

Evidence of General Economic Principles of Bargaining and Trade from 2,000 Classroom Experiments

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Are Canonical Experimental Results Robust?

- ▶ People **Assumed** this was true, until:
- ▶ Bem (JPSP 2011): 9 experiments / total $N > 1000$
 - ▶ "Feeling the Future: Experimental Evidence for Anomalous Retroactive Influences on Cognition and Affect"
- ▶ ESP is true?!
- ▶ Or, "standard" statistical practices are flawed...
- ▶ Open Science Collaboration (Science 2015)
 - ▶ "Estimating the Reproducibility of Psychological Science"
 - ▶ Replicate 100 Exp.@JPSP/JExpPsych/PsychSci 2008
 - ▶ Only 36 out of 100 replicate
 - ▶ Mean Effect Size = Slightly less than **Half** of original

Are Canonical Experimental Results Robust?

- ▶ Fail to Replicate due to bad incentives:
 - ▶ Publication Bias, Novelty Seeking, Budget Constraint
- ▶ Is Economics Immune/Better?
- ▶ Camerer et al. (Science 2016)
 - ▶ "Evaluating Replicability of Laboratory Experiments in Economics"
 - ▶ Replicate 18 AER/QJE Lab Experiments in 2011-14
 - ▶ 7 out of 18 Fail; Mean Effect Size = 66% of Original
- ▶ Brodeur et al. (AEJ-applied 2016)
 - ▶ Z-stat Humps right before 1.96 for AER/QJE/JPE
 - ▶ "Missing" p-values 0.25-0.10; "retrieved" just after 0.05
 - ▶ "Star Wars: The Empirics Strike Back"

Are Canonical Experimental Results Robust?

- ▶ Test Many Places w/ Standard Design
- ▶ Budget/Time Constraints Limit Scope
 - ▶ Oosterbeek et al. (2004): Meta-analysis of ultimatum game (Lack Standard Design)
 - ▶ Roth et al. (1991): Ultimatum game and market game in 4 countries (Fewer Places)
- ▶ **MobLab**: Ultimatum Game/Double Auction
 - ▶ Data From 10 Regions/Countries
 - ▶ Online Classroom Experiment Platform

MobLab Classroom Experimental Data

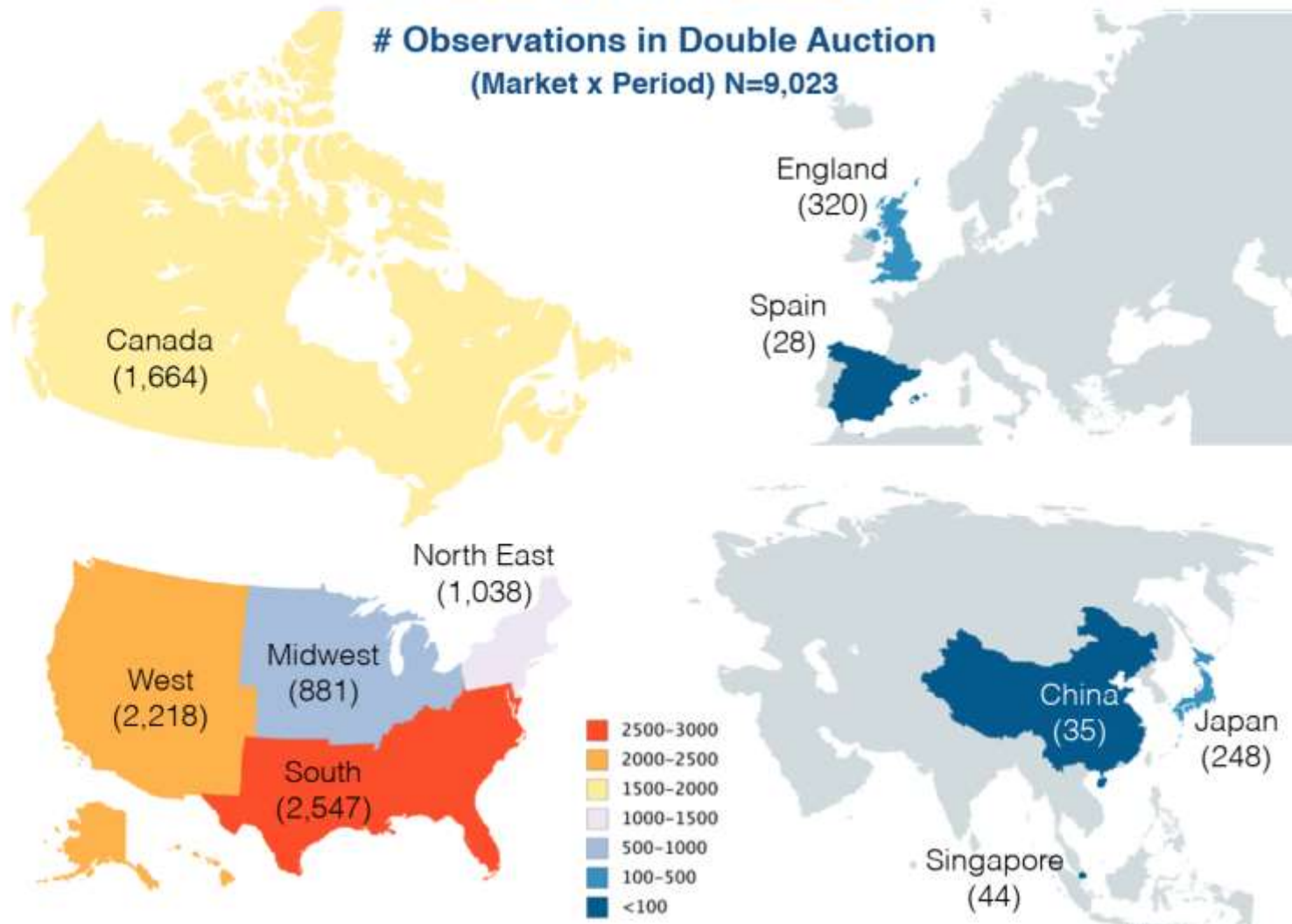
Cons:

1. Most are not incentivized by money
 - ▶ Other incentives: Class Grade, Internal Motivation
2. Students in courses NOT representative
 - ▶ But exactly as Chamberlin (1948) and Smith (1962)

▶ Pros:

1. No Publication Bias
2. Demographic Variation: 10 regions/countries
3. Exact Same Interface/Language/Design


Observation in Different Regions/Countries



Double Auction: Buyers

BUYER Order Book >

Value \$1.32
Oranges 1
Earnings \$0.91



\$0.97 Profit \$0.35

Bid

or

Buy at Lowest Ask

BIDS \$0.30
ASKS \$0.76
\$0.81


0 30.0s 60.0s 90.0s 120.0s

01:17

Double Auction: Sellers


SELLER Order Book >

Cost \$0.55
Oranges 3
Earnings \$0.00



\$3.00
\$2.25
\$1.50
\$0.75
0 30.0s 60.0s 90.0s 120.0s

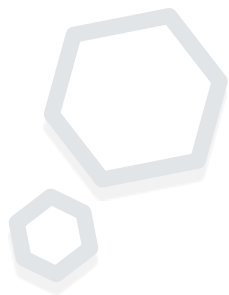
\$0.52 Profit $-\$0.03$

<  >

Ask or **Sell at Highest Bid**

BIDS	ASKS
\$1.49	\$1.77
\$1.42	

01:20



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

\$0.00 Profit -\$0.65

ASK


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


or Sell at Highest Bid

Seller's Profit = Sale Price - Cost of Production

SELLER Order Book >

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





Price	\$3.00
	\$2.25
	\$1.50
	\$0.75
Time	0:10
	0:20
	0:30
	0:40

Profit: **\$0.00** (circled in red)

Profit: -\$0.65

ASK

BIDS	ASKS
\$1.12 (circled in red)	\$2.26
\$1.10	\$2.98
\$0.77	--


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

BIDS **ASKS**

\$0.85	\$0.86
\$0.66	\$0.86
\$0.32	\$0.99

Profit \$1.38

\$0.00


BID

or Buy at Lowest Ask

Buyer's Profit = Value of consumption - Purchase Price

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

\$0.00 Profit \$1.38

BIDS ASKS

\$0.85 \$0.86
\$0.66 \$0.86
\$0.32 \$0.99

BID or Buy at Lowest Ask

Detailed description: This is a screenshot of a mobile application interface for a buyer. At the top, it says 'BUYER' and 'Order Book >'. Below this, there's a summary section for 'Oranges' showing a 'Value' of \$1.38 (circled in red), 'Oranges' quantity of 0/3, and 'Earnings' of \$0.00. To the right is a line graph showing price over time, with a data point at \$1.34. Below the summary is a profit section showing a profit of \$0.00 (circled in red) and a total value of \$1.38. At the bottom, there are two options: 'BID' with a slider and 'Buy at Lowest Ask'. The 'ASKS' column shows prices of \$0.86, \$0.86, and \$0.99, with the top \$0.86 price circled in red.

When does a transaction occur?

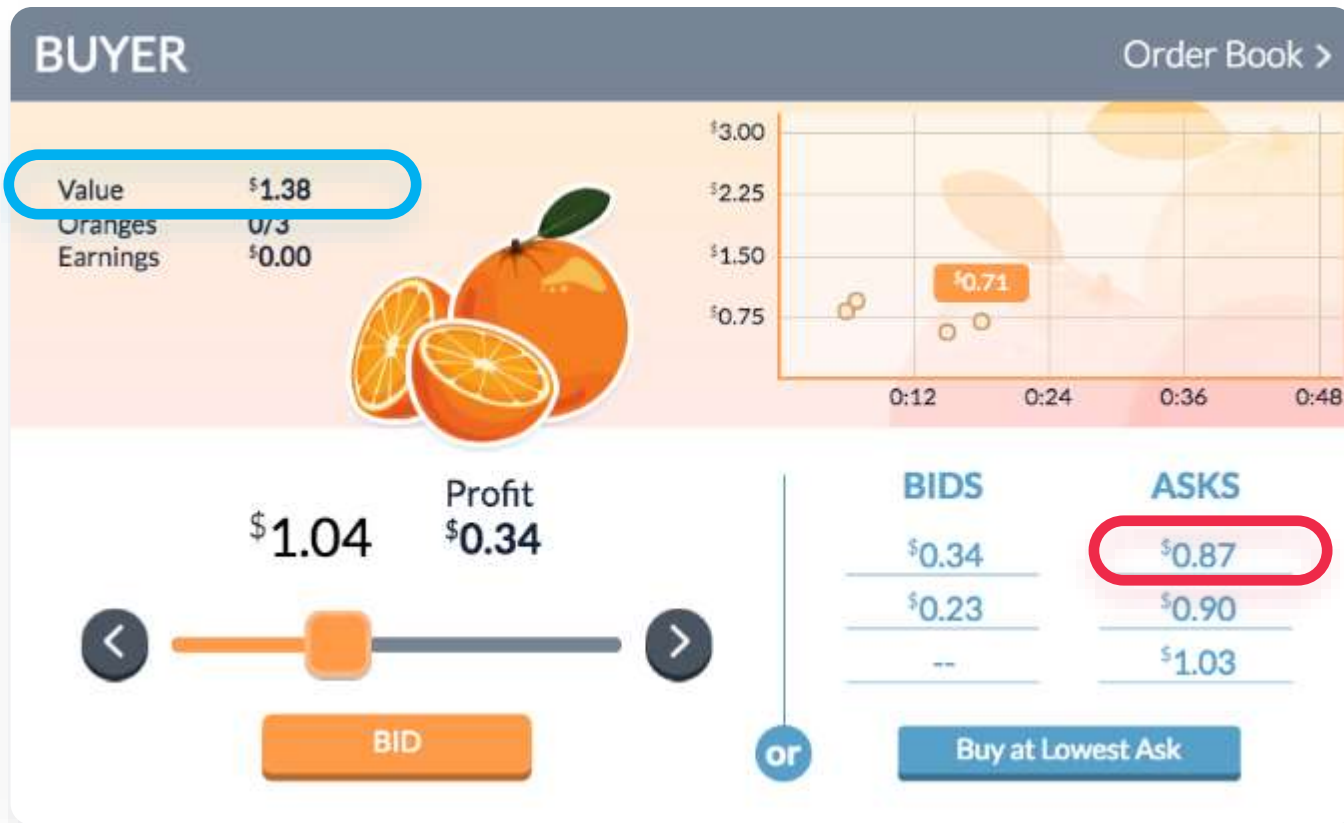
- Someone uses Buy at Lowest Ask Sell at Highest Bid
- A Buyer places a BID higher than the lowest outstanding Ask
- A Seller places an ASK lower than the highest outstanding Bid

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



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

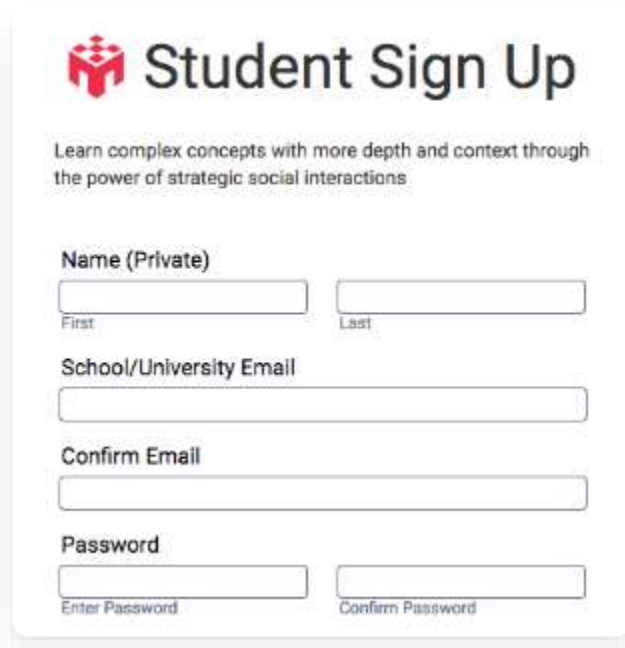
As a buyer, what is your profit if you
“Buy at Lowest Ask”?




