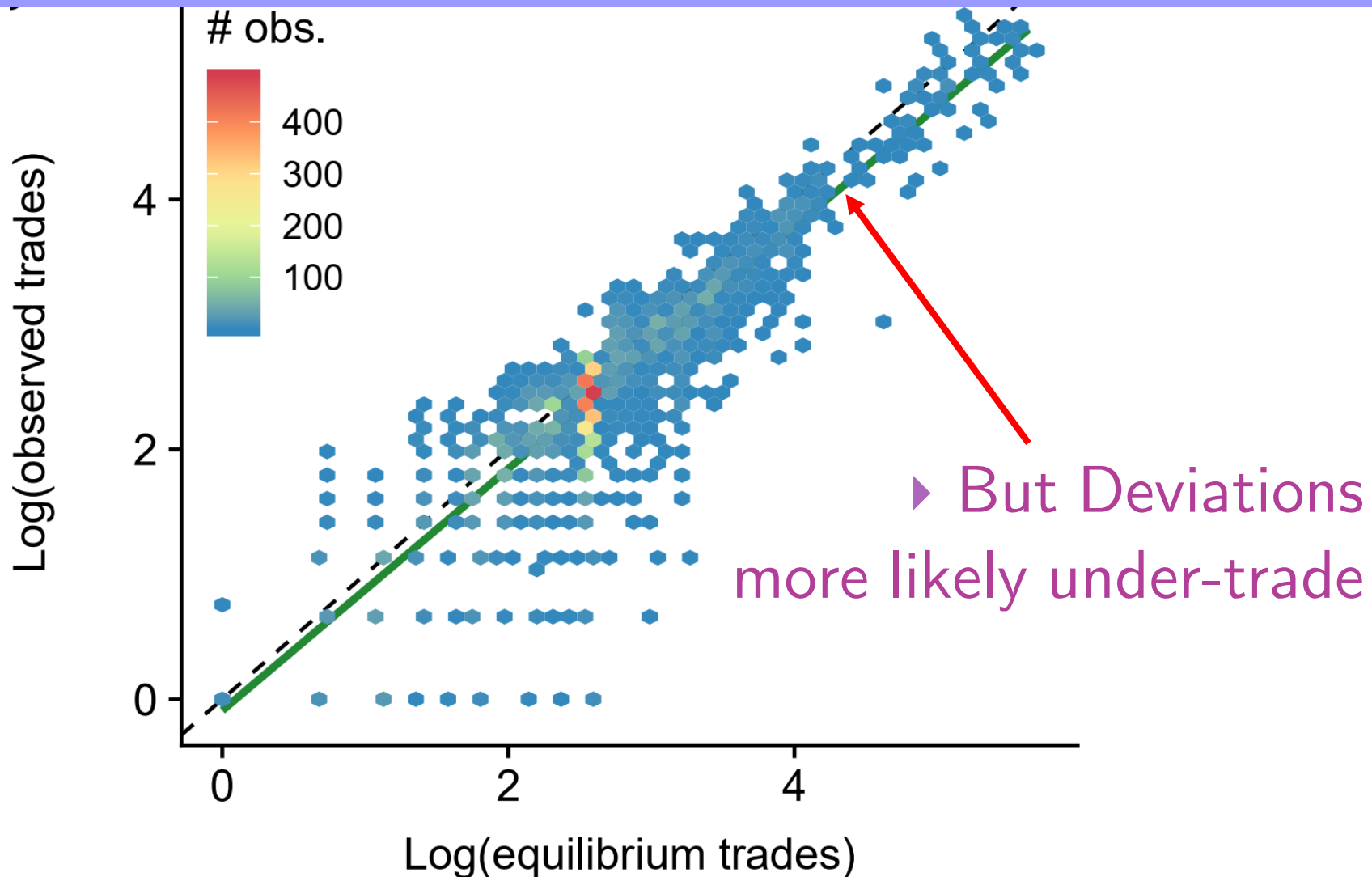
Summary Statistics

	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):
$$\delta = \frac{1}{Q} \sum_{q=1}^Q \frac{P_q - P_{CE}}{P_{CE}}$$

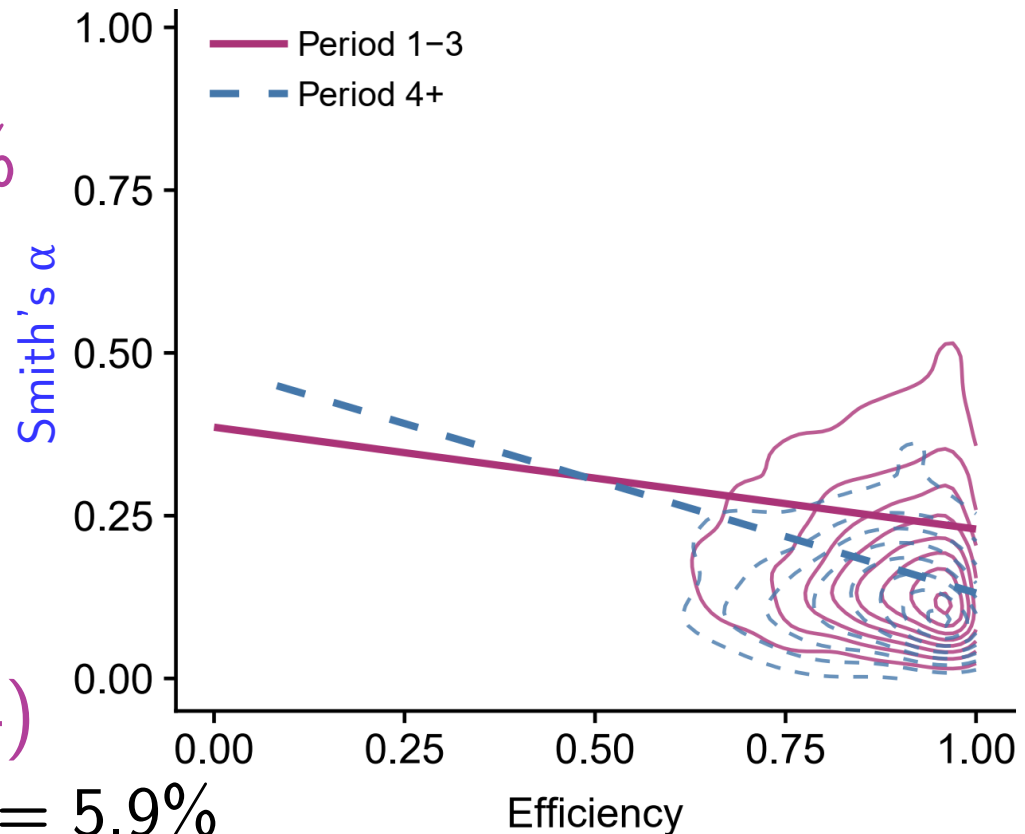
Smith's Alpha:
$$\alpha = \frac{\sqrt{\frac{1}{Q} \sum_{q=1}^Q (P_q - P_{CE})^2}}{P_{CE}}$$

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

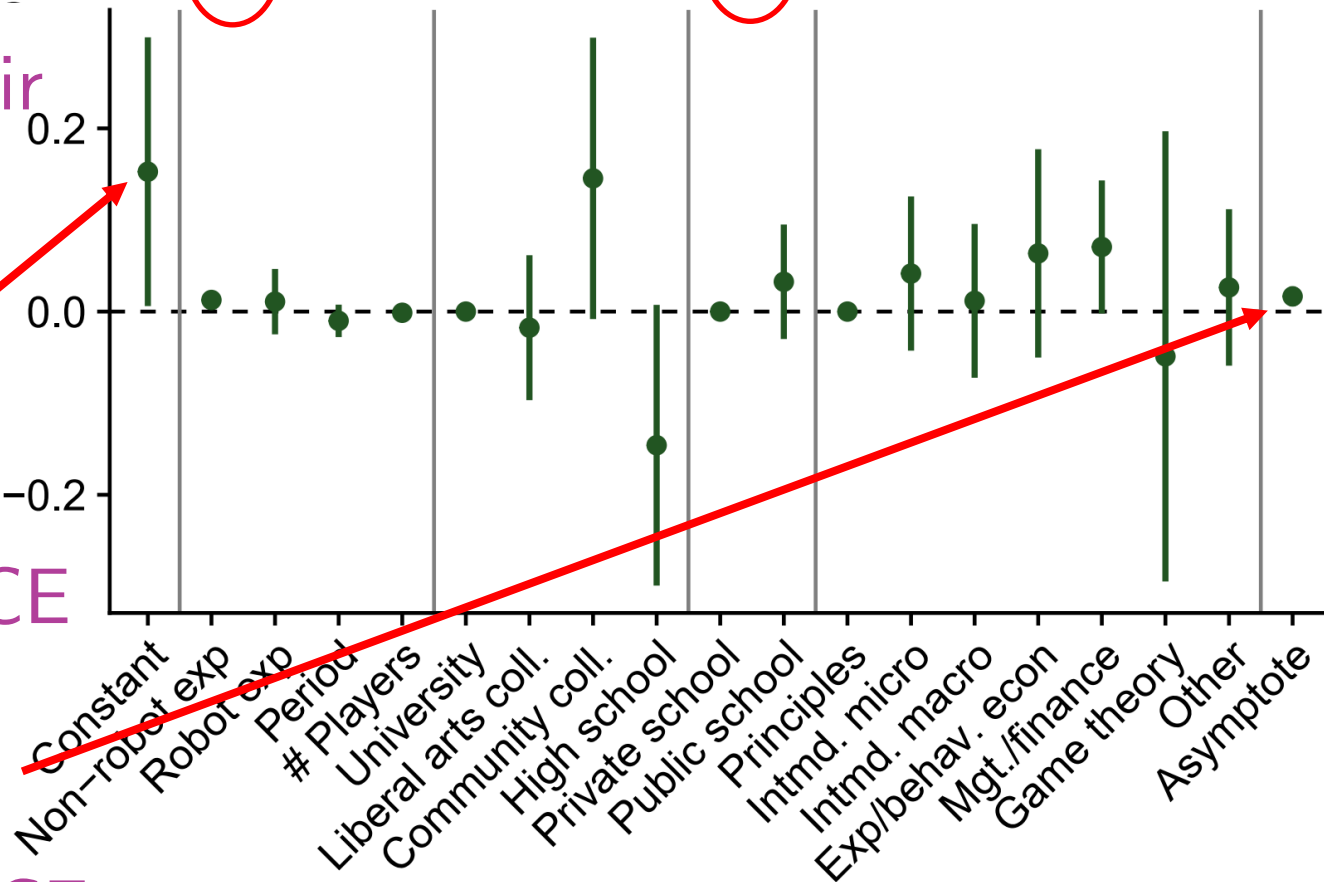
$$y_{it} = (1/t)\mathbb{X}_i \cdot \beta_1 + (1 - 1/t)\beta_2 + \epsilon_{it},$$

▶ as in Noussair et al. (1995)

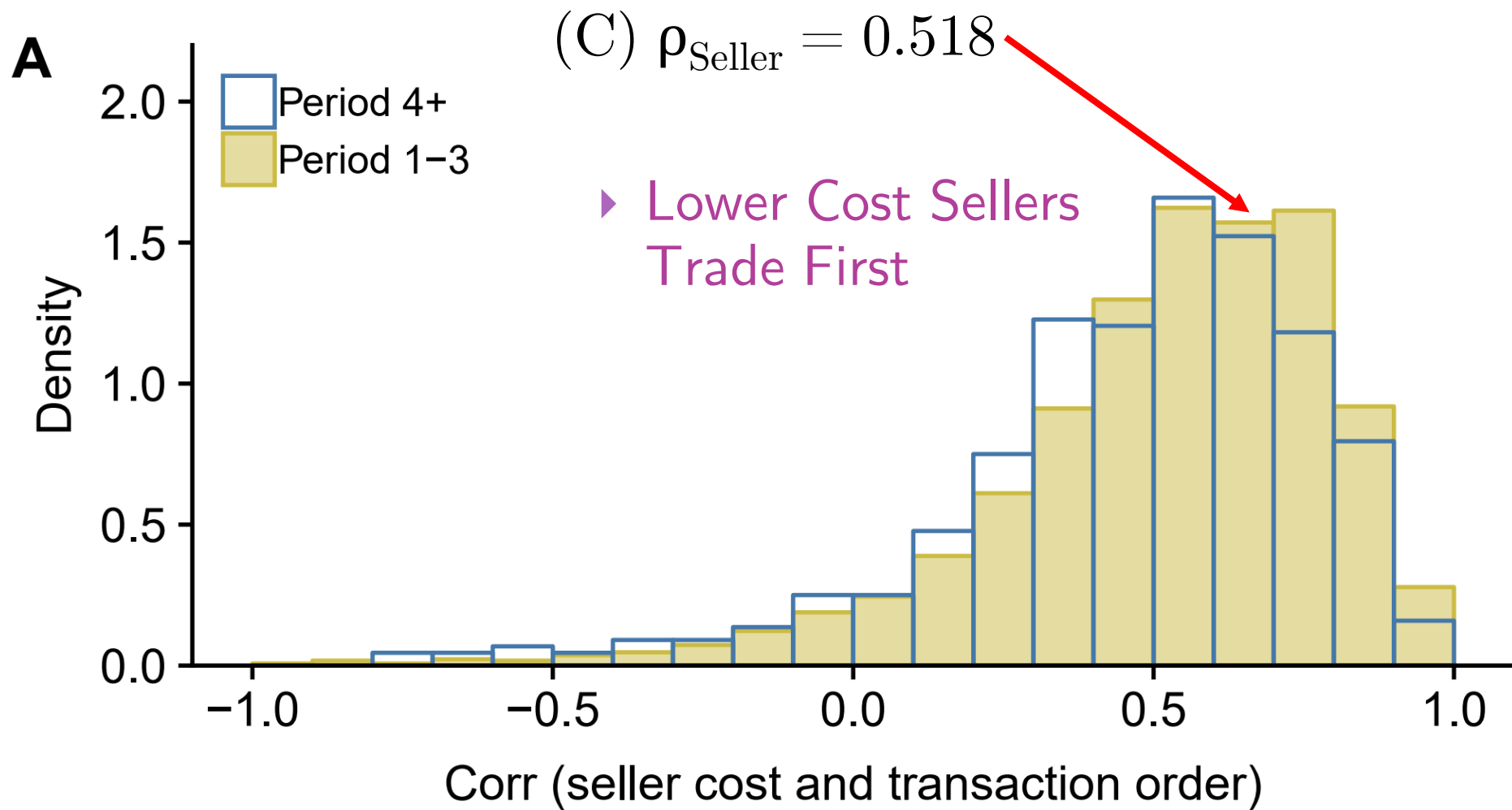
▶ 1st Trade:
▶ On average 15.3% above CE

▶ (t=1)