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

Sign up www.moblab.com or download the app

- 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

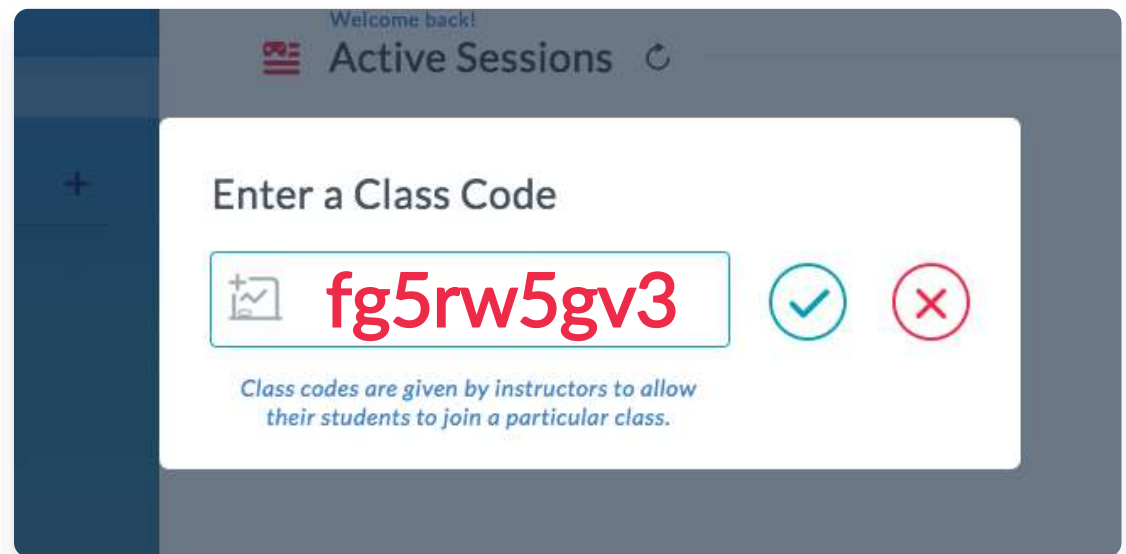
School/University Email



Confirm Email

Password




Enter Password Confirm Password

- 2 Join the class



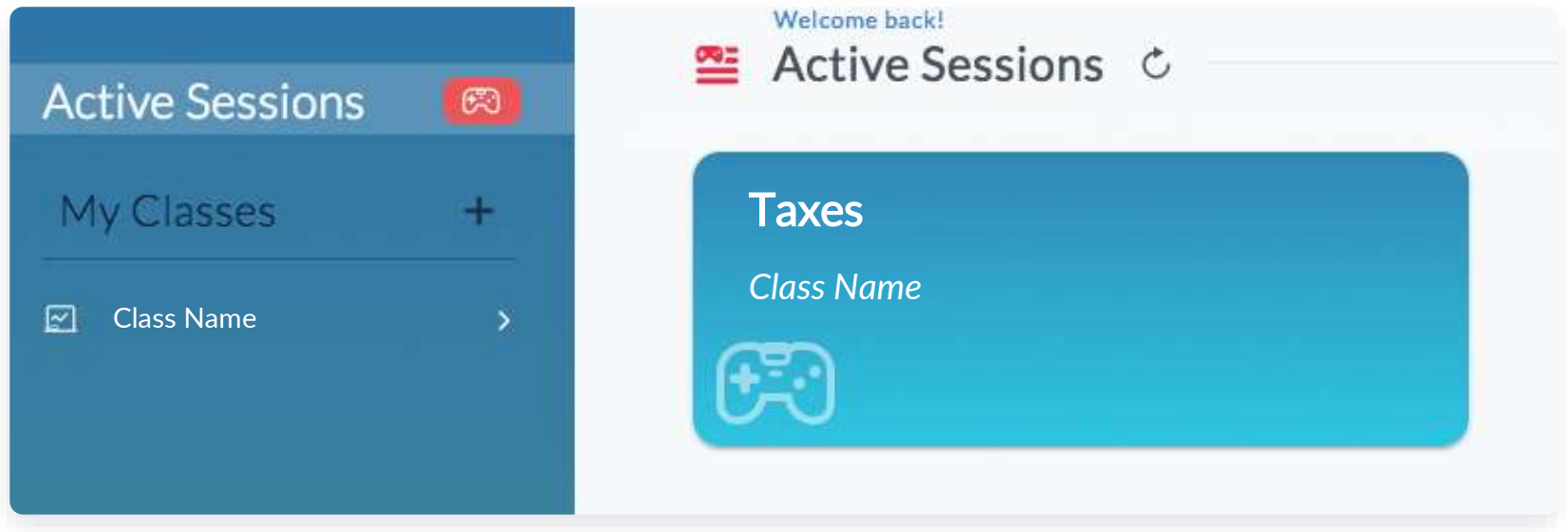
Welcome back!
 **Active Sessions** 

Enter a Class Code

 **fg5rw5gv3**  

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

Enter the Activity



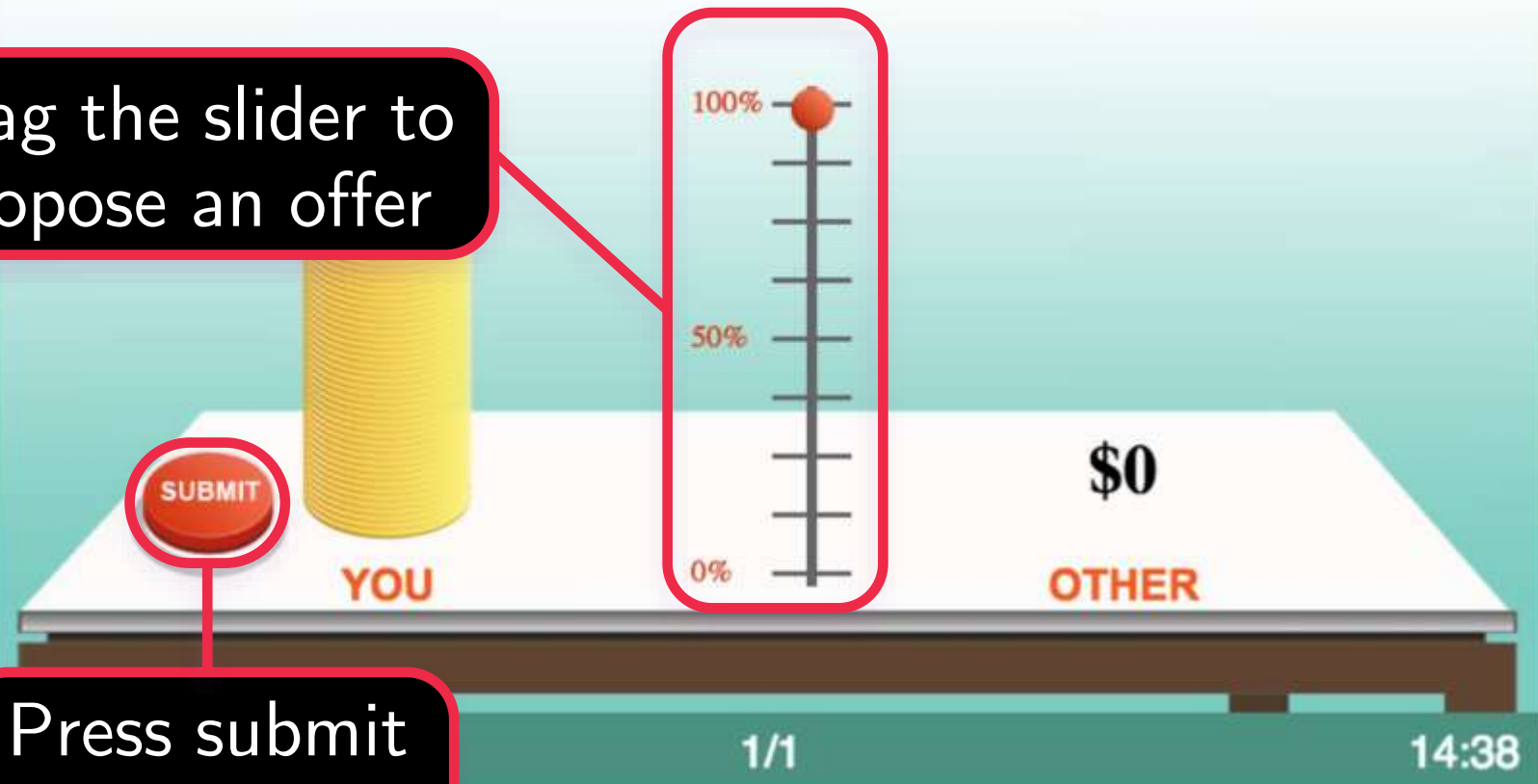
Ultimatum Game:

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

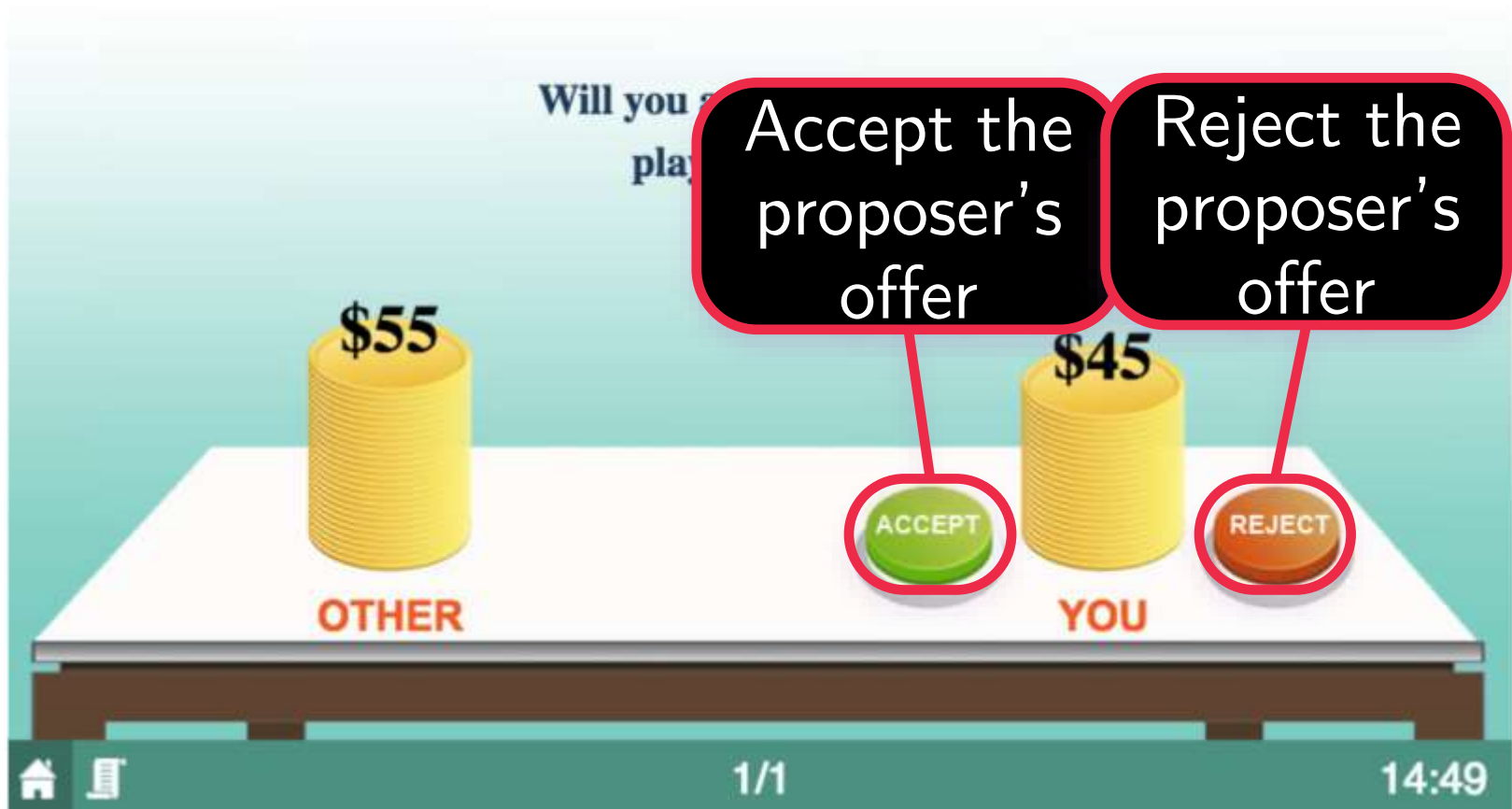


Press submit to finalize

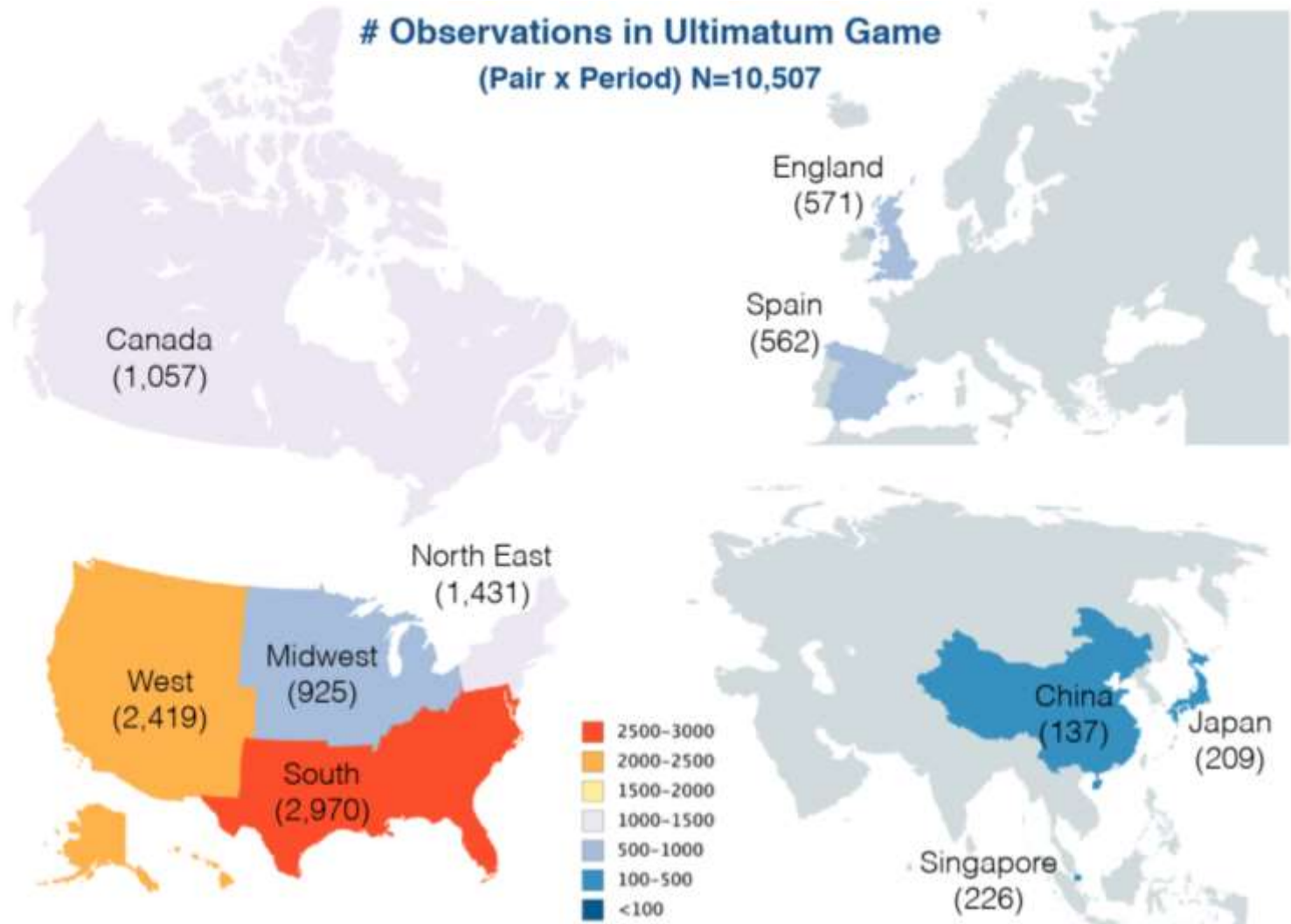
Ultimatum Game: Respondent

Ultimatum

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



Observation in Different Regions/Countries



Default Configurations

▶ **Ultimatum:** Default pie size is 100

▶ 82% used this

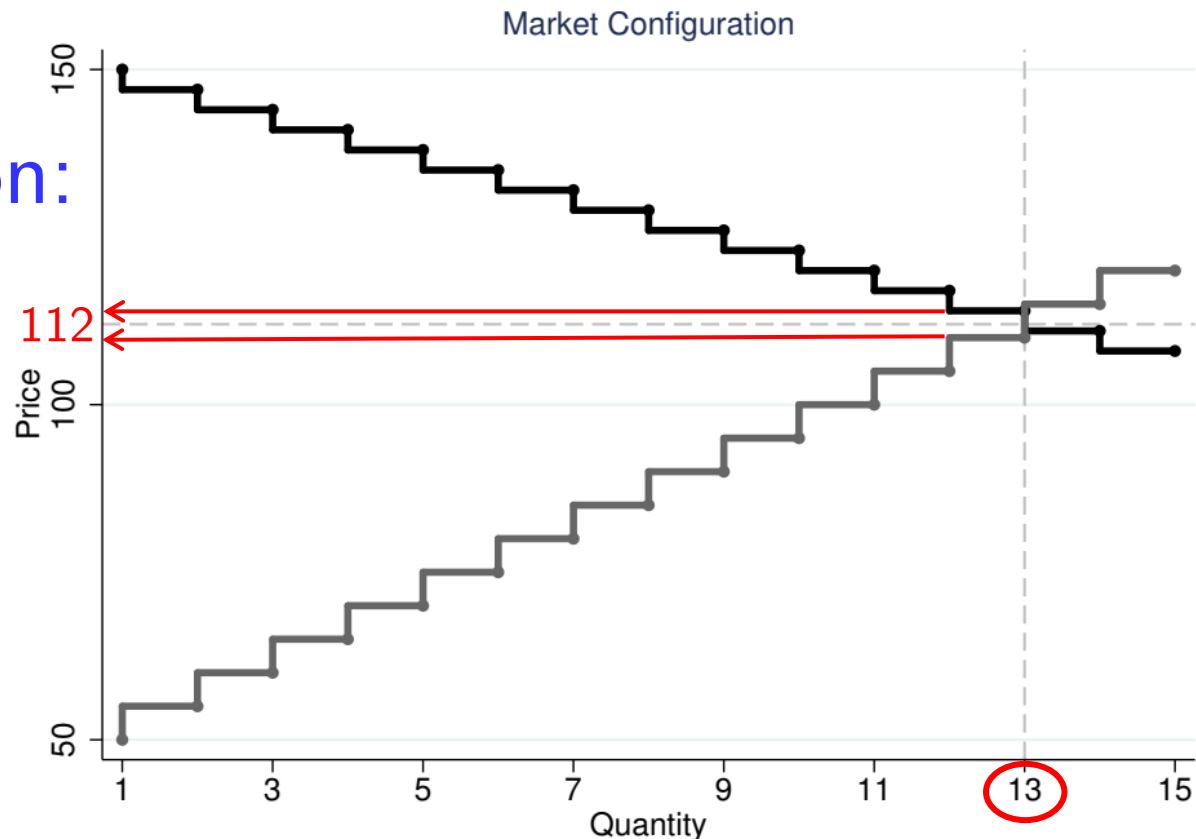
▶ **Double Auction:**

▶ 5 buyers,

▶ 5 sellers,

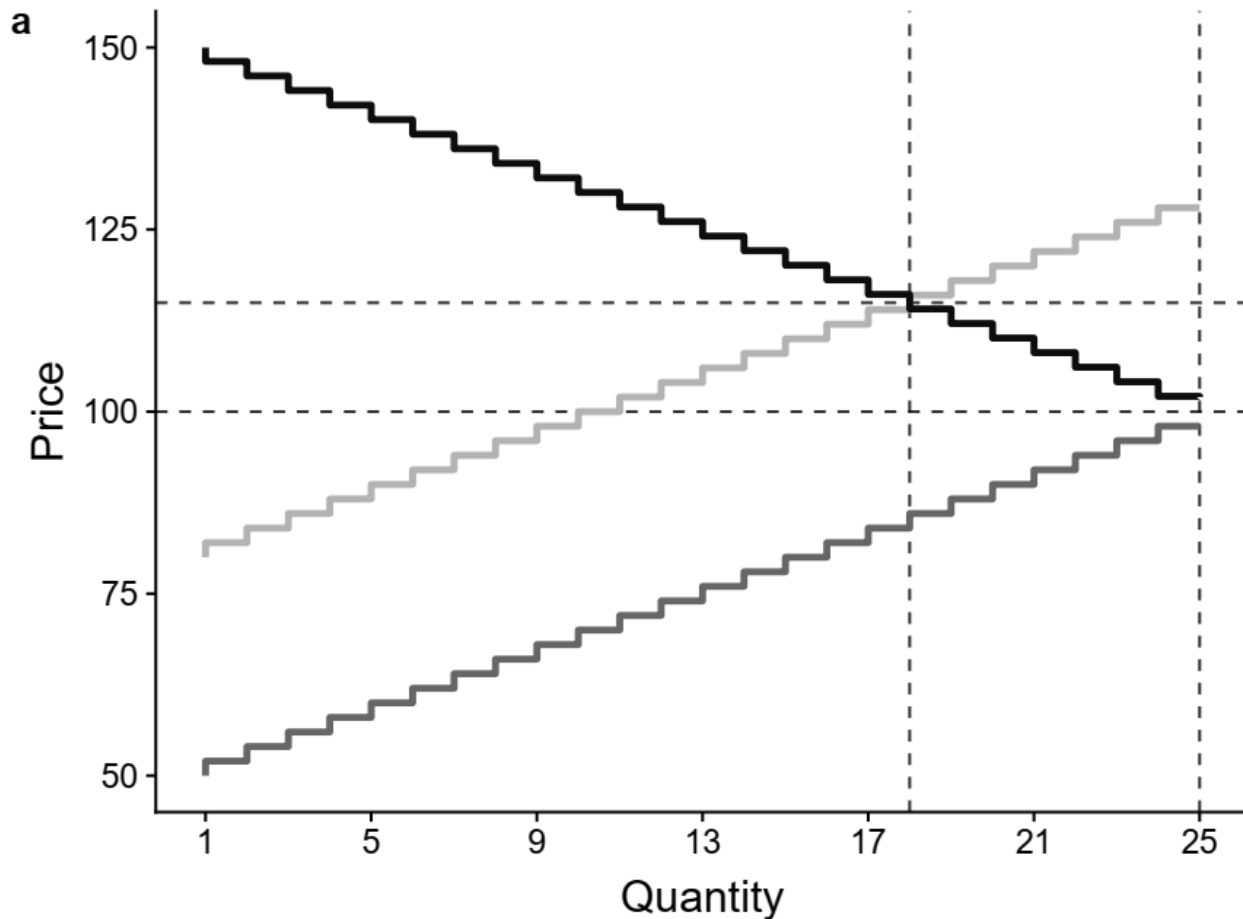
each player has
3 cost/value

▶ 36% used this



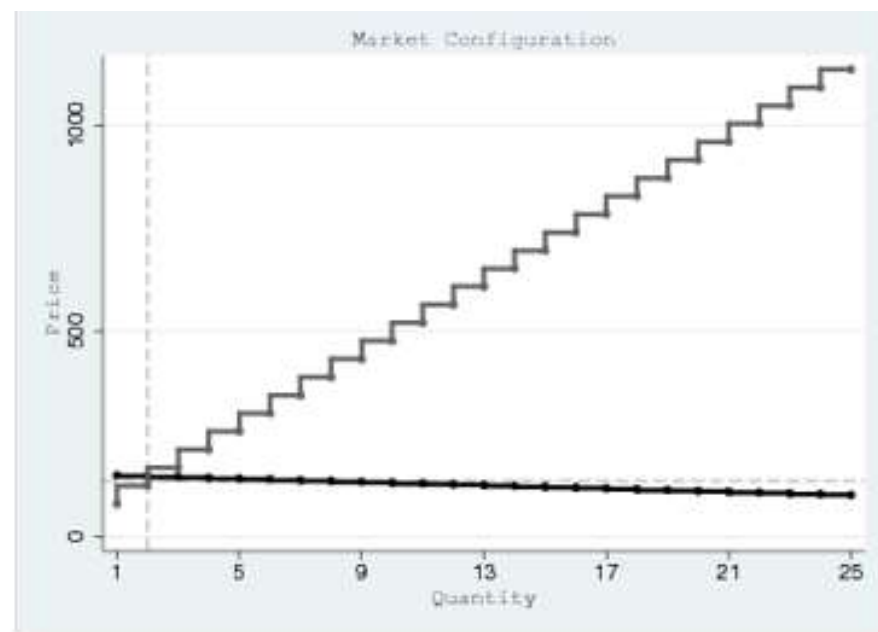
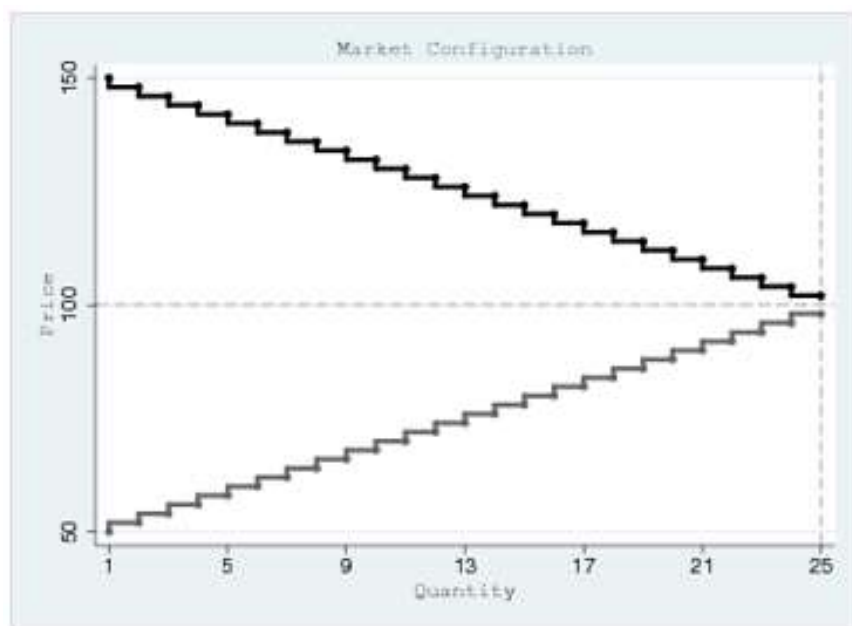
Fewer Default in Double Auction Since...

Instructors Frequently Shift S-D when Teaching



One Outlier **Excluded** in Double Auction

Original Market #228 vs. Outlier Market #1750



Original Market #228



Competitive Market (Continuous Double Auction)

Monitor

Competitive Market (Continuous Double Auction) Show Timer

50 All Play Only Robots

Supply (Pennies) Valid Range: 0-9999

Min Cost: 50 Max Cost: 98

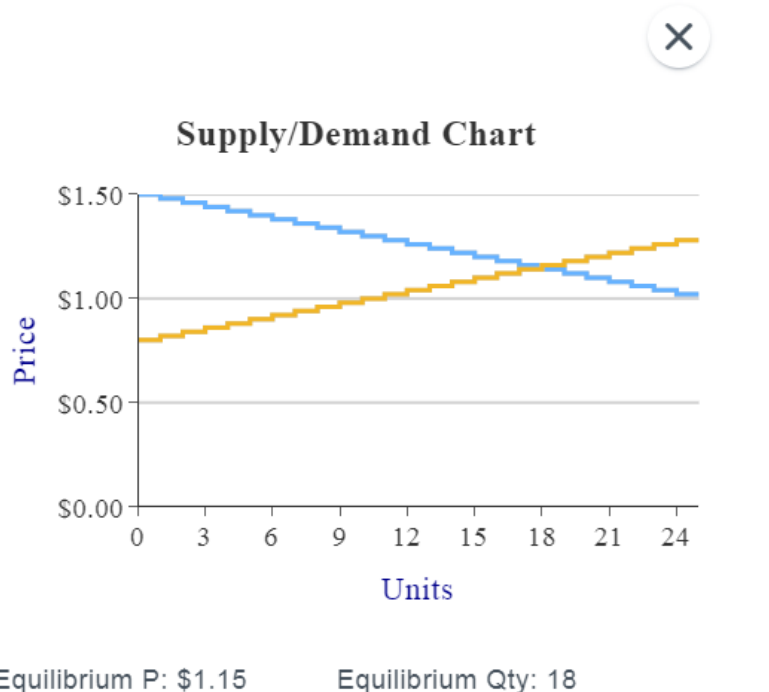
Price Controls: None Price Control Value (Pennies):

Tax or Subsidy: None Tax or Subsidy Value (Pennies):

Unit / Person: 1

Supply/Demand Graph

Intended Shift in Supply (Didn't Occur)



Competitive Market (Continuous Double Auction)

Monitor

Competitive Market (Continuous Double Auction) Show Timer

50 All Play Only Robots

Supply (Pennies)

Valid Range: 0-9999

Min Cost: 80

Max Cost: 136

Price Controls: None

Tax or Subsidy: None

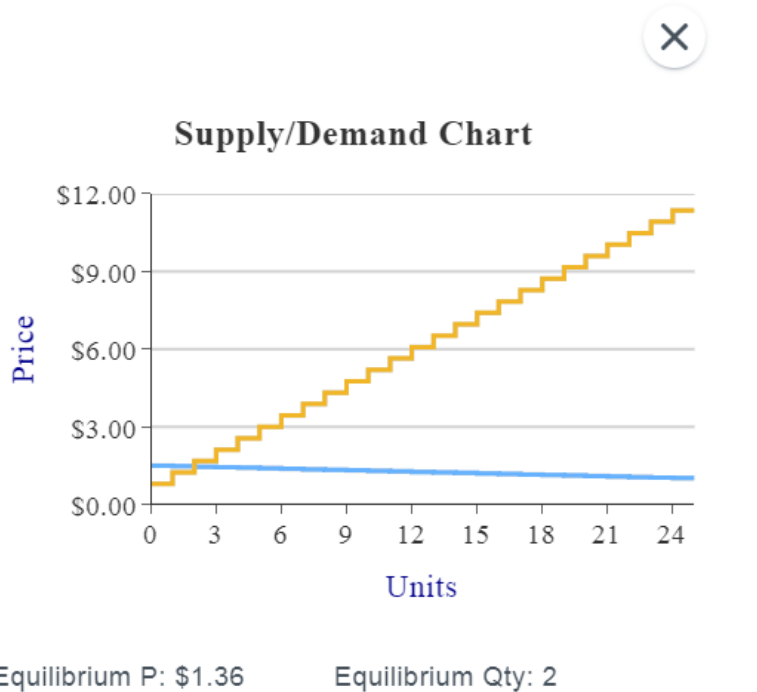
Unit / Person: 1

Price Control Value (Pennies):

Tax or Subsidy Value (Pennies):

Supply/Demand Graph

Outlier Market #1750



Equilibrium P: \$1.36

Equilibrium Qty: 2

Competitive Market (Continuous Double Auction)

Monitor

Competitive Market (Continuous Double Auction)

Show Timer

50

All Play Only Robots

Min Cost
0-9999

102

Max Value

150

Supply (Pennies)

Valid Range: 0-9999

Min Cost

80

Max Cost

1,136

Price Controls

None

Price Control Value (Pennies)

Tax or Subsidy

None

Tax or Subsidy Value (Pennies)

Unit / Person

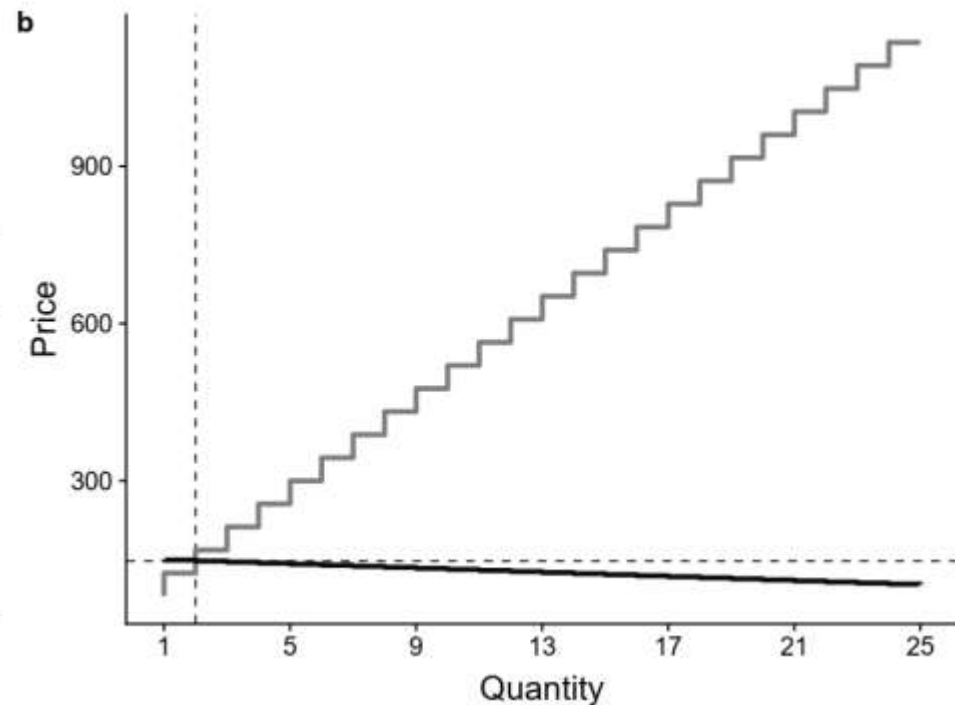
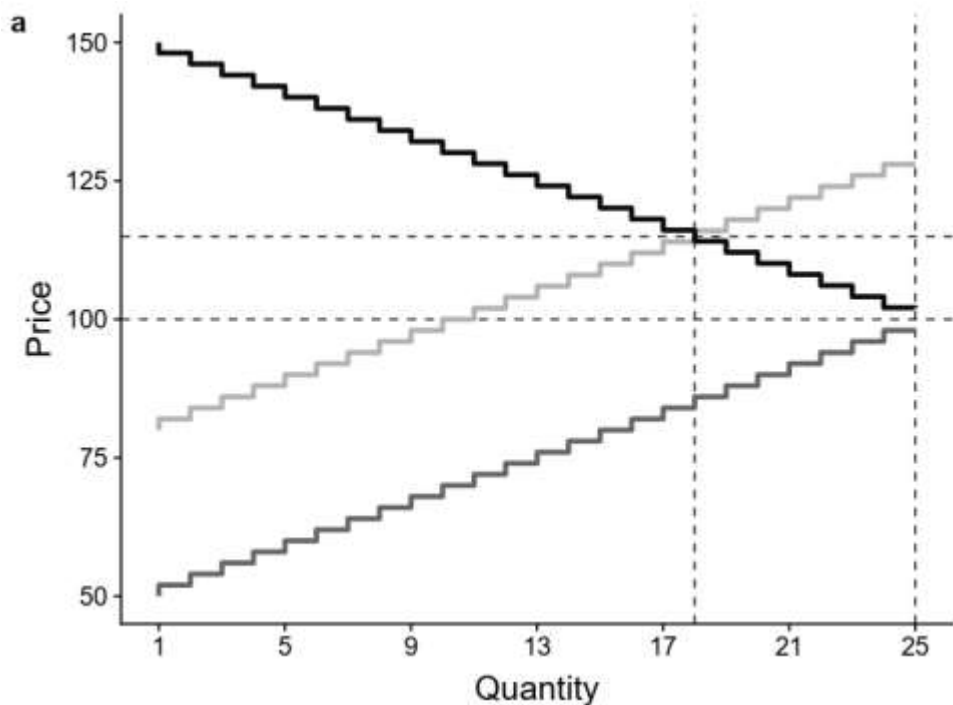
1

Supply/Demand Graph

Advanced

One Outlier Excluded in Double Auction

Original Market #228 vs. Outlier Market #1750



Summary Statistics

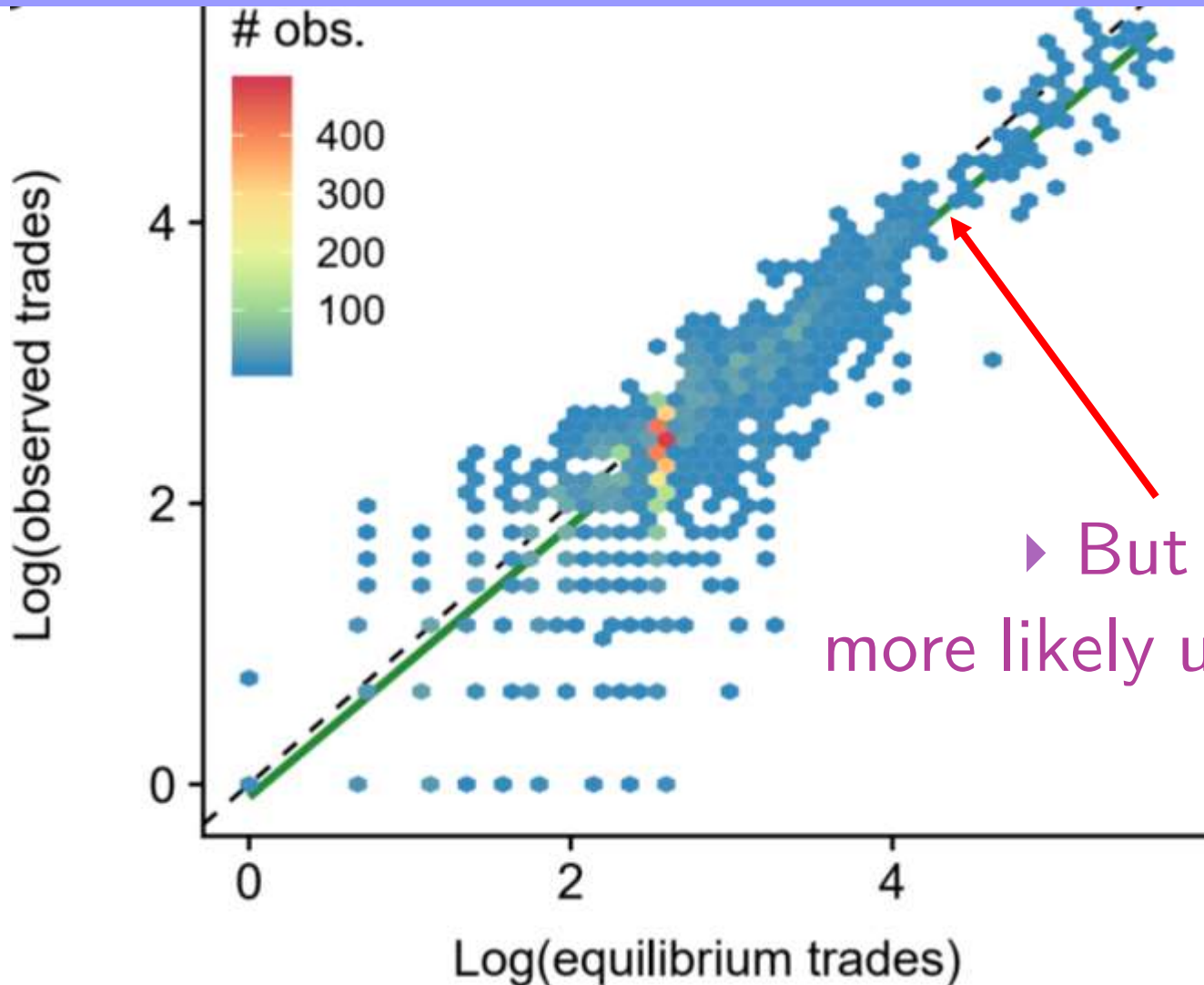
	Mean	(s. d.)
Double Auction	(5,809 Markets)	
MED δ - Accuracy	0.070	(0.280)
Smith's α - Fluctuation	0.279	(0.294)
Efficiency	81.5%	(25.8%)
Ultimatum Game	(6,505 Pairs)	
Proposal Offer	36.82	(18.16)
Acceptance Rate	64.0%	(48.0%)

Mean Error Deviation (MED):

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

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

Double Auction: Trade Volume Close to CE!