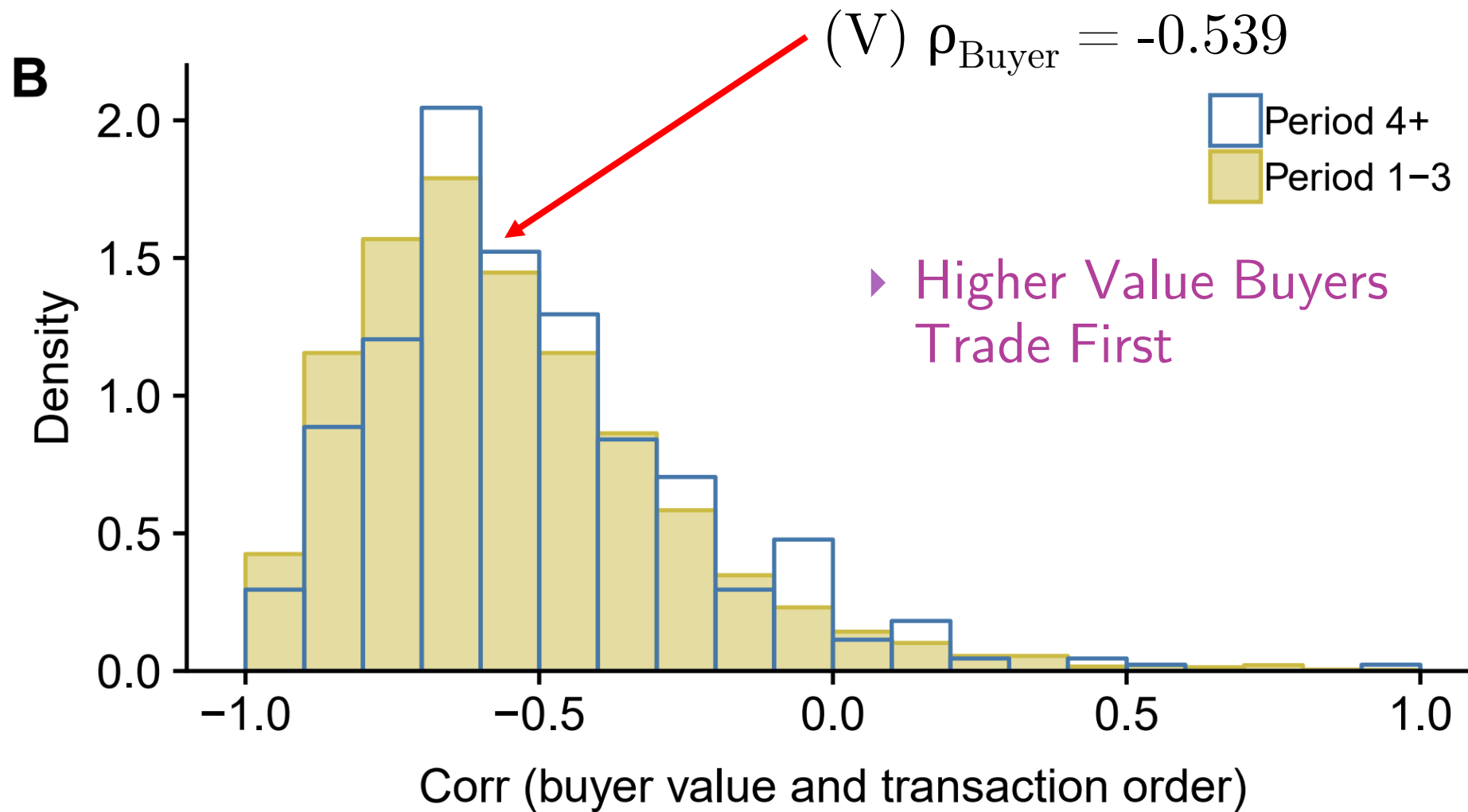
▶ Converge to:
▶ 1.7% above CE



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

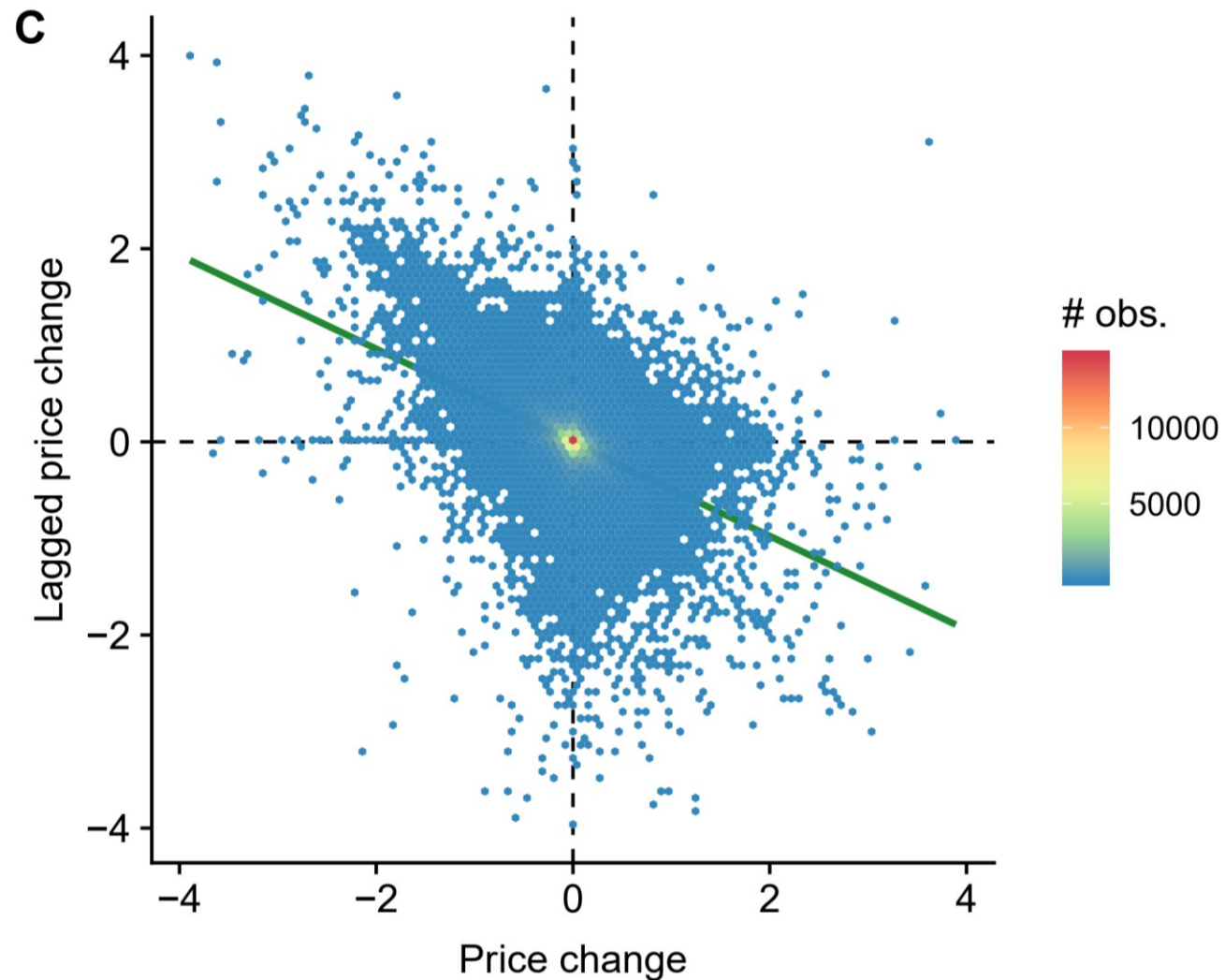


MobLab Double Auction: Buyer Rank-Order Correlation(Transaction Order, Buyer Value)

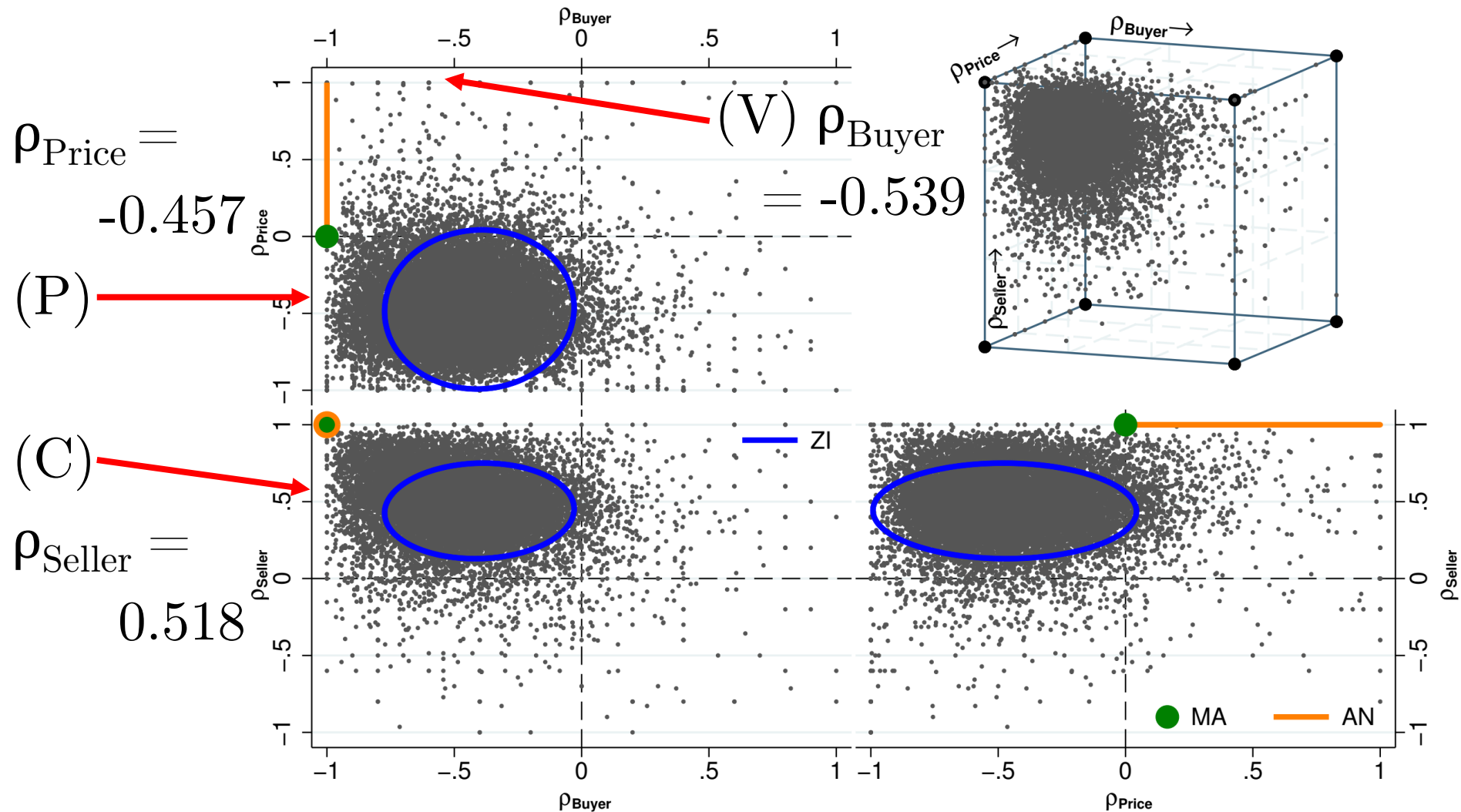


MobLab Double Auction:

Price Change Autocorrelation = -0.457

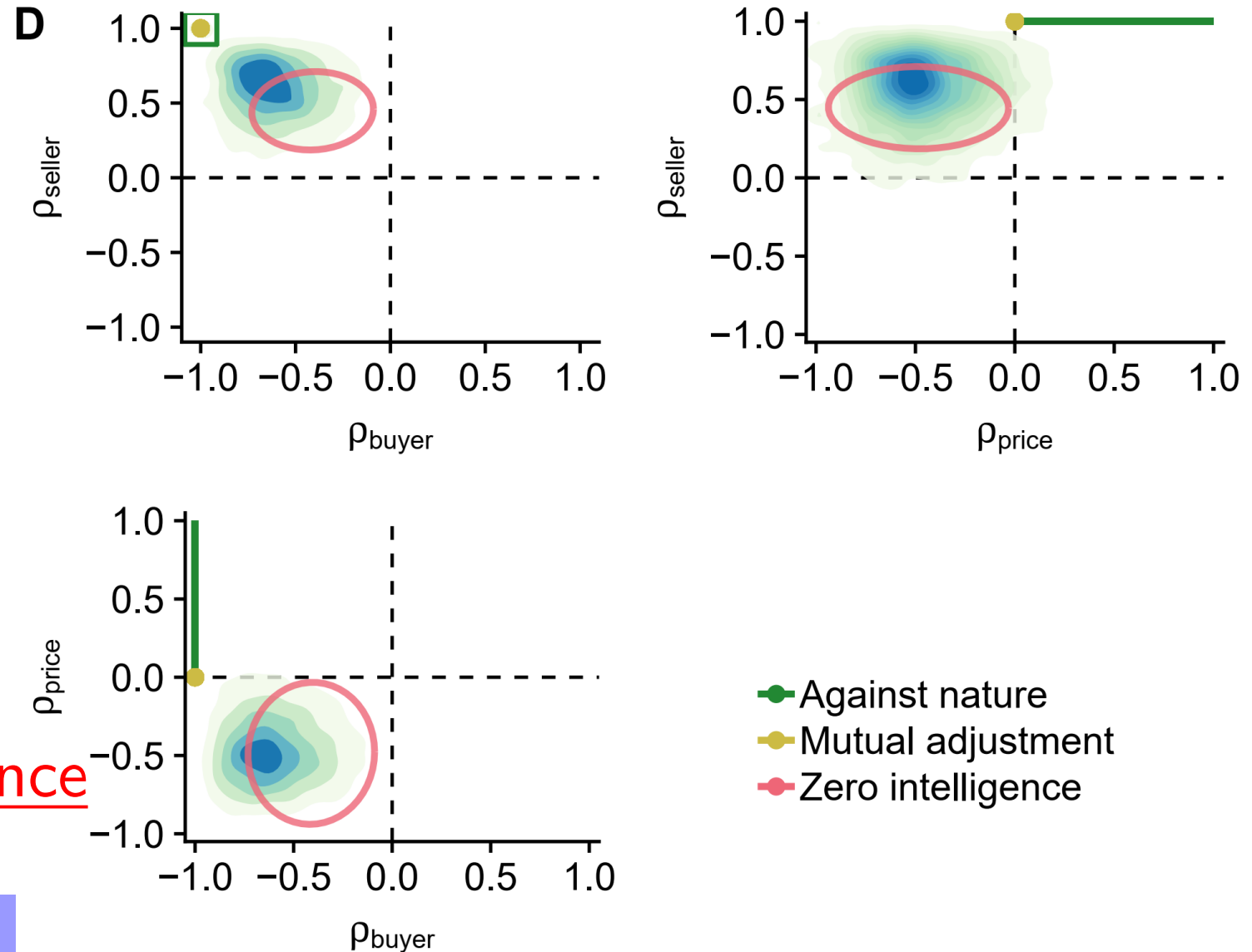


MobLab Double Auction: Correlation Between Order and P/V/C



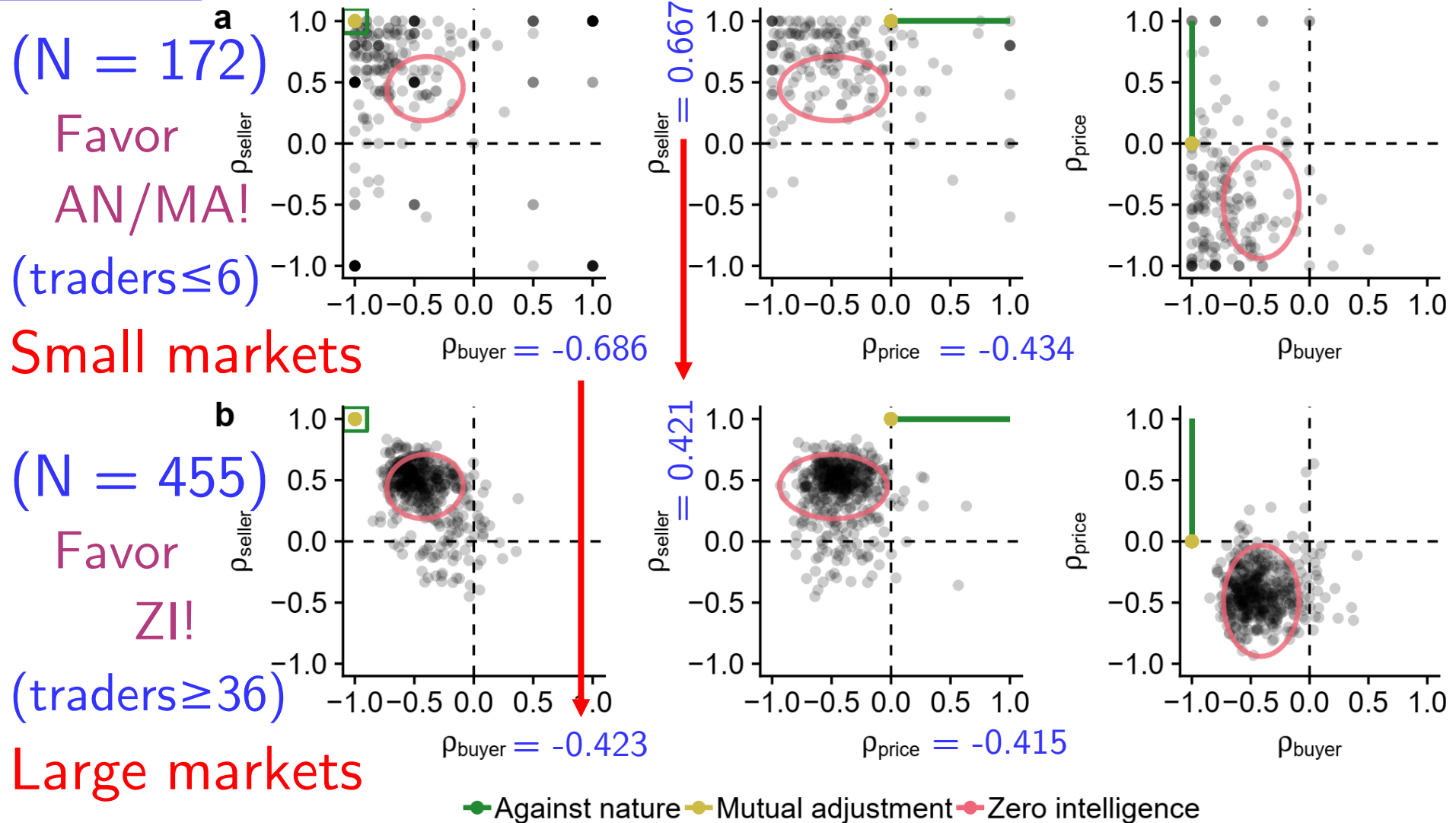
MobLab Double Auction: Testing Theories of Price Formation

- ▶ **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)

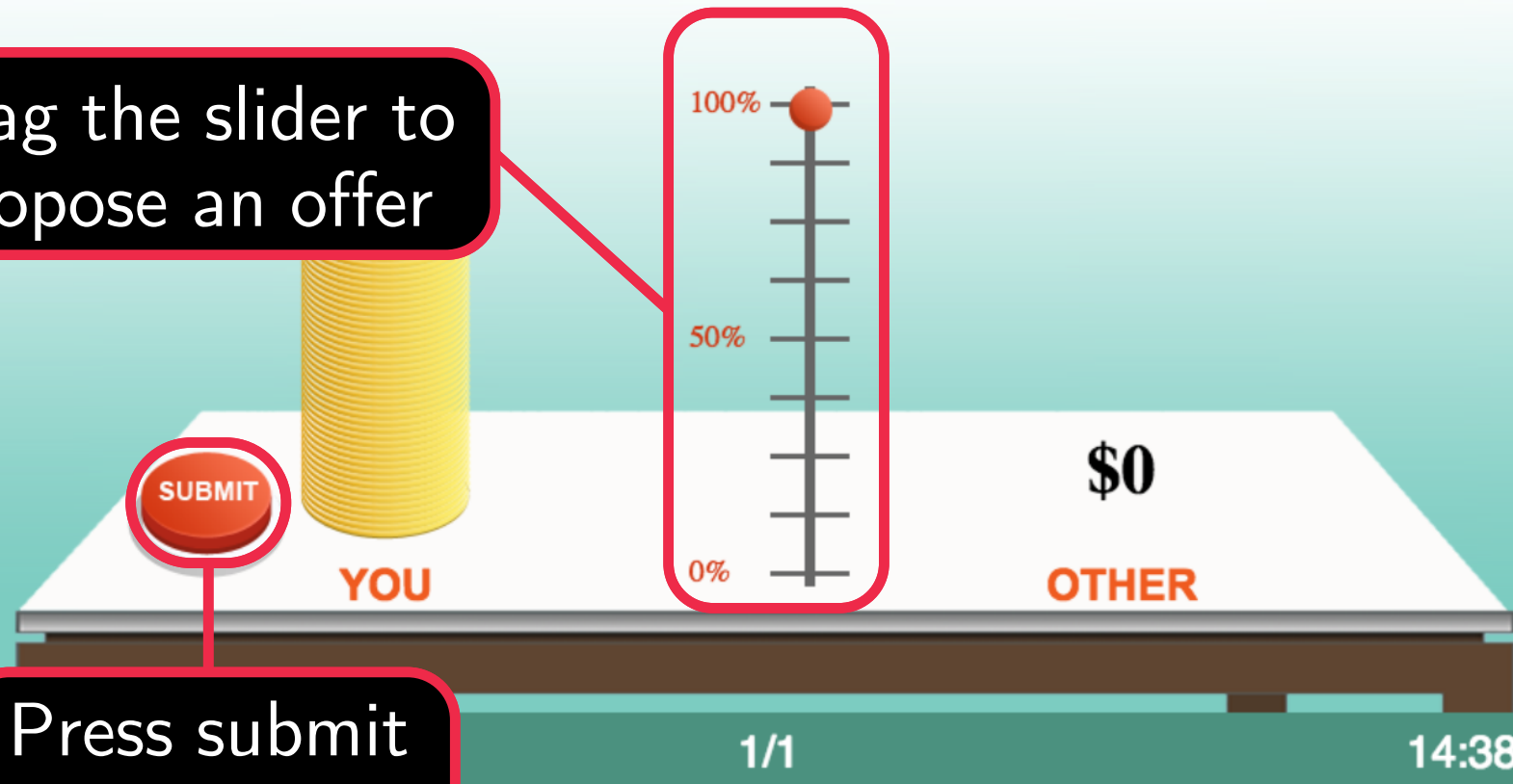
MobLab Ultimatum Game:

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?

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 accept the proposer's offer?

The screenshot shows a game interface with a white table. On the left, a stack of gold coins is labeled '\$55' and 'OTHER'. On the right, a stack of gold coins is labeled '\$45' and 'YOU'. In the center, there are two buttons: a green 'ACCEPT' button and a brown 'REJECT' button. Two callout boxes with red borders point to these buttons. The left callout box contains the text 'Accept the proposer's offer' and the right callout box contains 'Reject the proposer's offer'. At the bottom of the screen, there is a green navigation bar with a home icon, a list icon, the text '1/1', and the time '14:49'.

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)

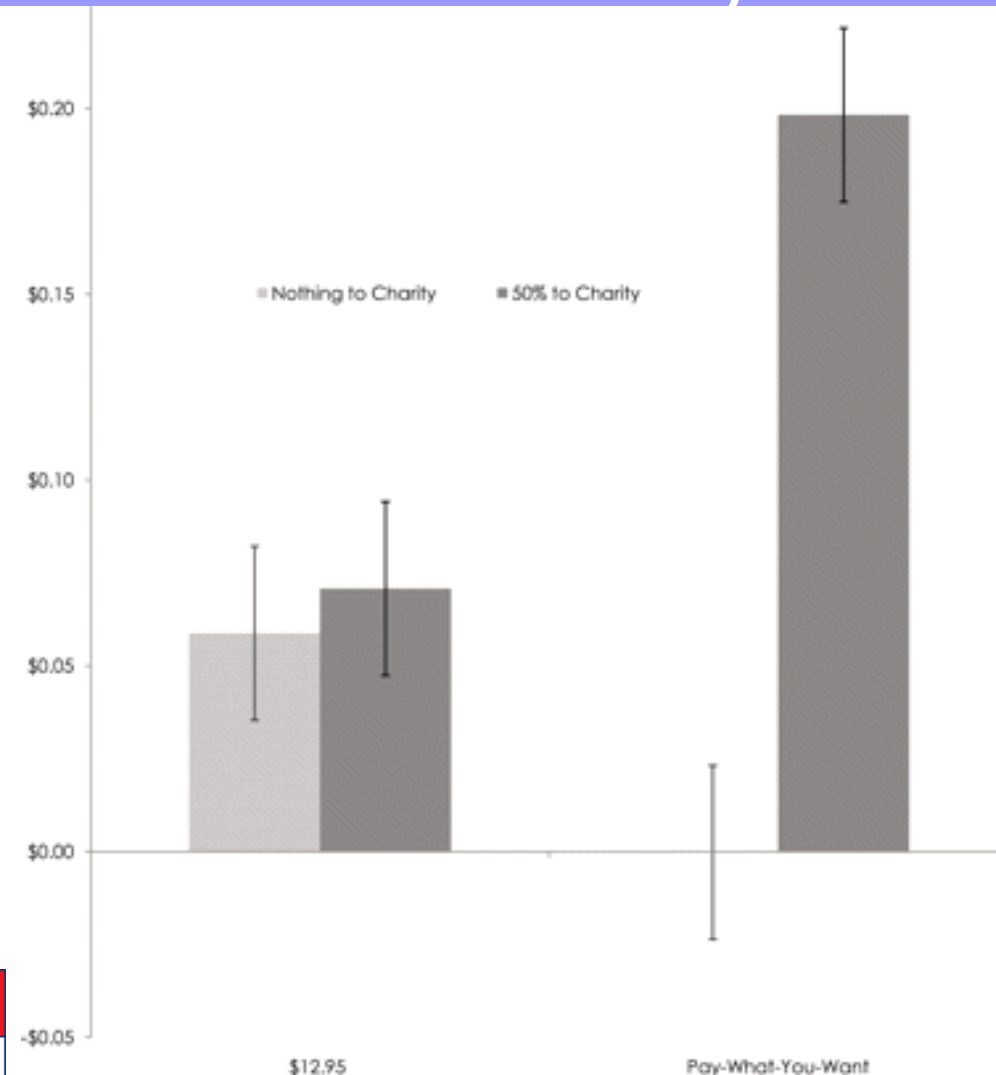
Disneyland Photo Field Experiment (還真的有攝影師開價的實驗)

- ▶ 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 disclosed...



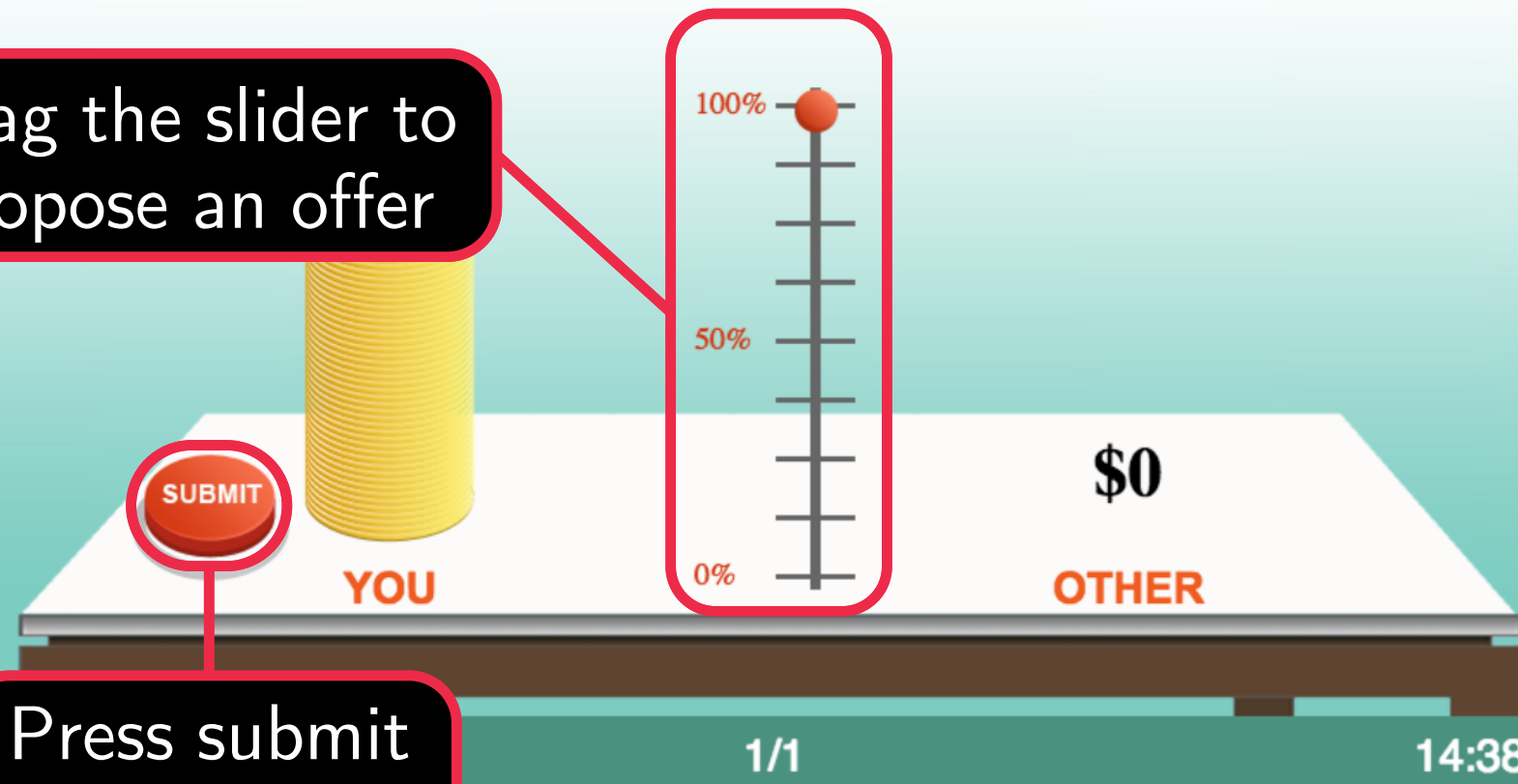
MobLab Ultimatum Game:

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



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.

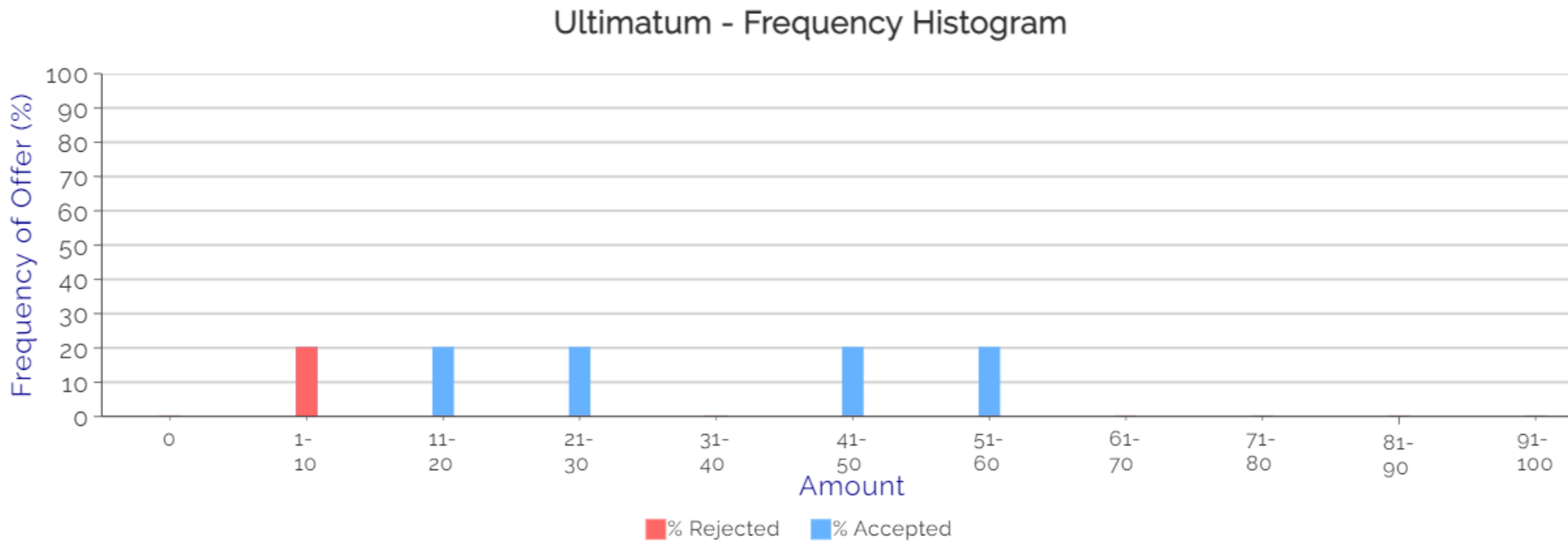
Will you accept the proposer's offer?

The interface shows a table with two stacks of coins. The left stack is labeled '\$55' and 'OTHER'. The right stack is labeled '\$45' and 'YOU'. Below the 'YOU' stack are two buttons: a green 'ACCEPT' button and a brown 'REJECT' button. Red circles highlight both buttons, with callout boxes above them containing the text 'Accept the proposer's offer' and 'Reject the proposer's offer'.

1/1 14:49

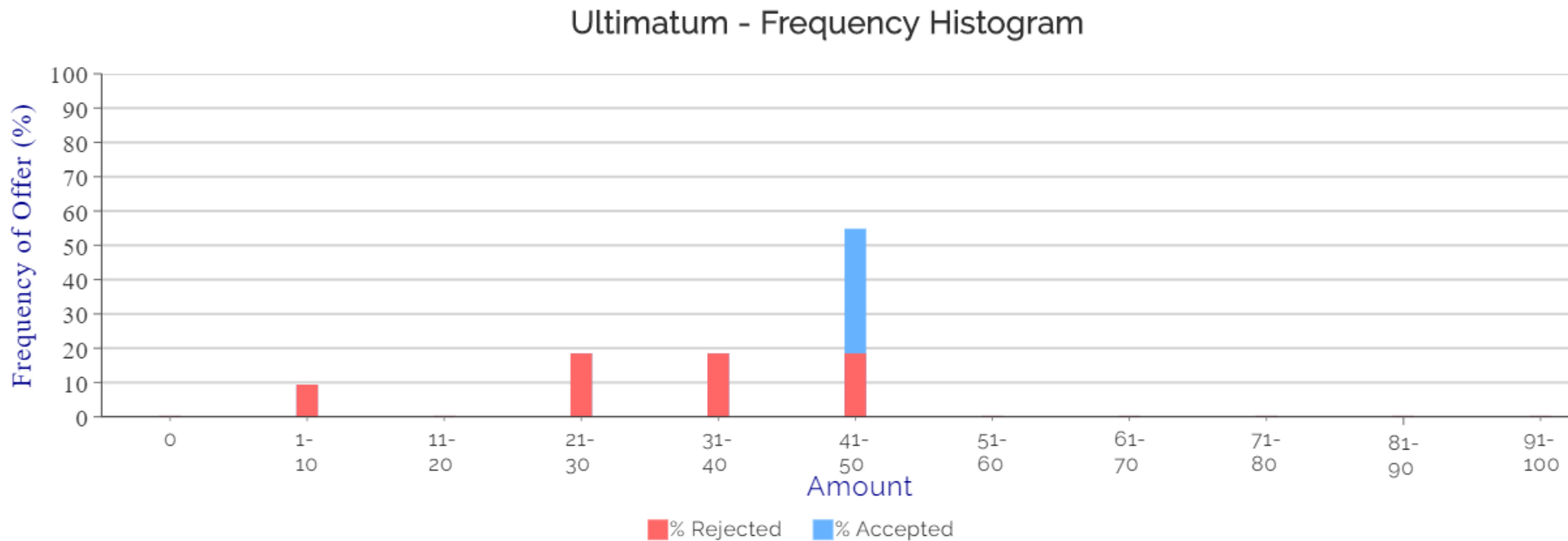
MobLab Ultimatum Game: EE-BGT 21S Results:

# 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



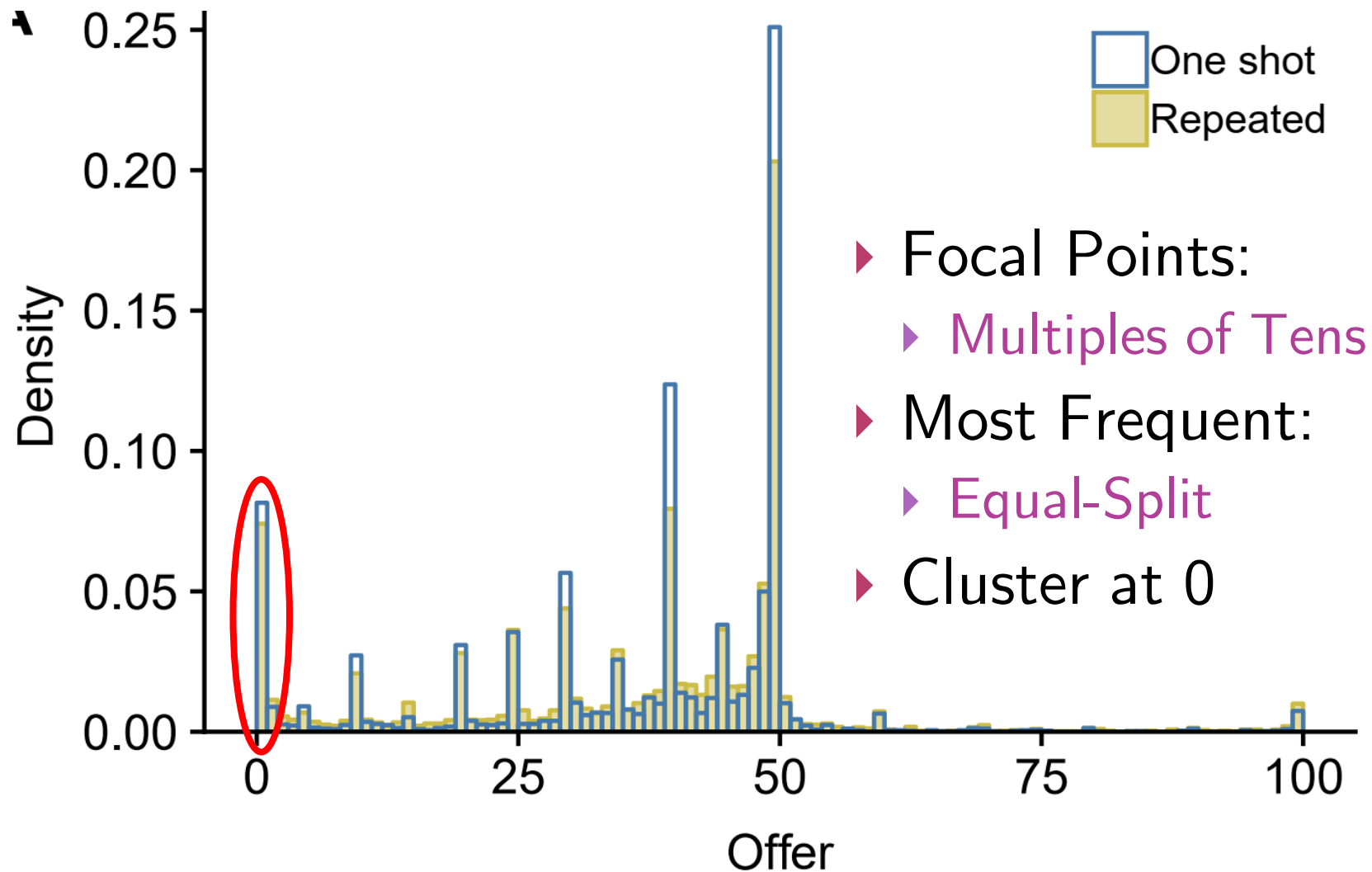
MobLab Ultimatum Game: CCU Results:

# 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

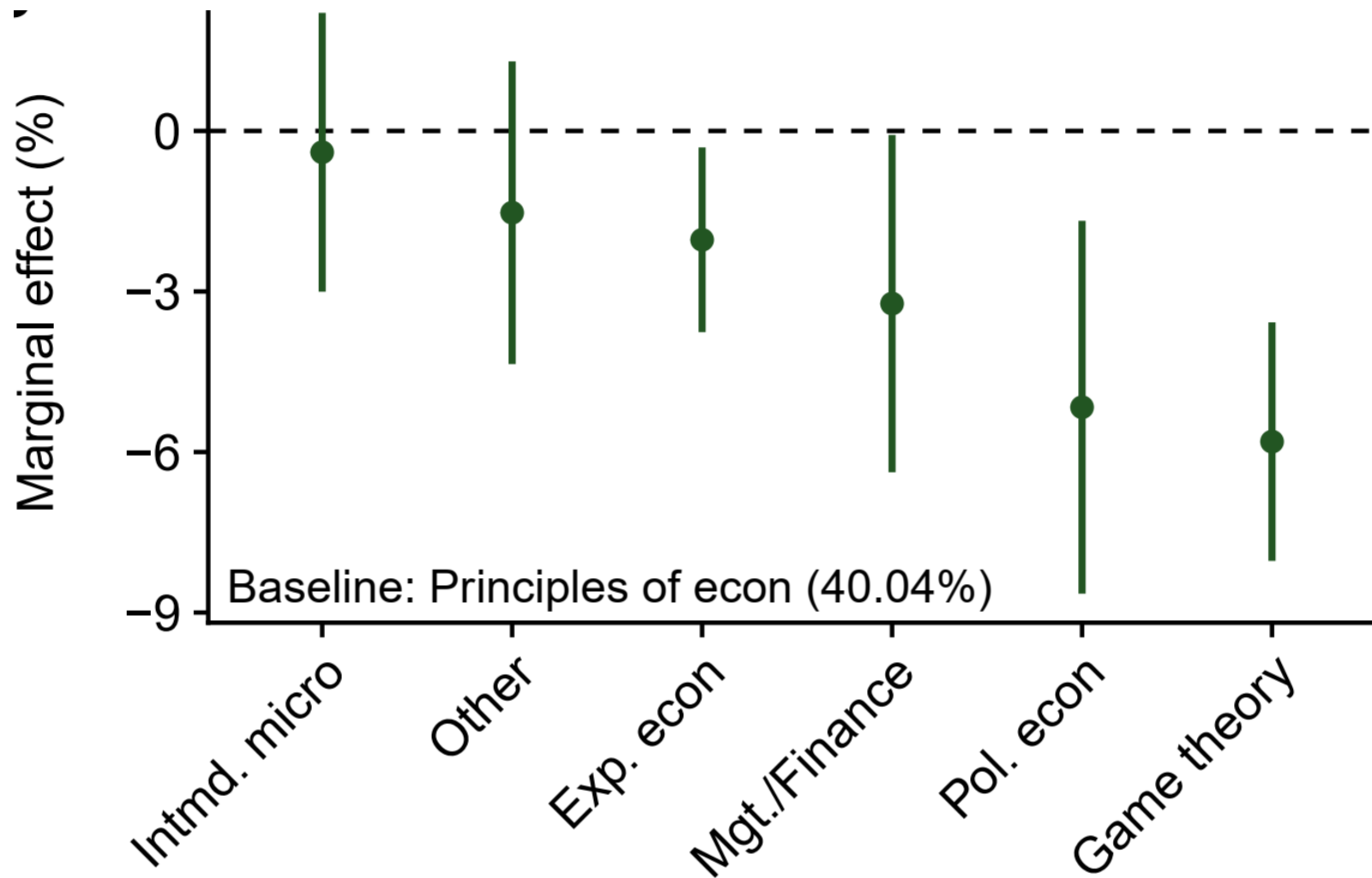


MobLab Ultimatum Game:

Proposal Offers

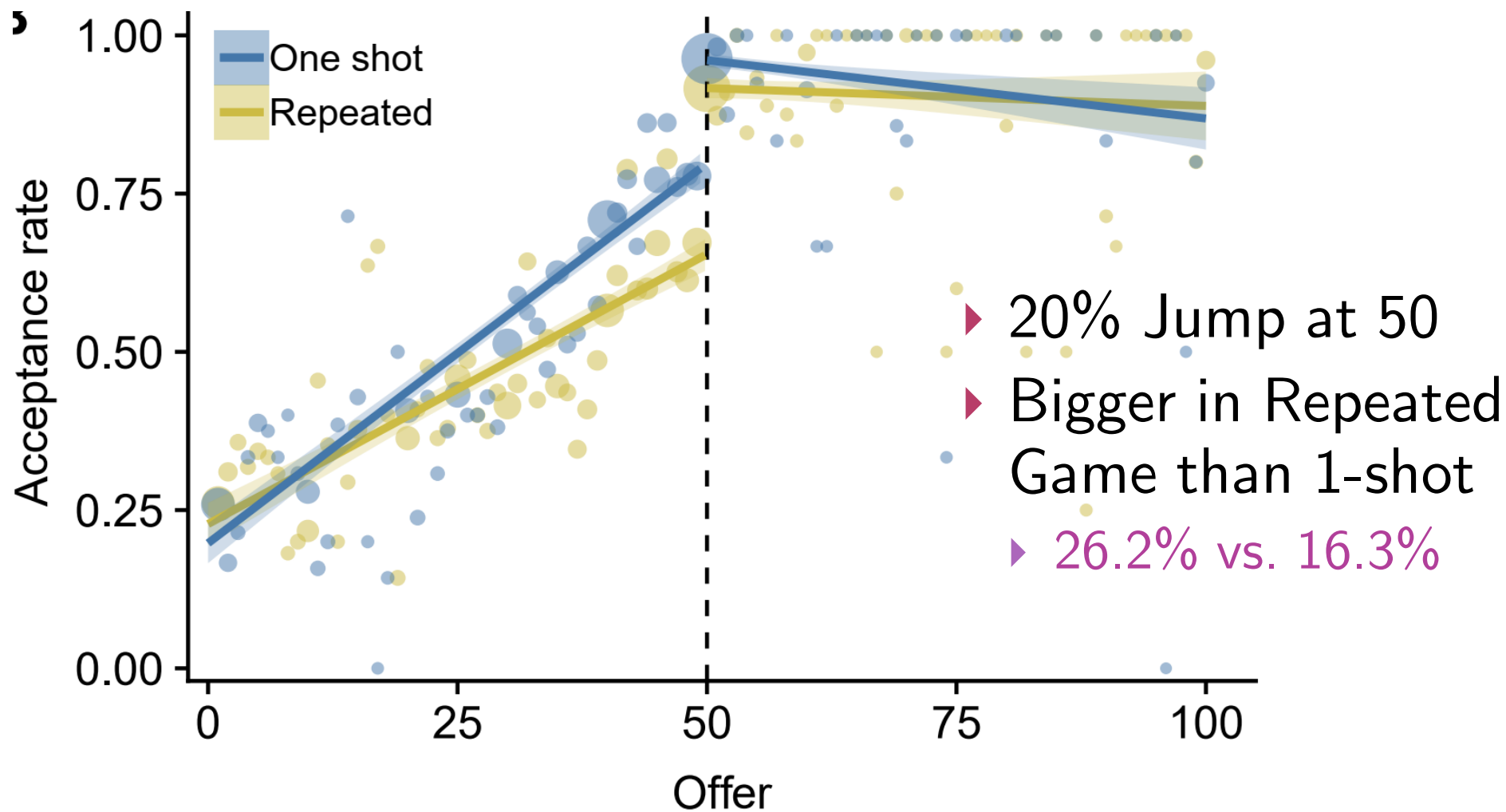


MobLab Ultimatum Game: Proposal Offer - Class Effect

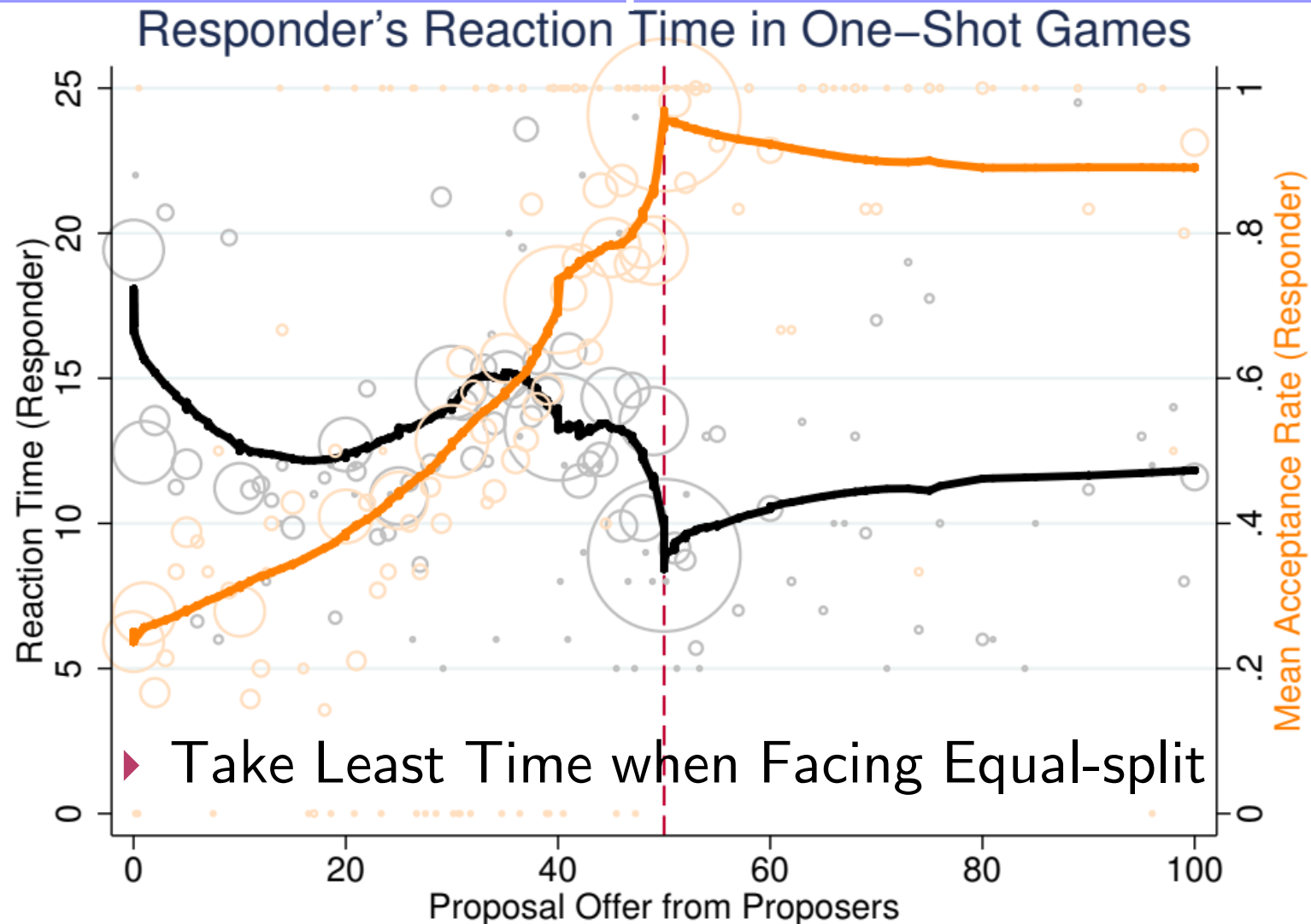


MobLab Ultimatum Game:

Acceptance Rate (Fit 2-part Regression)

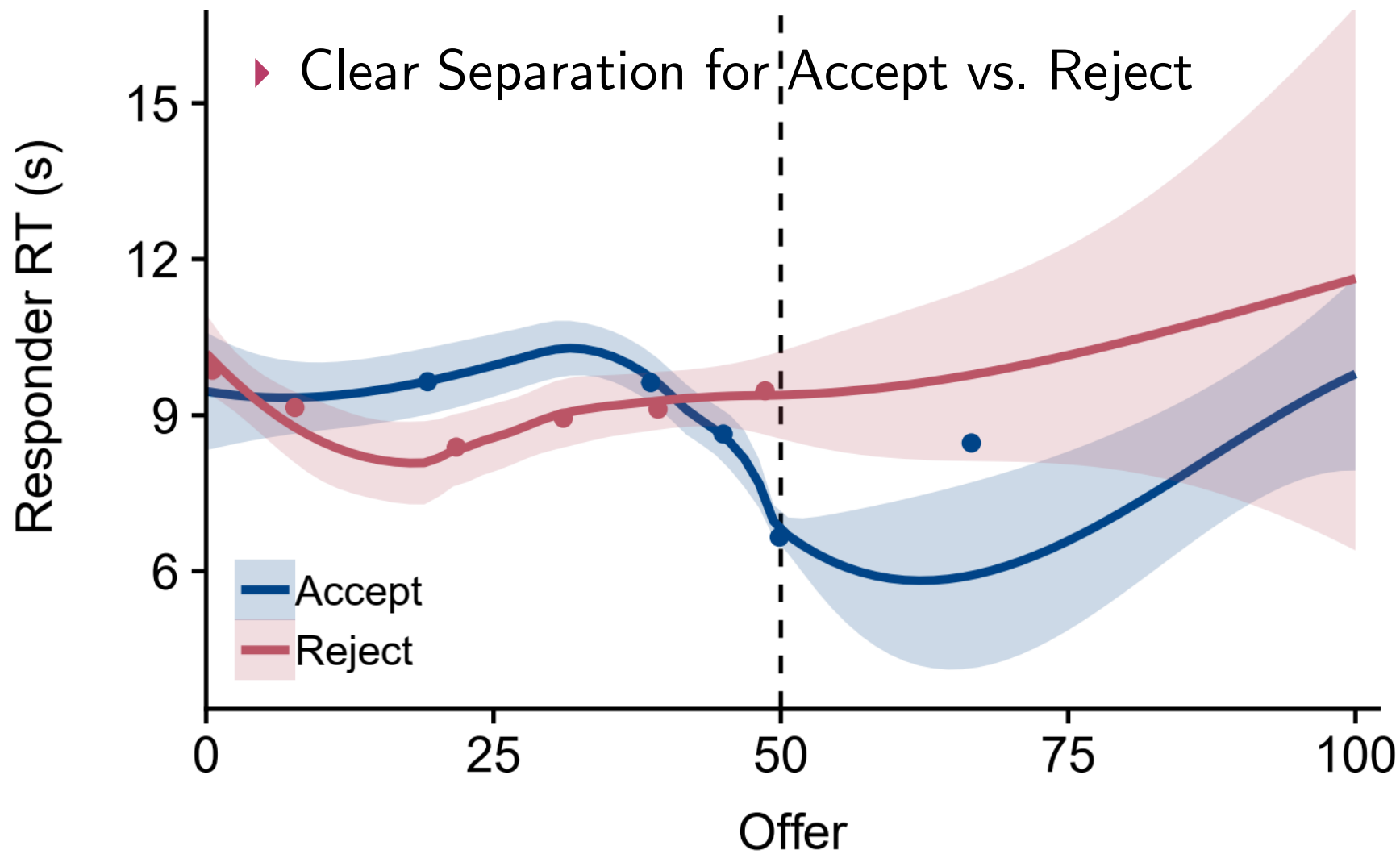


MobLab Ultimatum Game: Acceptance Rate and Response Time



MobLab Ultimatum Game:

Response Time



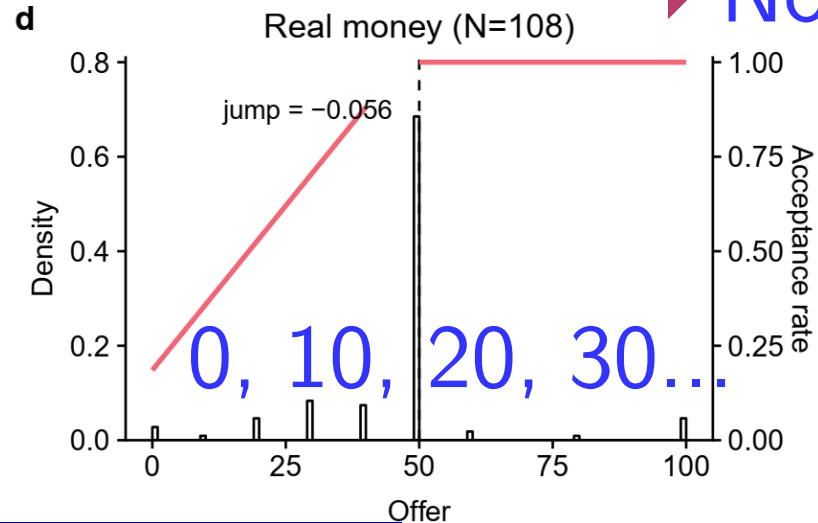
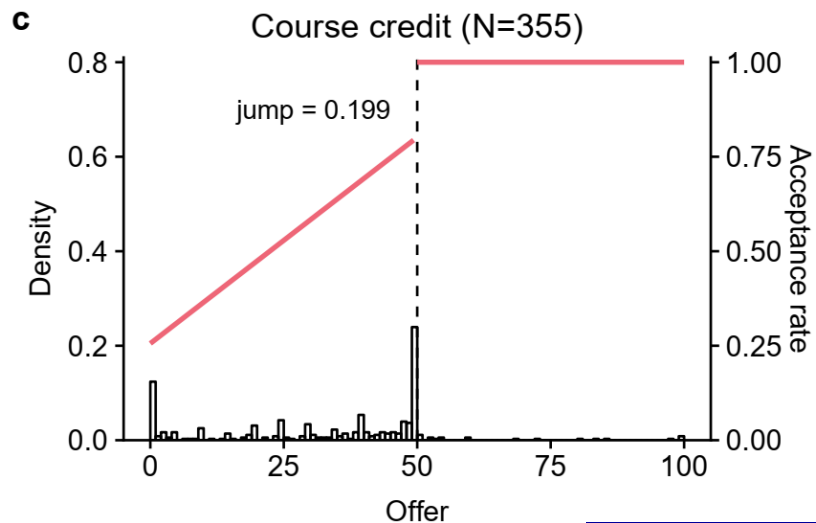
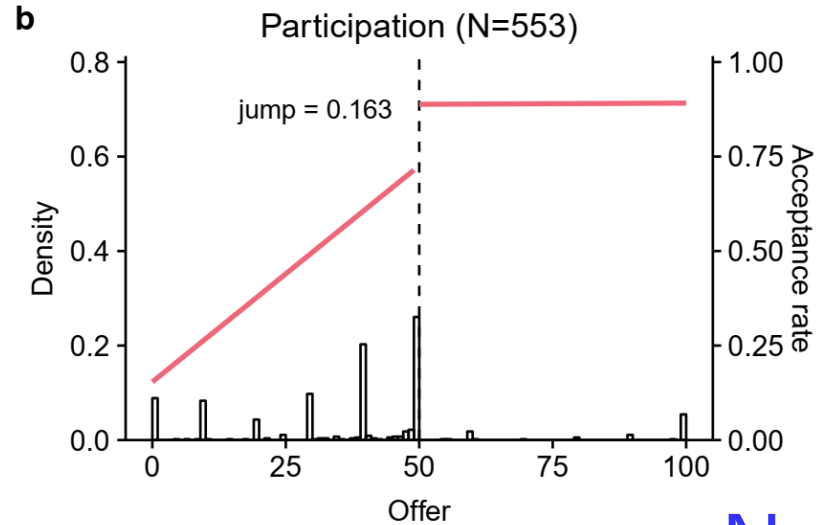
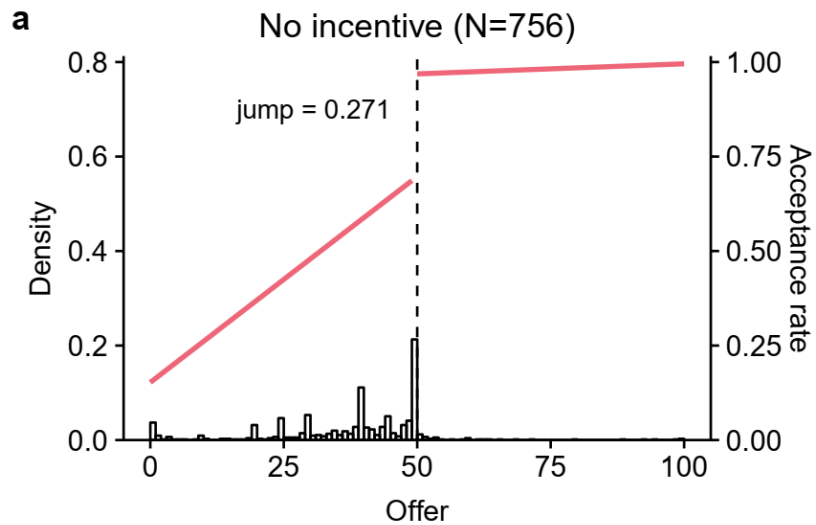
MobLab Ultimatum Game:

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%)

Exp/Beh Econ
@US-South
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)

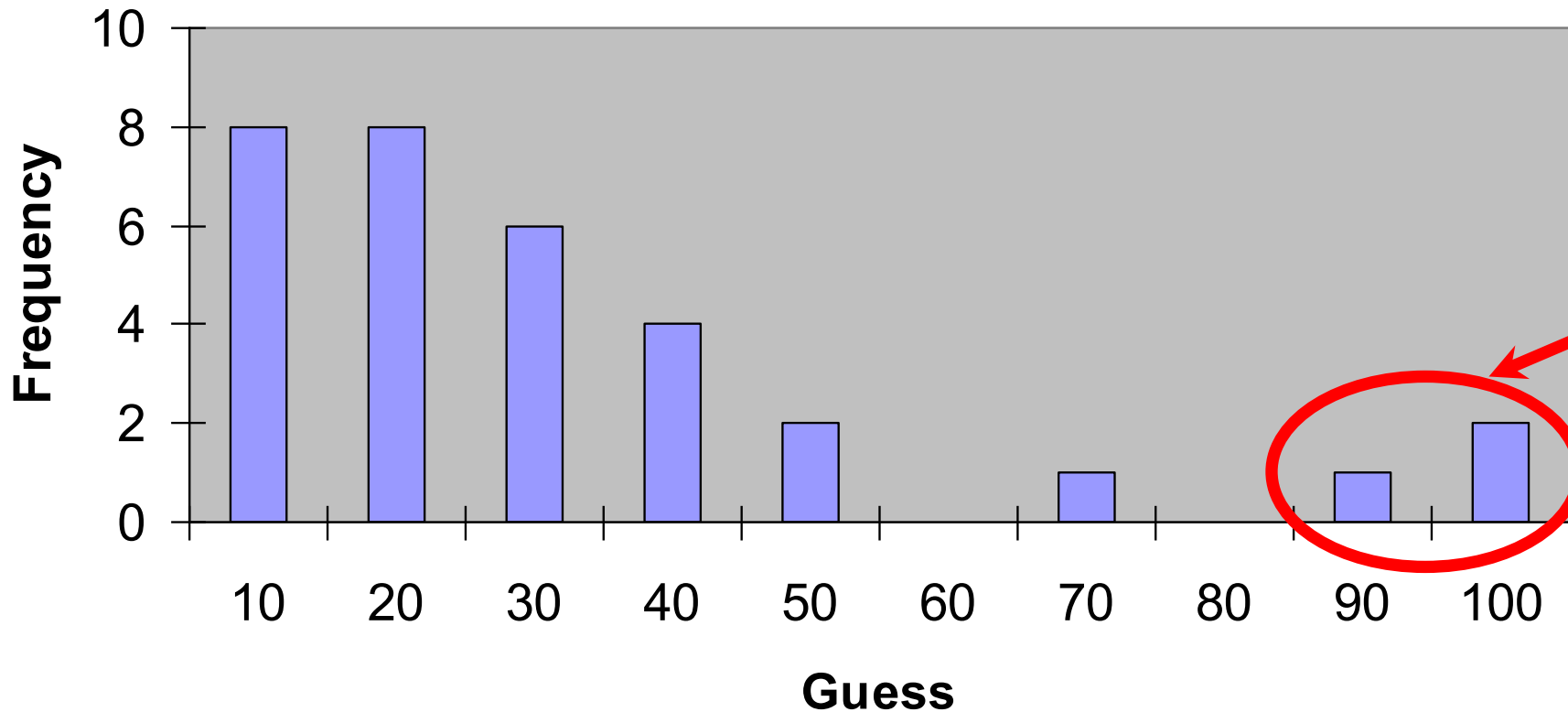
- ▶ **p -Beauty Contest** (選美結果預測賽局, 又稱「猜測(平均的三分之二)賽局」)
 - ▶ aka Guessing Game or $2/3$ of the Average Game
- ▶ **Environment:** (遊戲規則)
- ▶ **N Players** (參與者)
- ▶ **Action of Players:** (參與者的決策)
 - ▶ Each player guess a number from 0-100 (每位參與者都猜一個0-100數字)
- ▶ **Outcome:** (結果)
 - ▶ Number closest to $p=2/3$ 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

▶ 小口判

	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. Contin

My Own Choice

▶ 小口判

	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

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)
- ▶ 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！