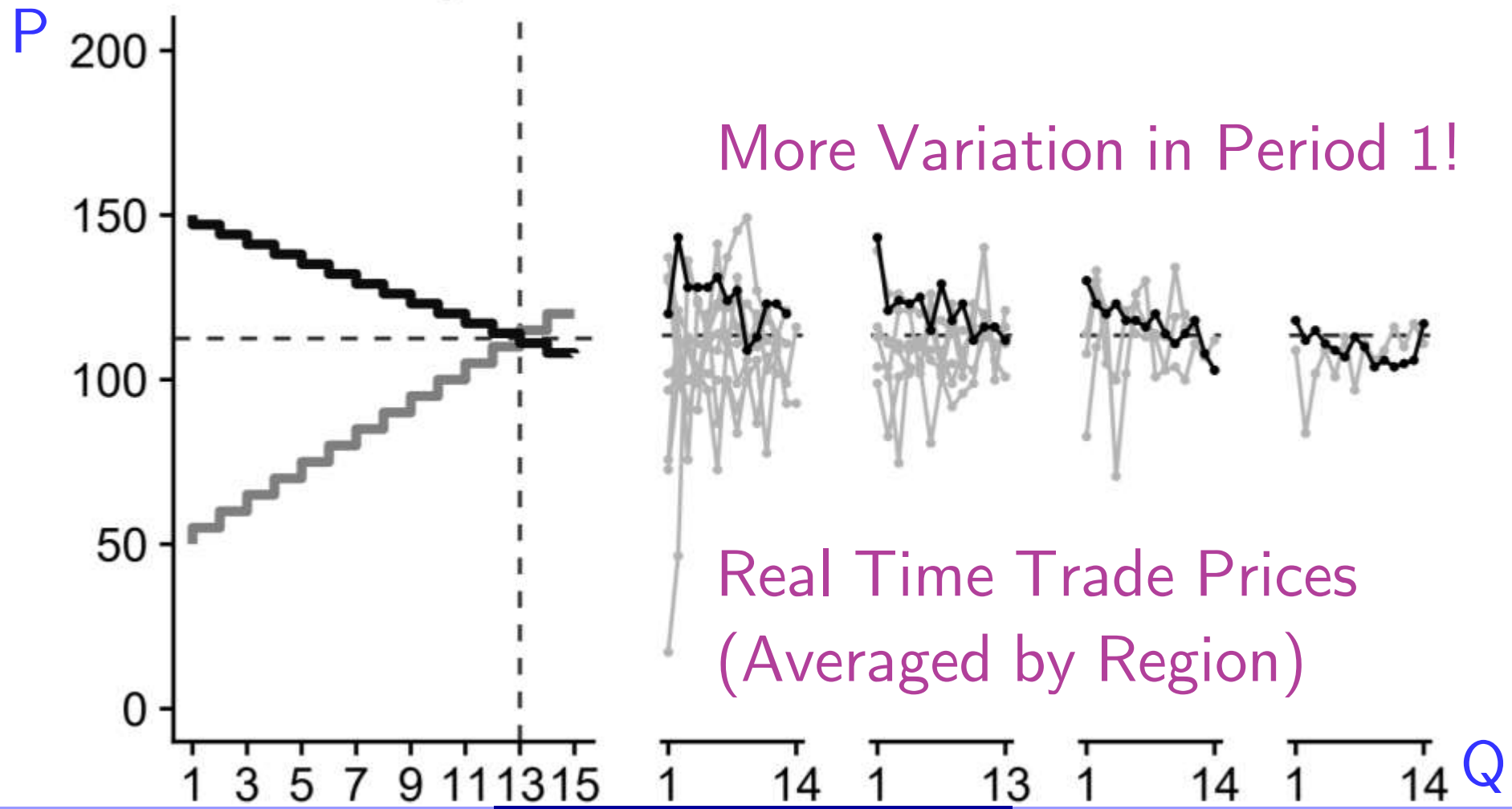


► But Deviations
more likely under-trade

Double Auction:

Price Convergence to CE

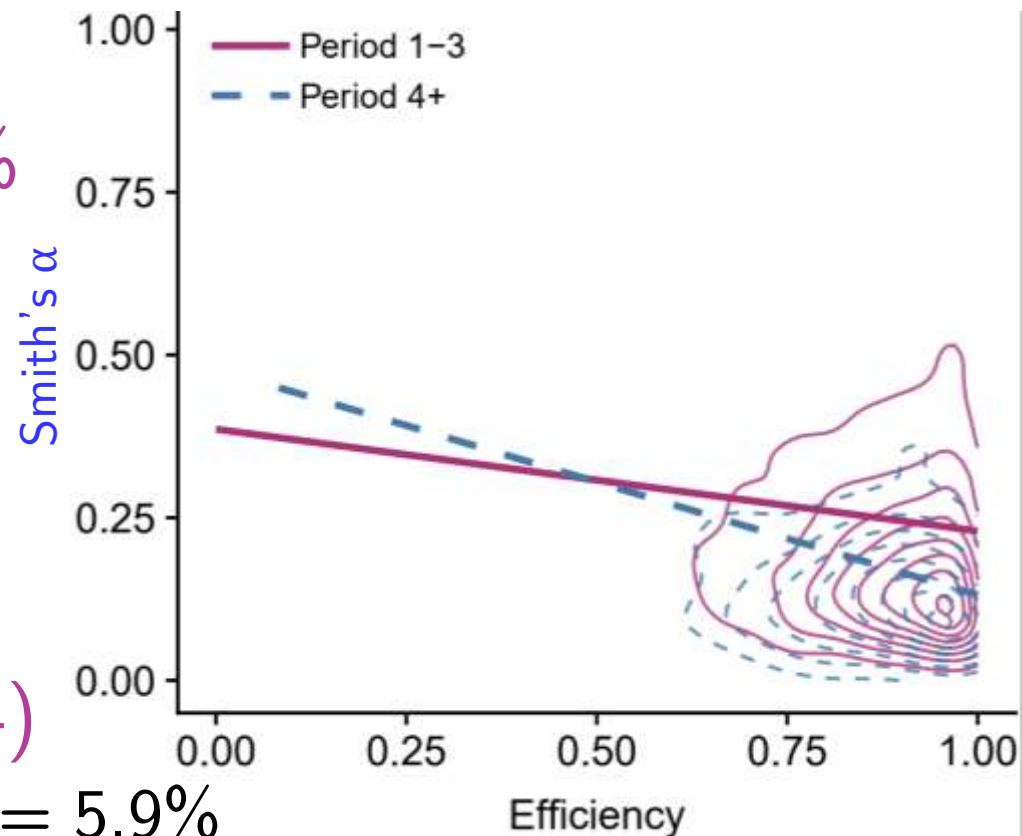
Market configuration Period 1 Period 2 Period 3 Period 4



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%



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)

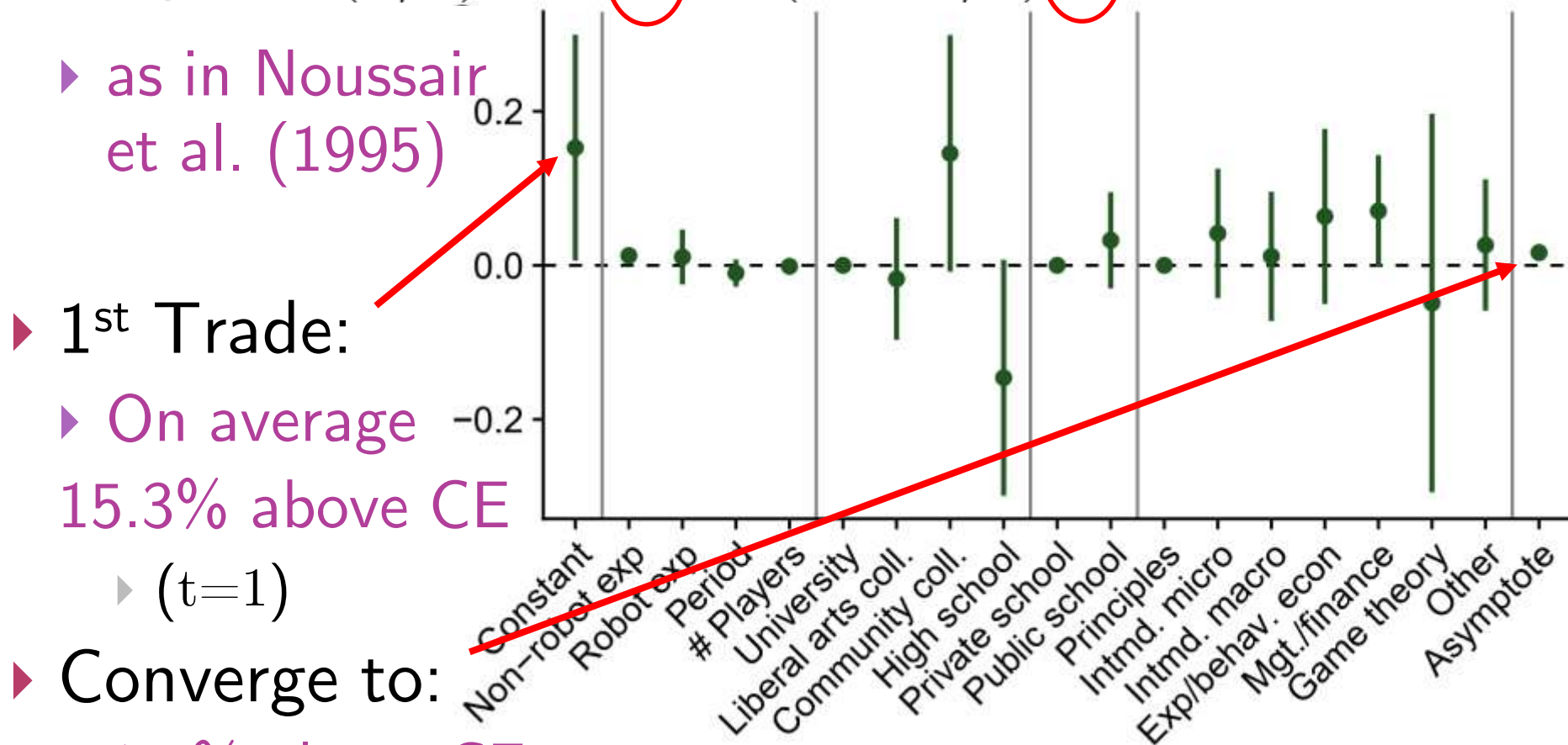
▶ 1st Trade:

▶ On average 15.3% above CE

▶ (t=1)

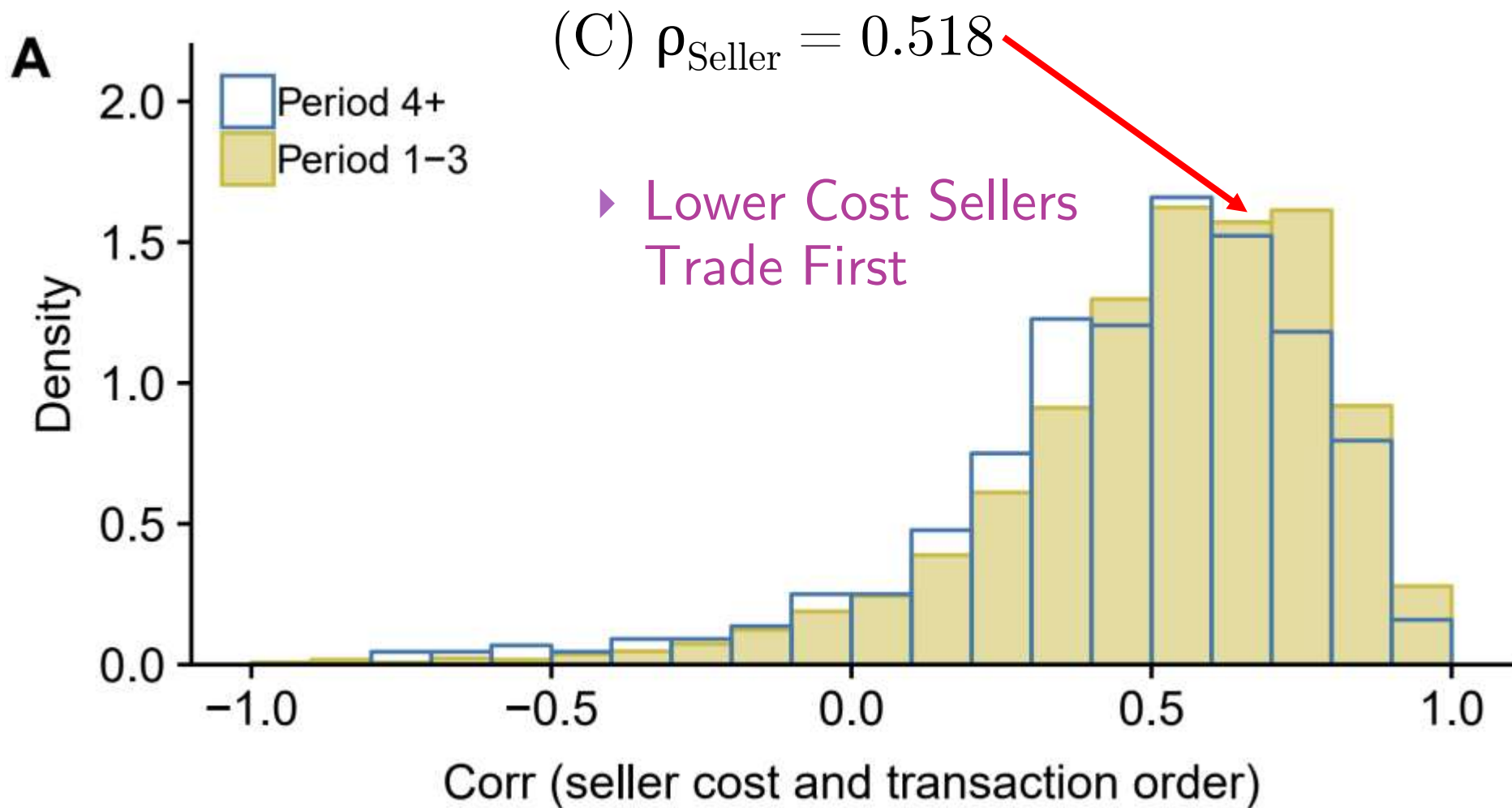
▶ Converge to:

▶ 1.7% above CE



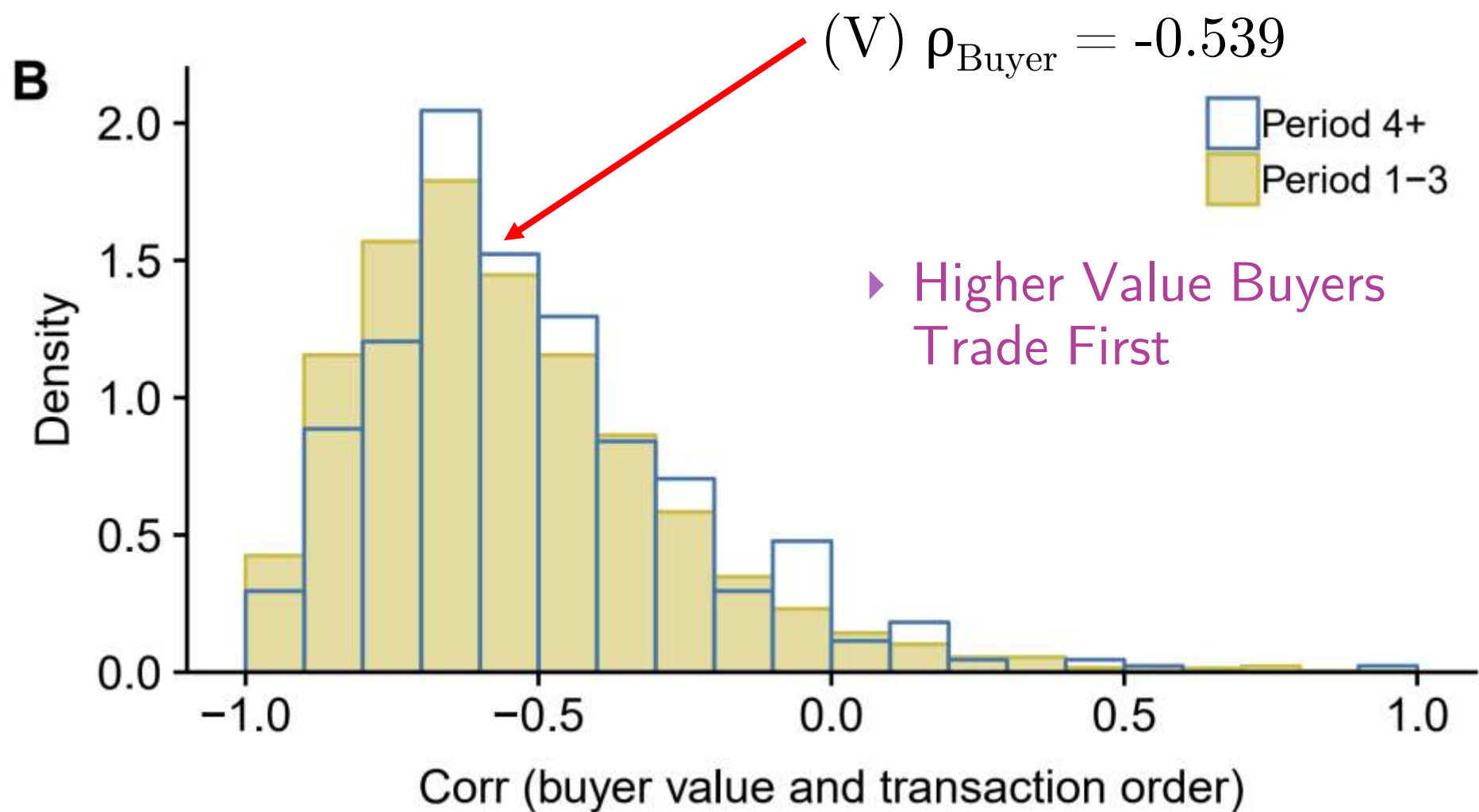
Double Auction: Seller Rank-Order Corr.

Correlation(Transaction Order, Seller Cost)



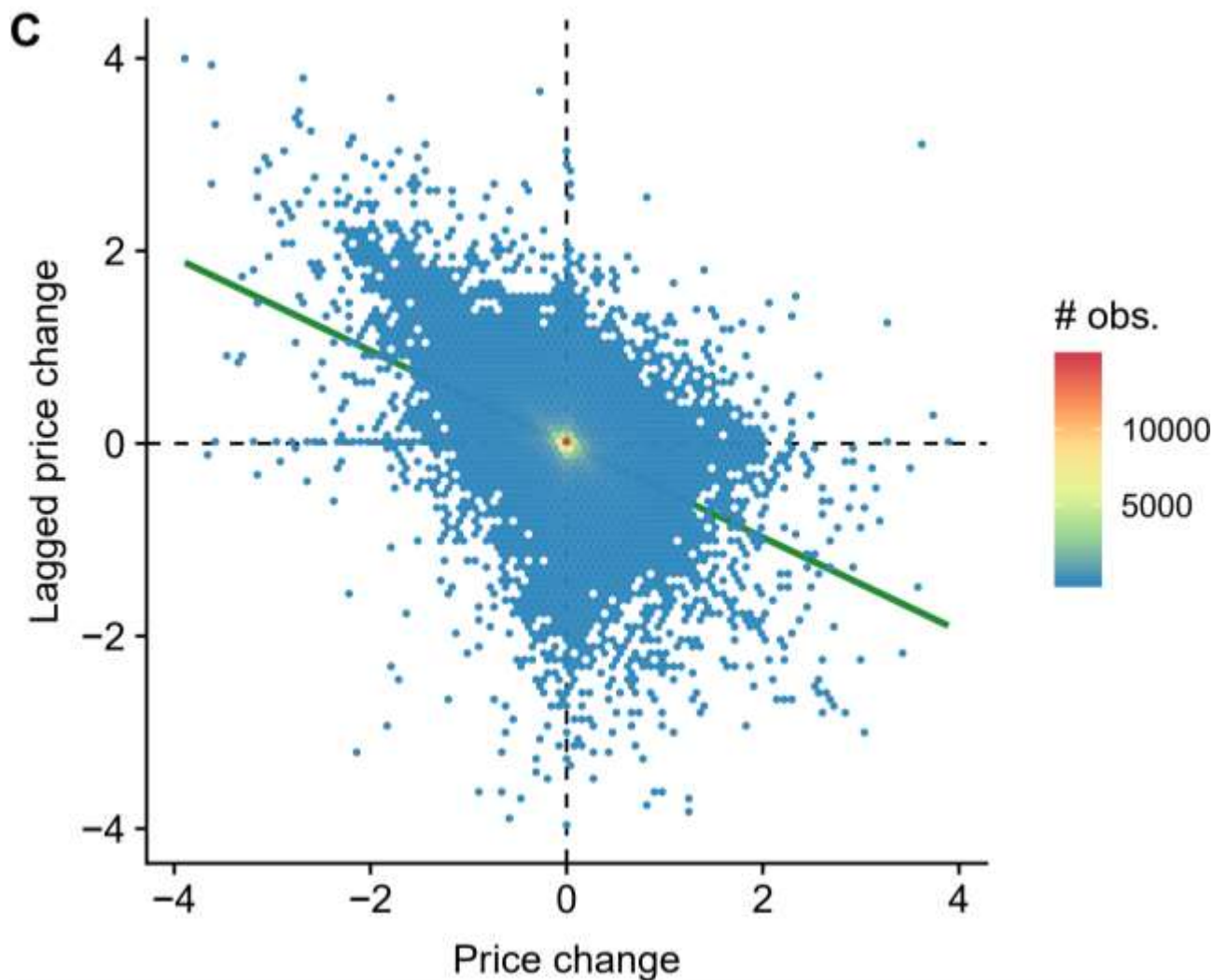
Double Auction: Buyer Rank-Order Corr.

Correlation(Transaction Order, Buyer Value)

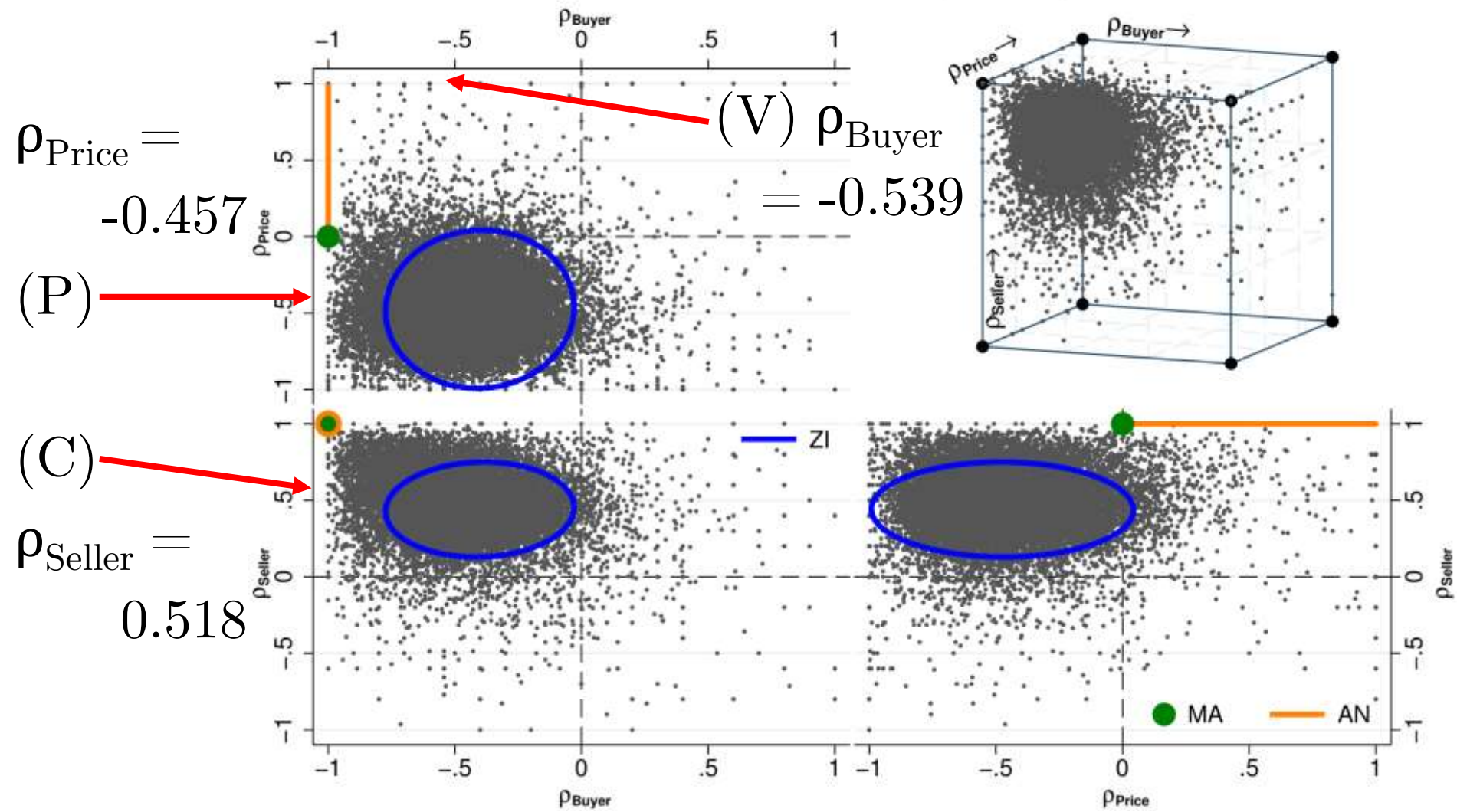


Double Auction:

Price Change Autocorrelation = -0.457



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



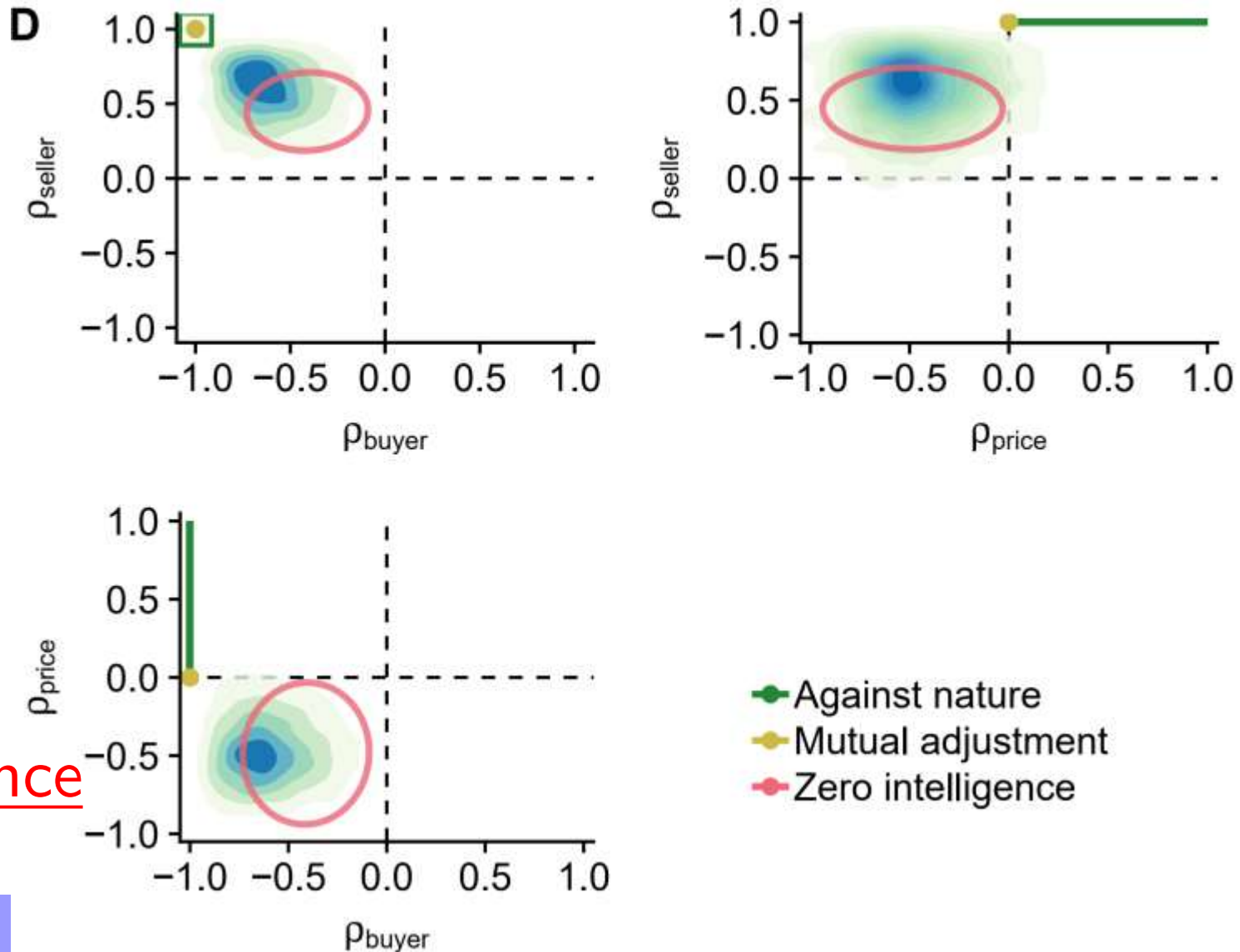
Double Auction:

Testing Theories of Price Formation

▶ **MA:**
Wilson
(1987)

▶ **AN:**
Friedman
(1991)

▶ **ZI:**
0-intelligence



Robustness:

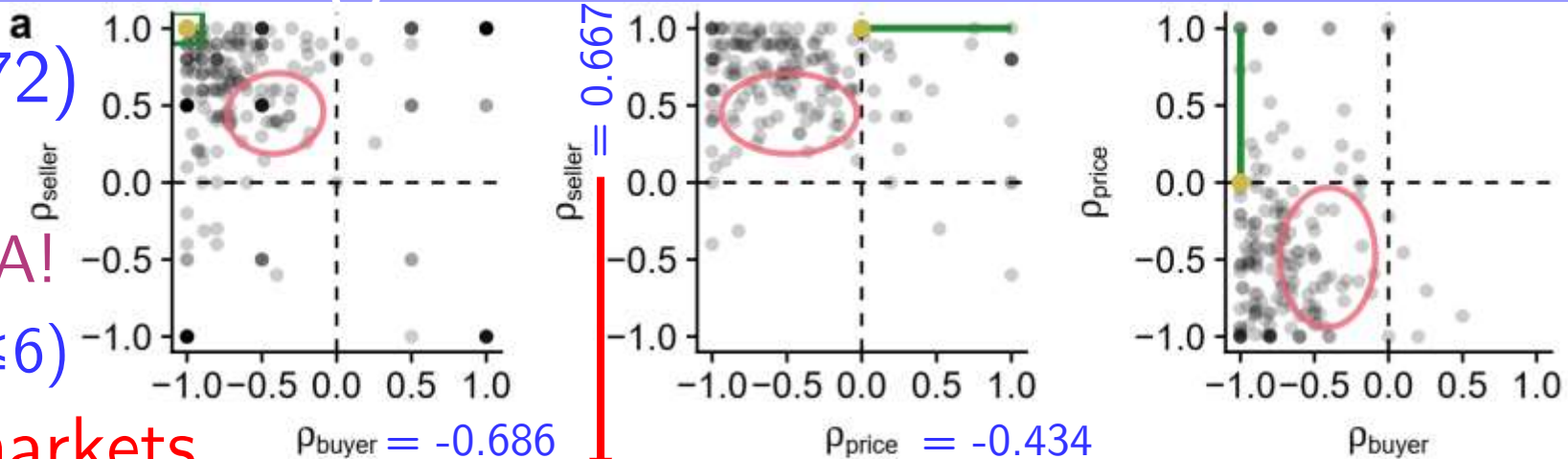
Small vs. Large Markets: ZI or Not!!!

(N = 172)

Favor
AN/MA!

(traders ≤ 6)

Small markets

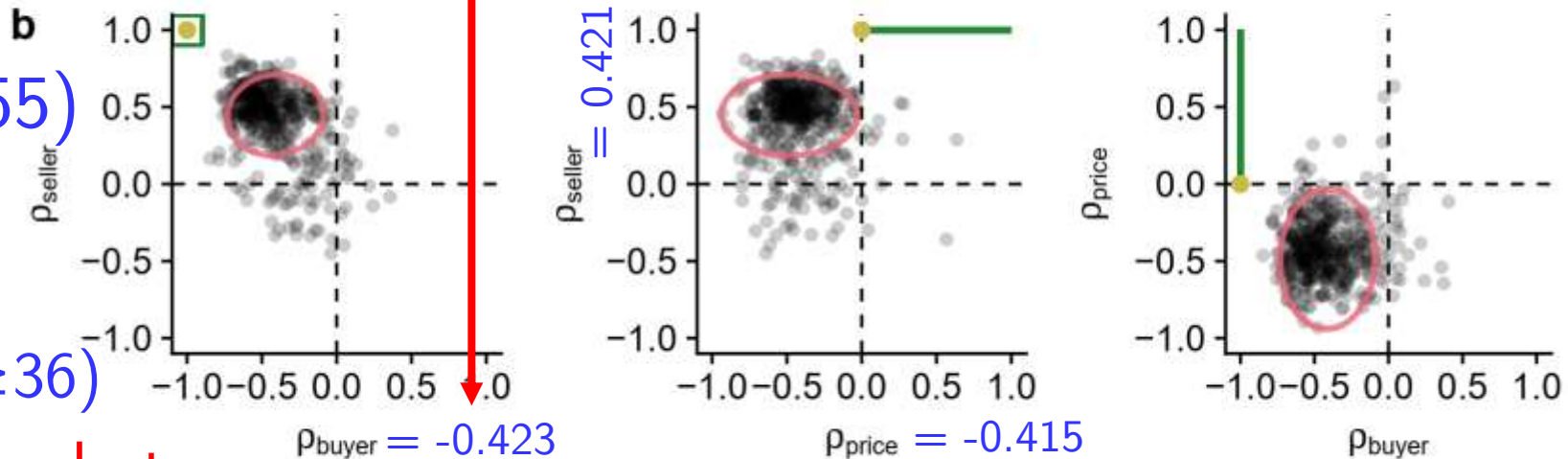


(N = 455)

Favor
ZI!

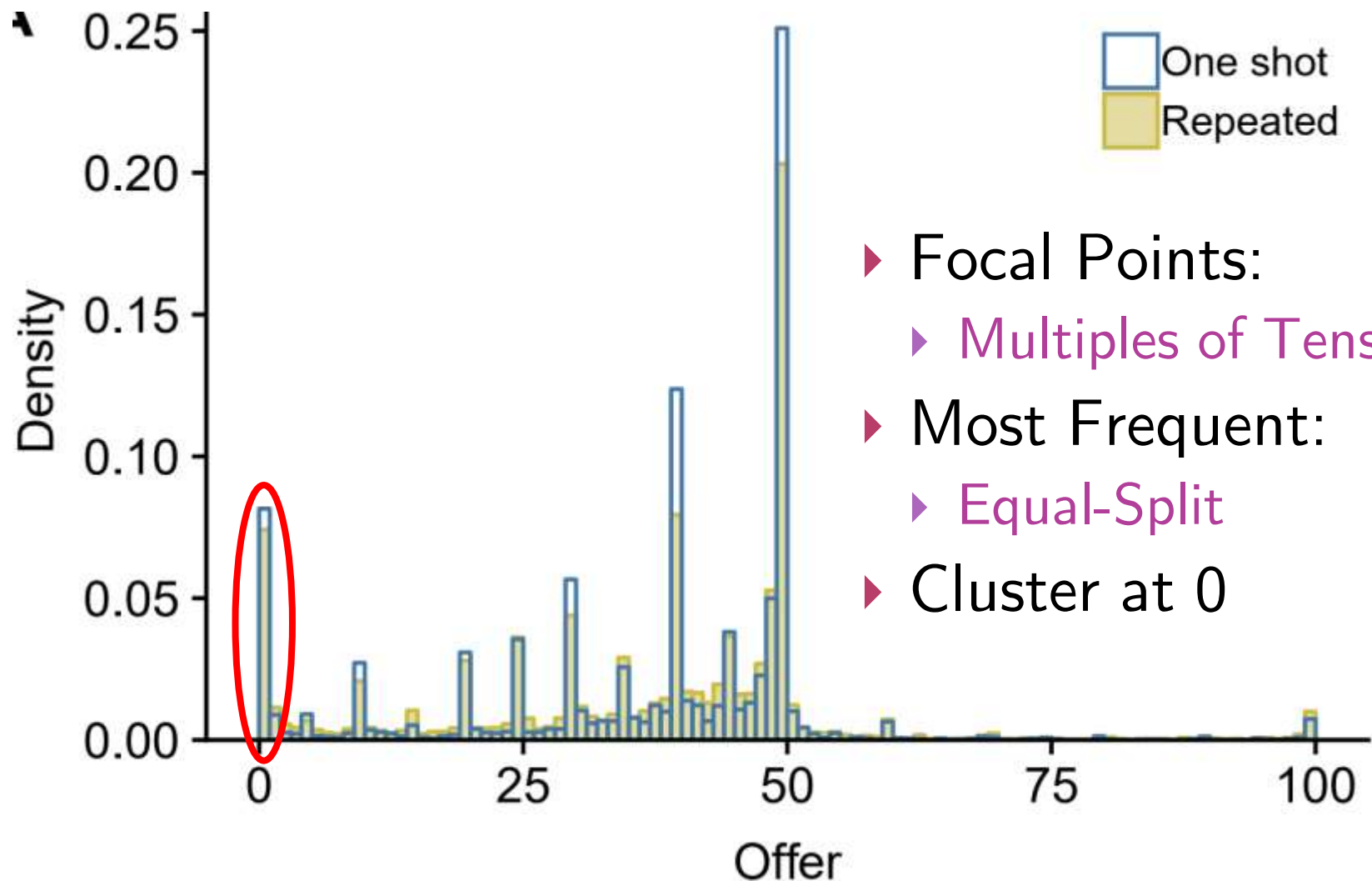
(traders ≥ 36)

Large markets



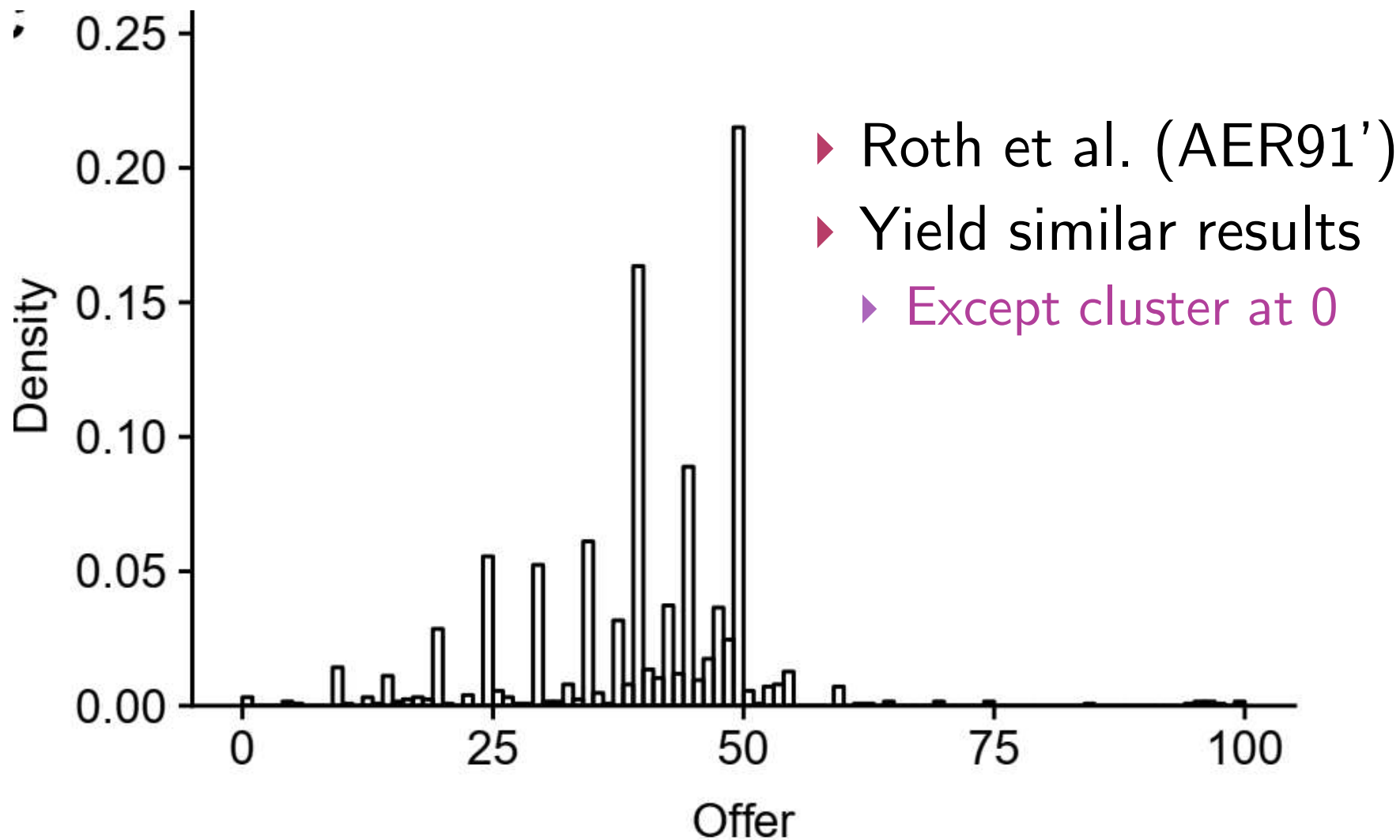
— Against nature — Mutual adjustment — Zero intelligence

Ultimatum: Proposal Offers



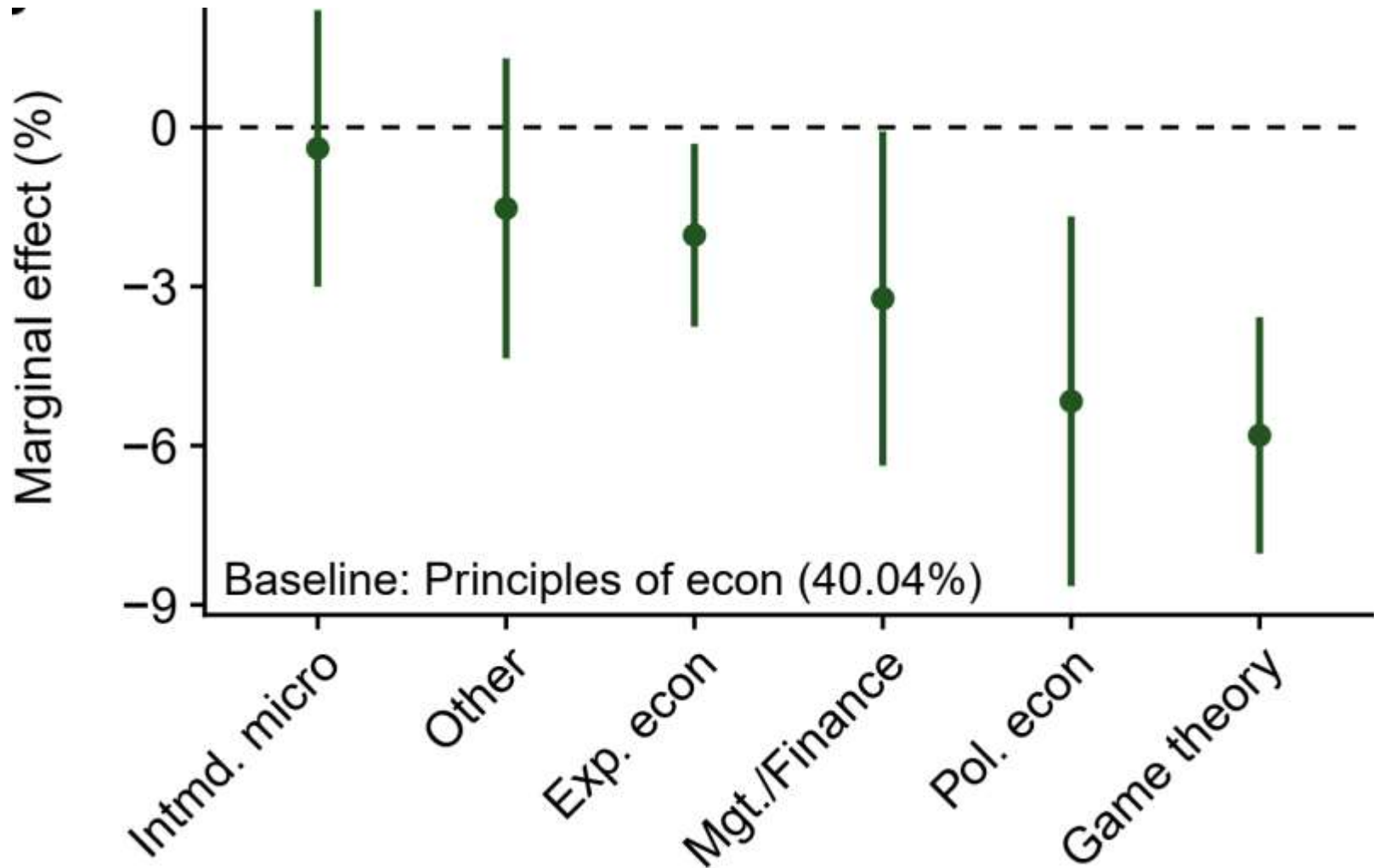
Ultimatum:

Proposal Offers of Roth et al. (AER91')



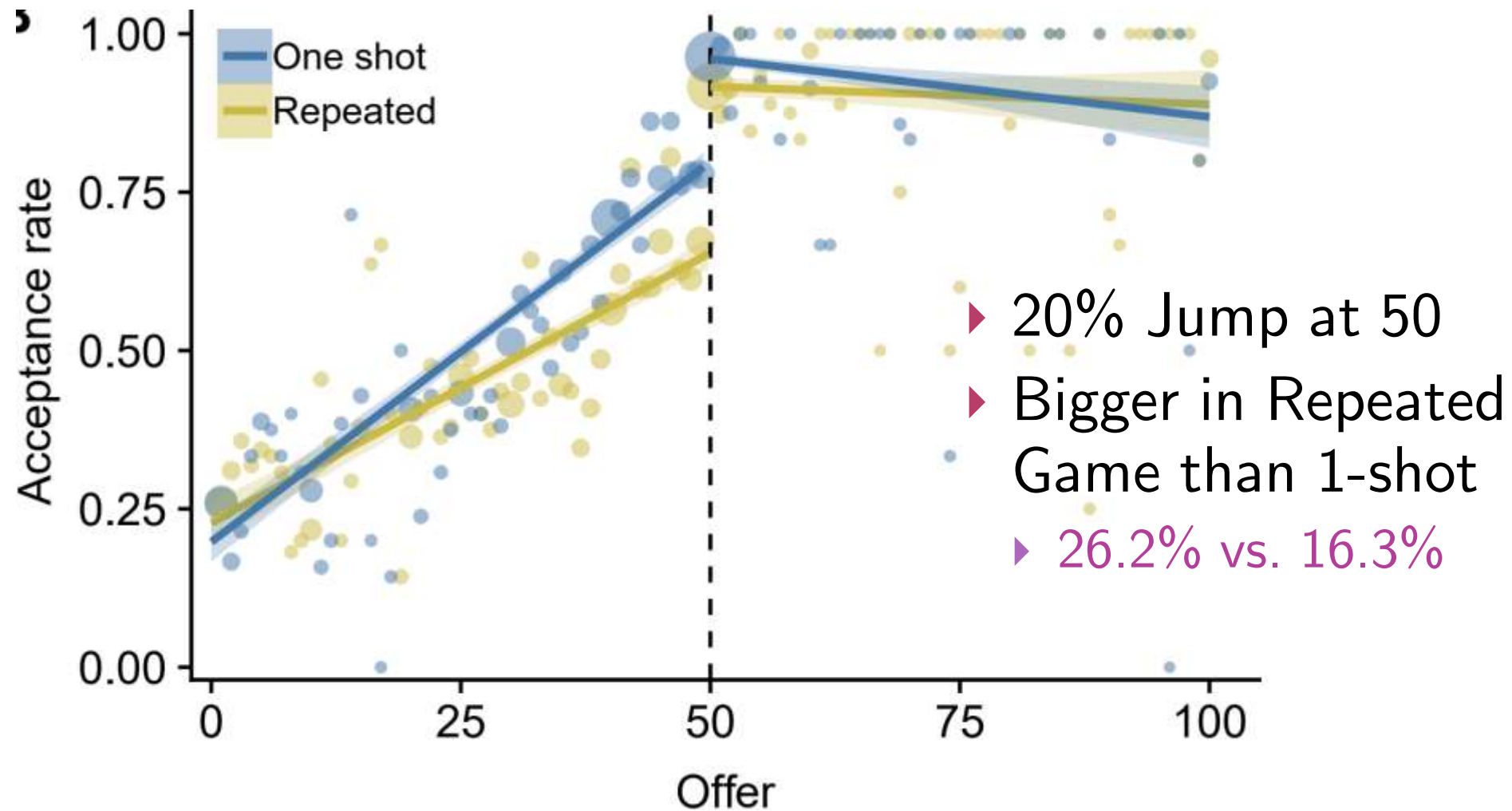
Ultimatum:

Proposal Offer - Class Effect



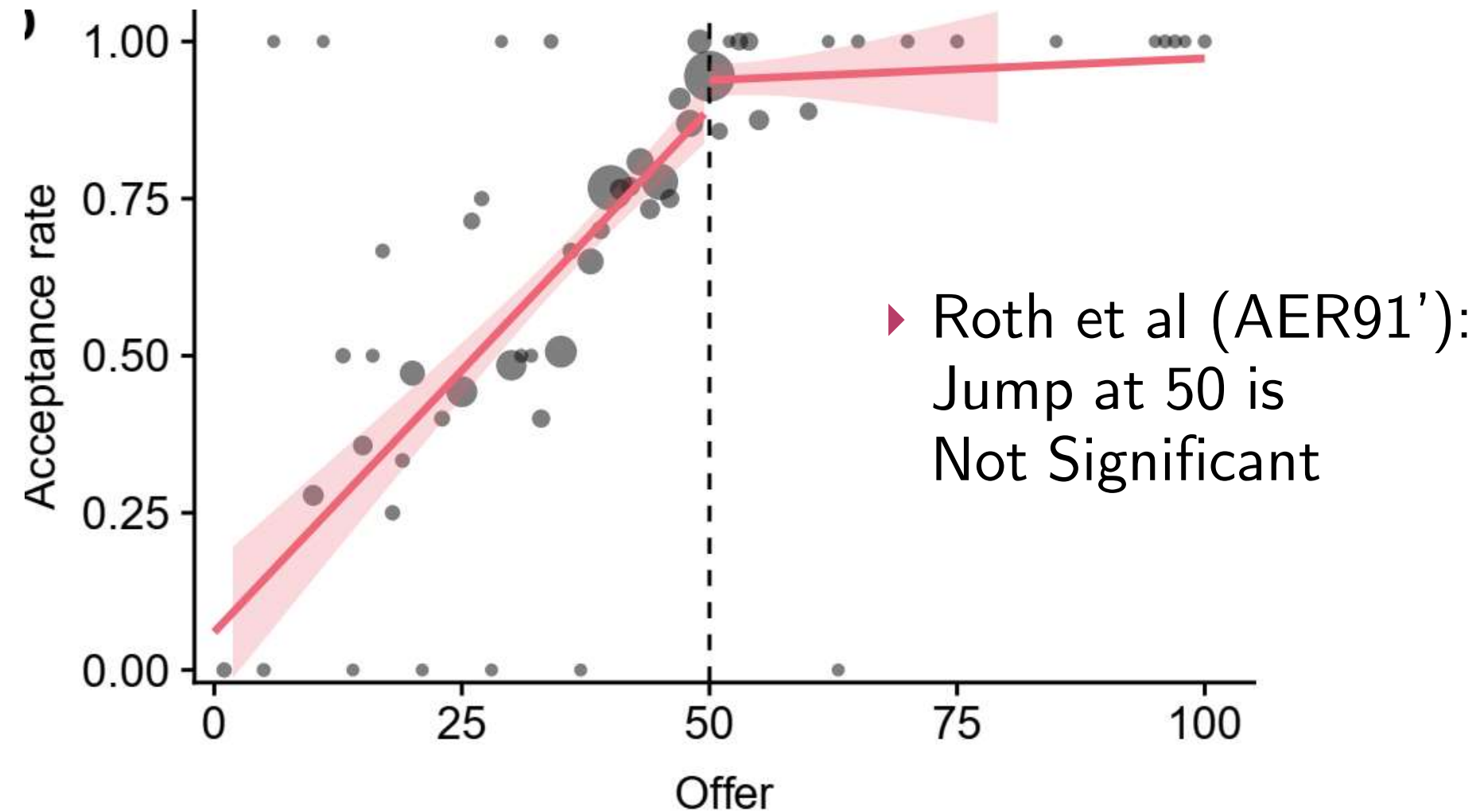
Ultimatum:

Acceptance Rate (Fit 2-part Regression)



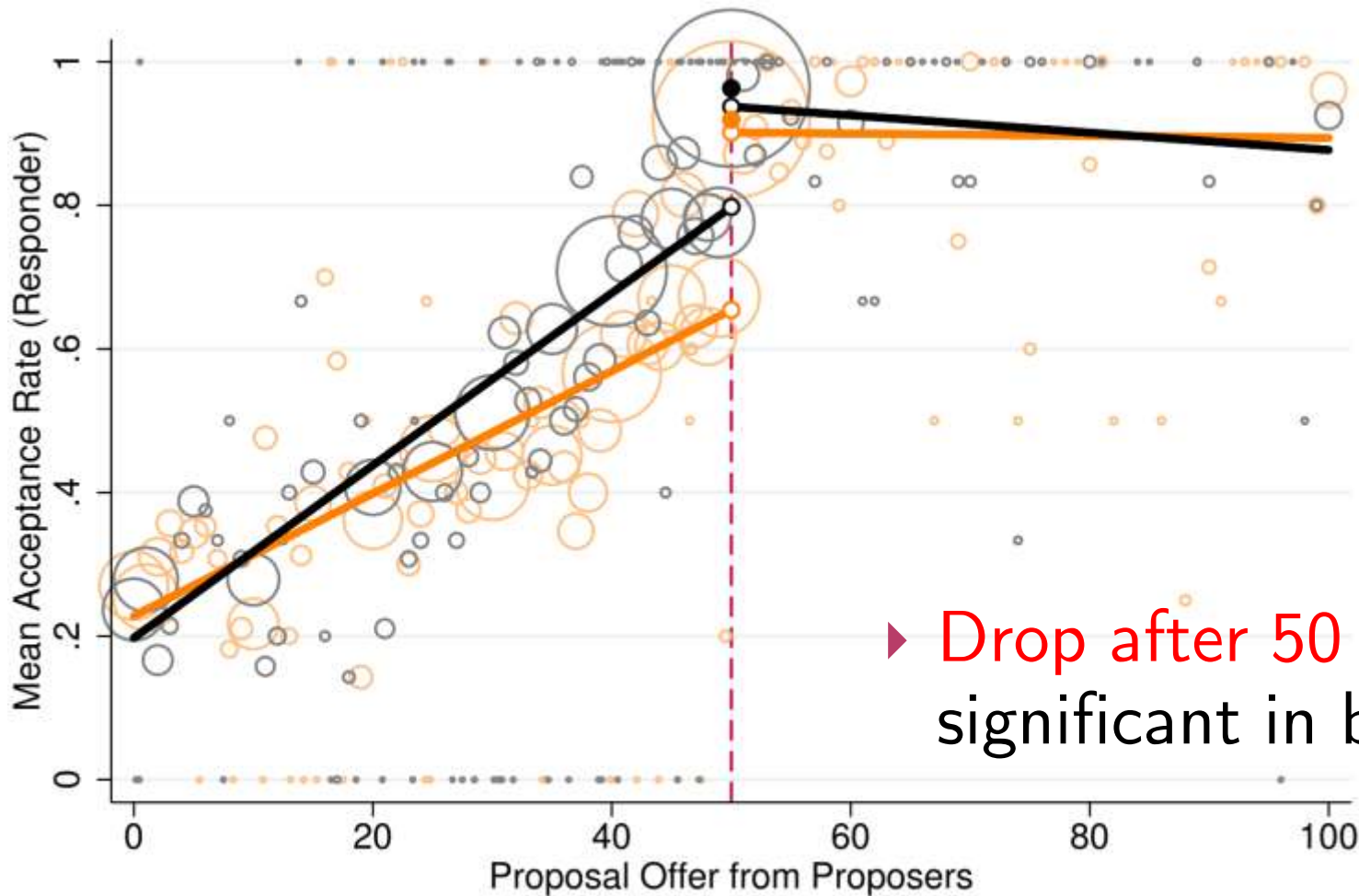
Ultimatum:

Acceptance Rate of Roth et al. (AER91')



Ultimatum:

Acceptance Rate (Fit 3-Part Regression)

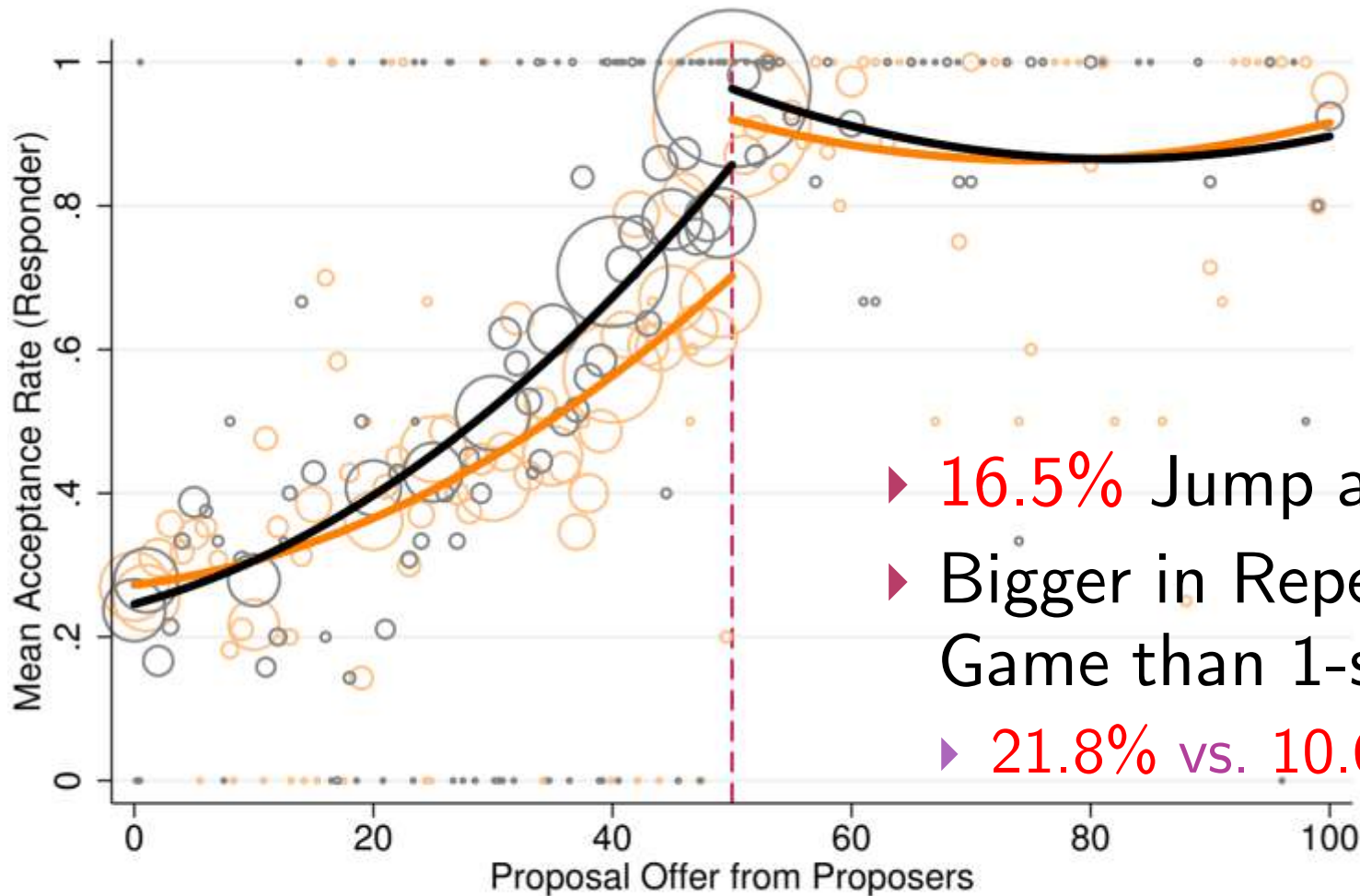


► Drop after 50 Not significant in both

○ One-Shot Game ○ Repeated Game

Ultimatum:

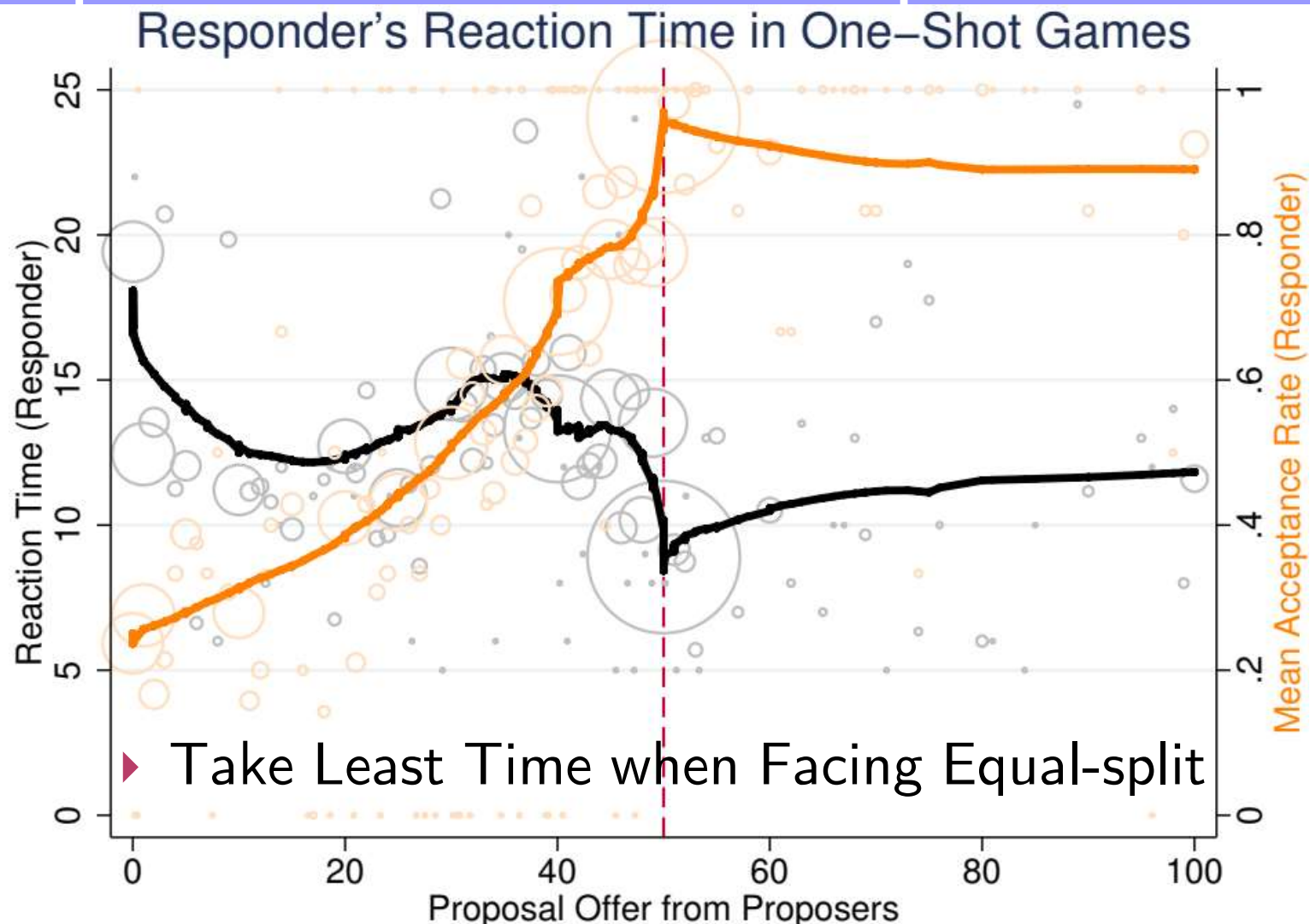
Acceptance Rate (Fit Quadratic)



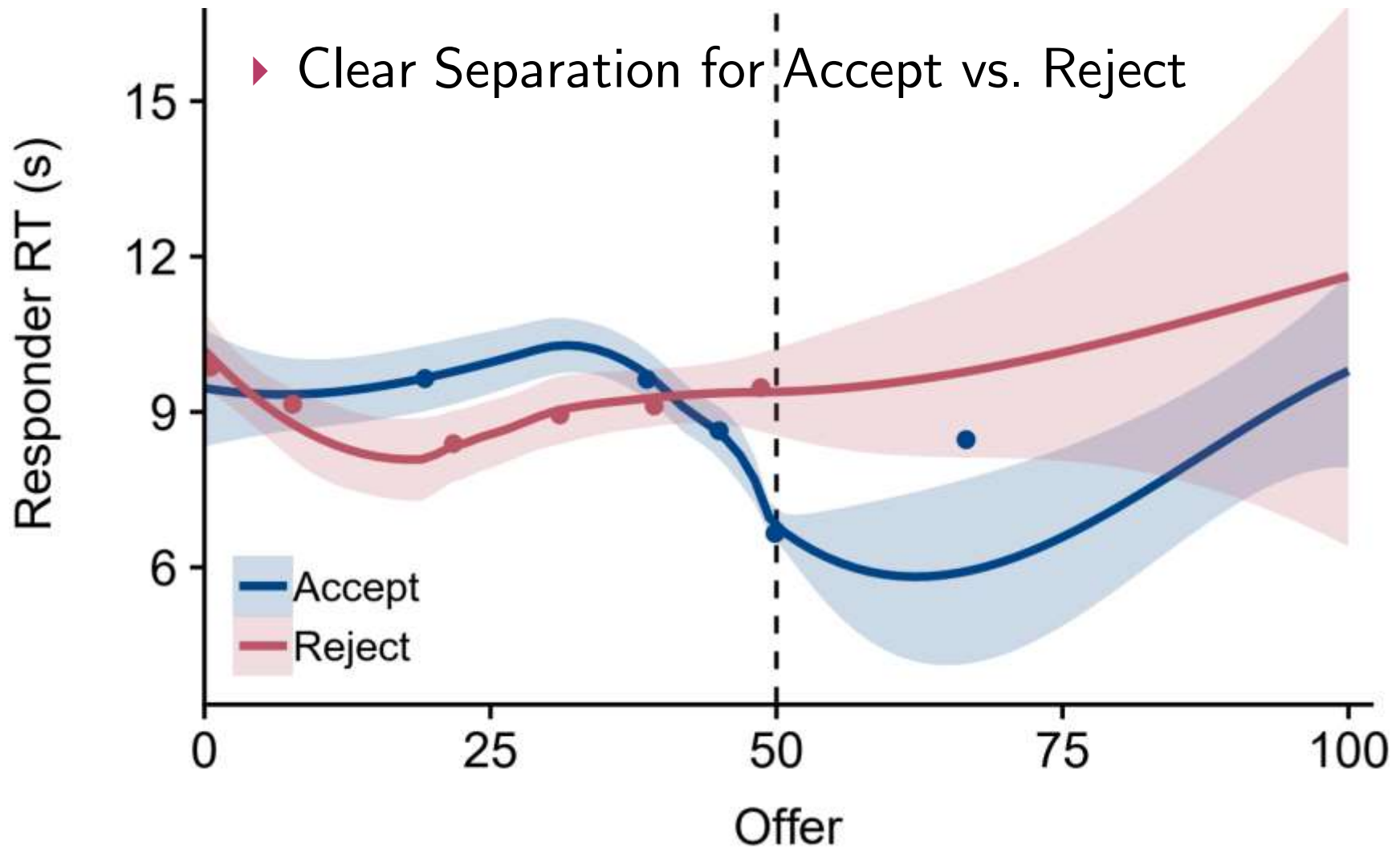
- ▶ 16.5% Jump at 50
- ▶ Bigger in Repeated Game than 1-shot
- ▶ 21.8% vs. 10.6%

Ultimatum:

Acceptance Rate and Response Time



Ultimatum: Response Time

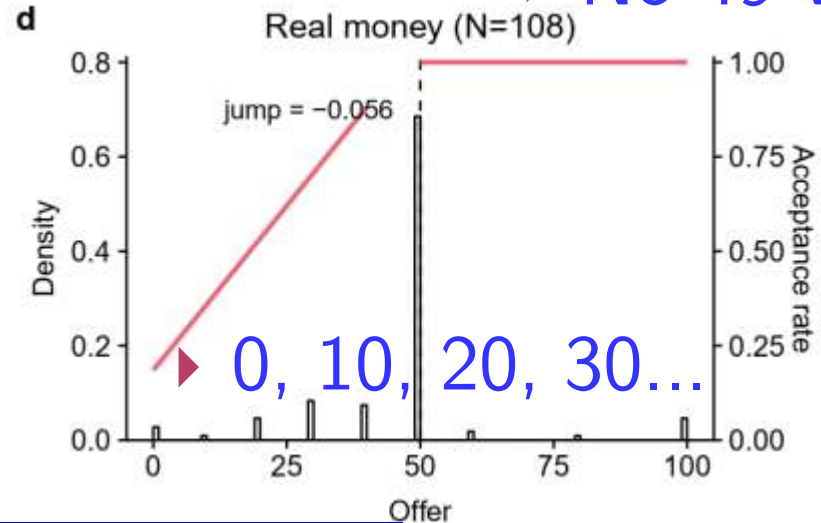
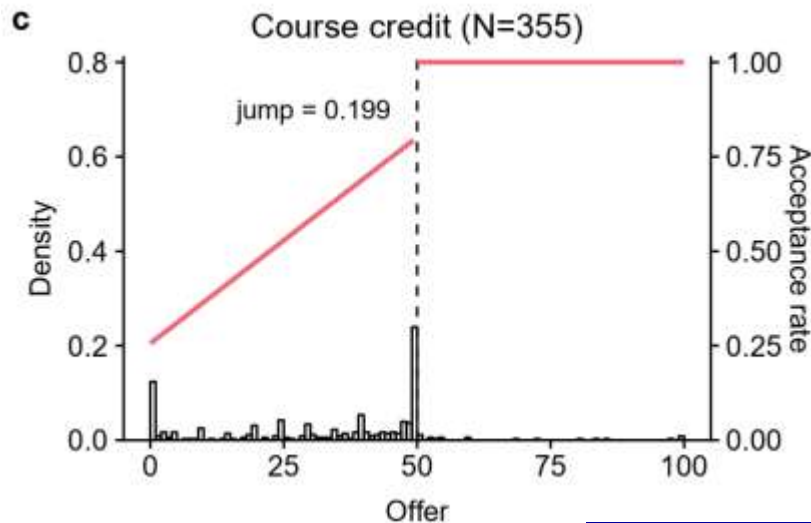
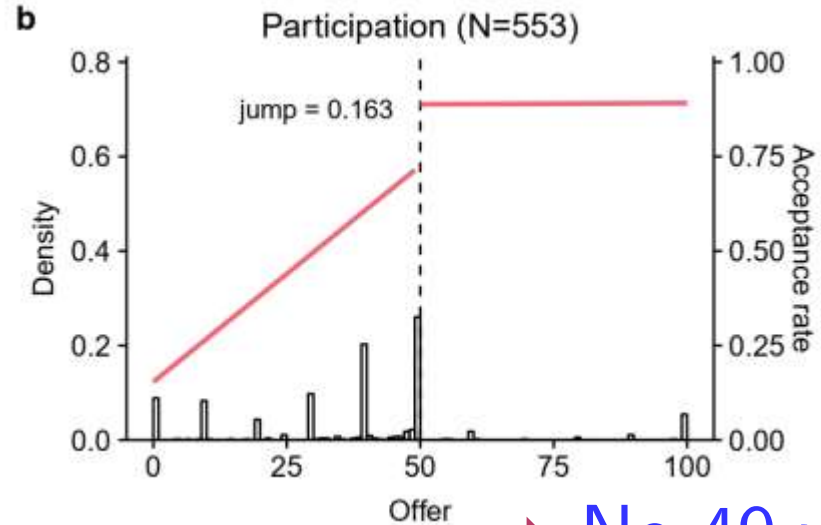
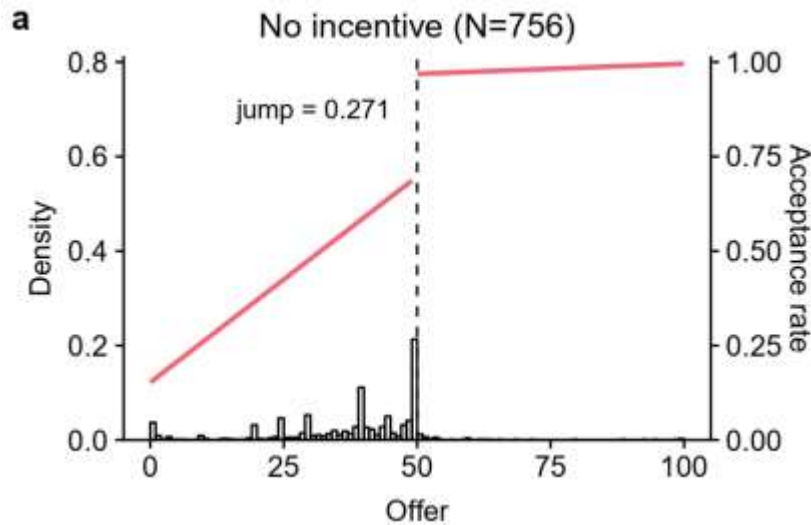


Robustness Check:

Do Incentives Matter?

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

Incentives Matter Less: 58/490 Syllabi



► No 49 vs. 50!

Ultimatum:

Heterogeneity - Proposal Offers

▶ Heterogeneity from variation between regions =

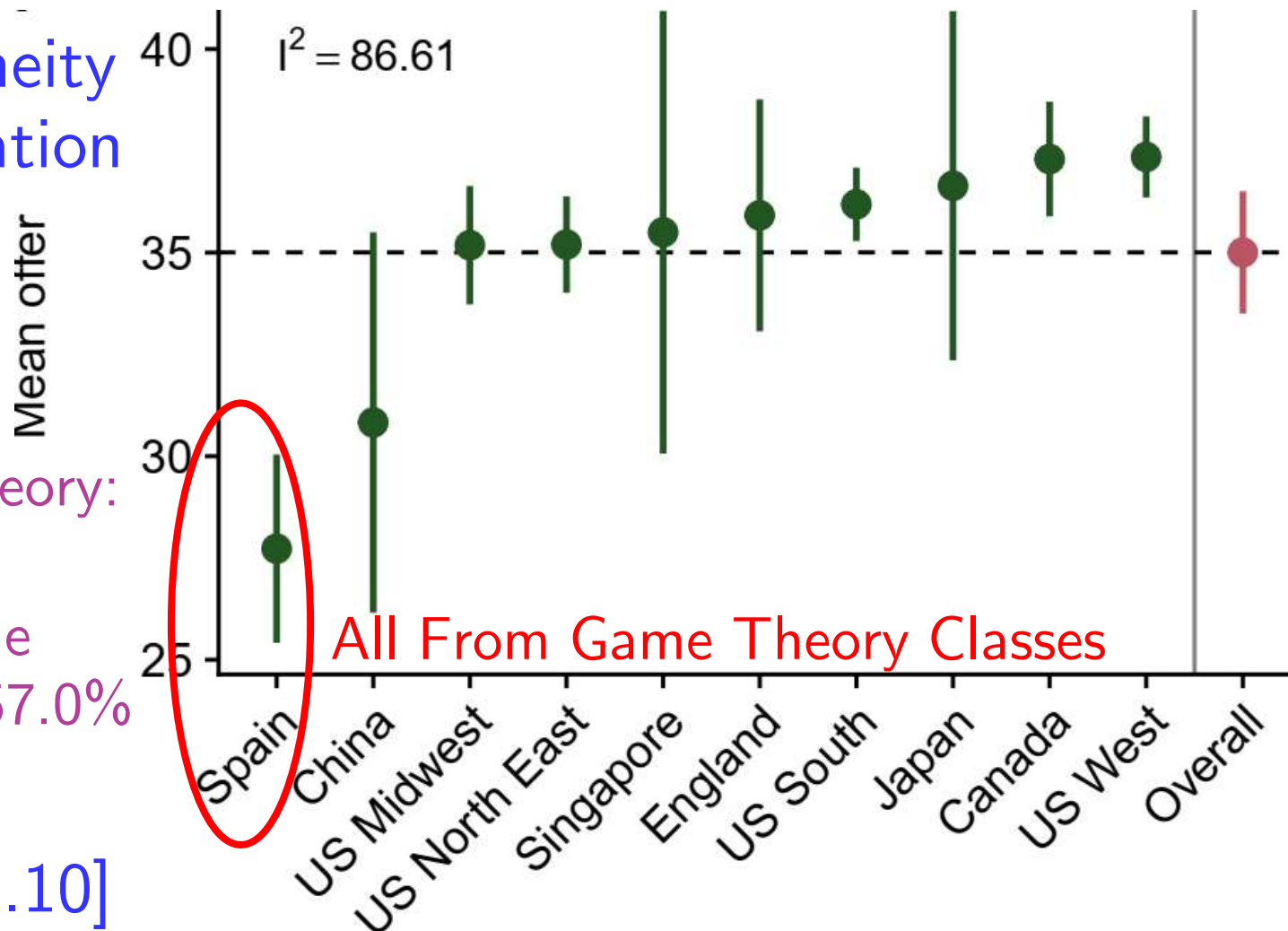
▶ 86.61%

▶ Game Theory: 74.0%

▶ Non-Game Theory: 57.0%

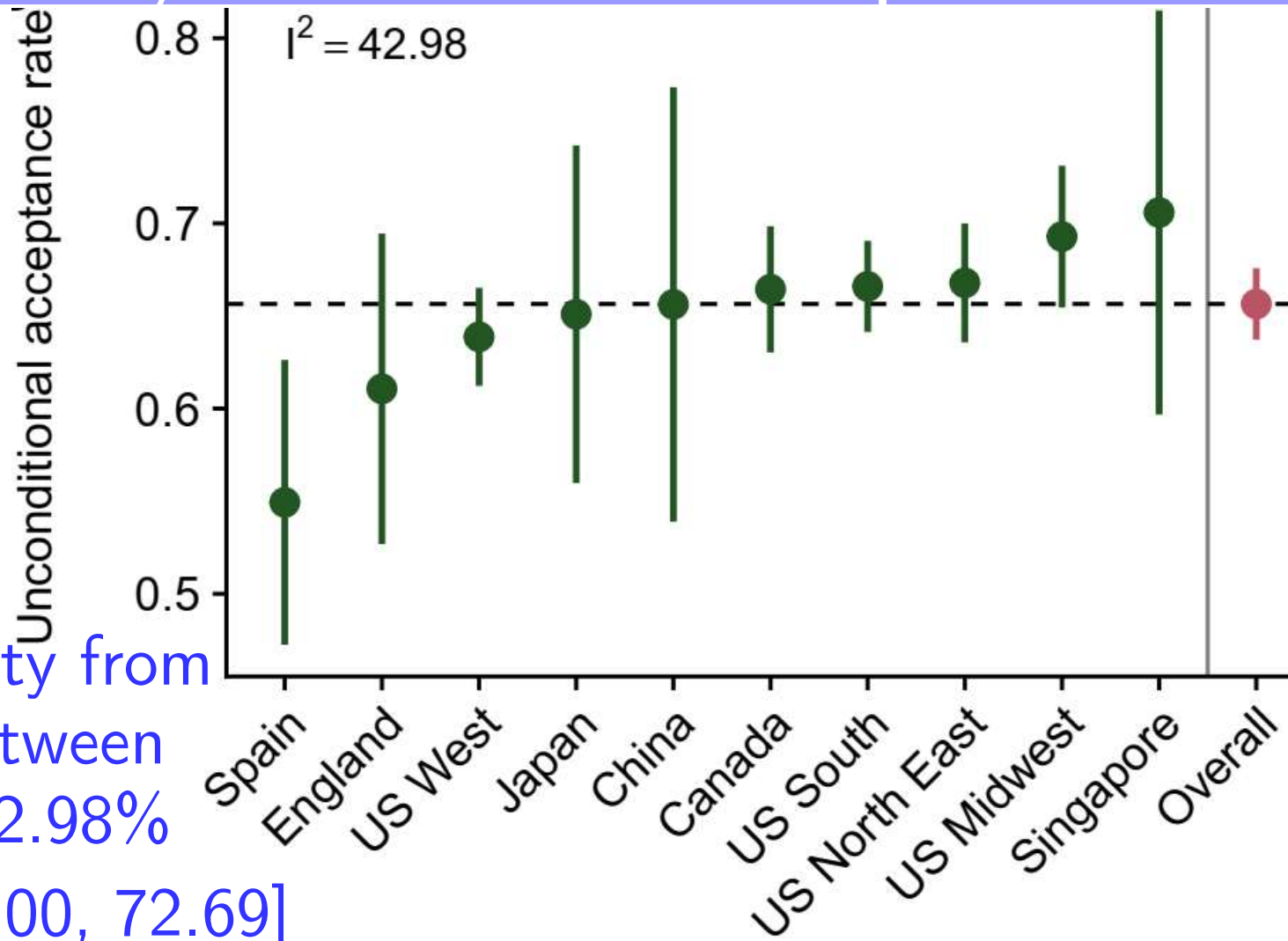
▶ 95% CI:

▶ [77.31, 92.10]



Ultimatum:

Heterogeneity – Uncond. Acceptance

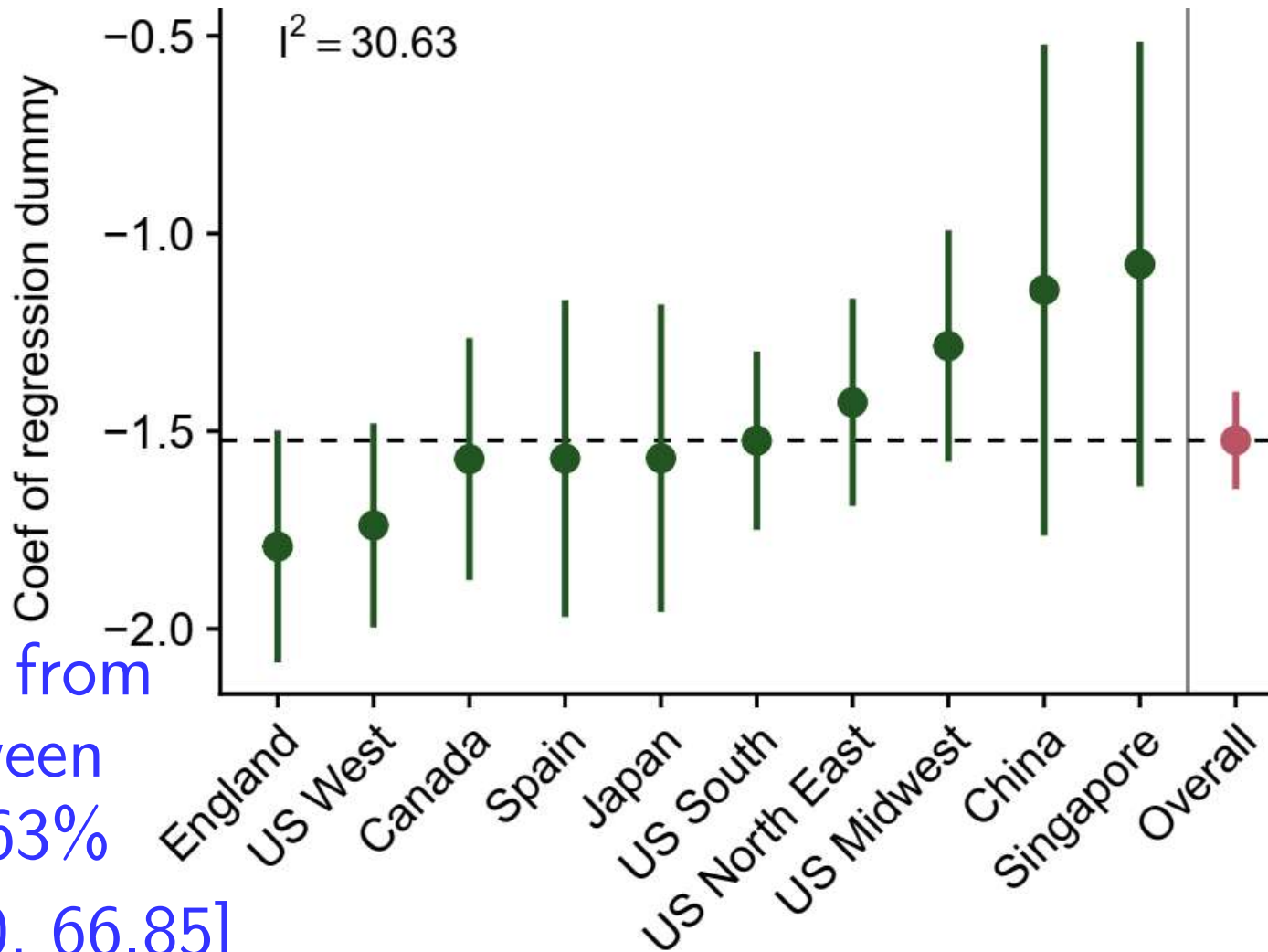


▶ Heterogeneity from variation between regions = 42.98%

▶ 95% CI: [0.00, 72.69]

Ultimatum:

Heterogeneity – Cond. Acceptance



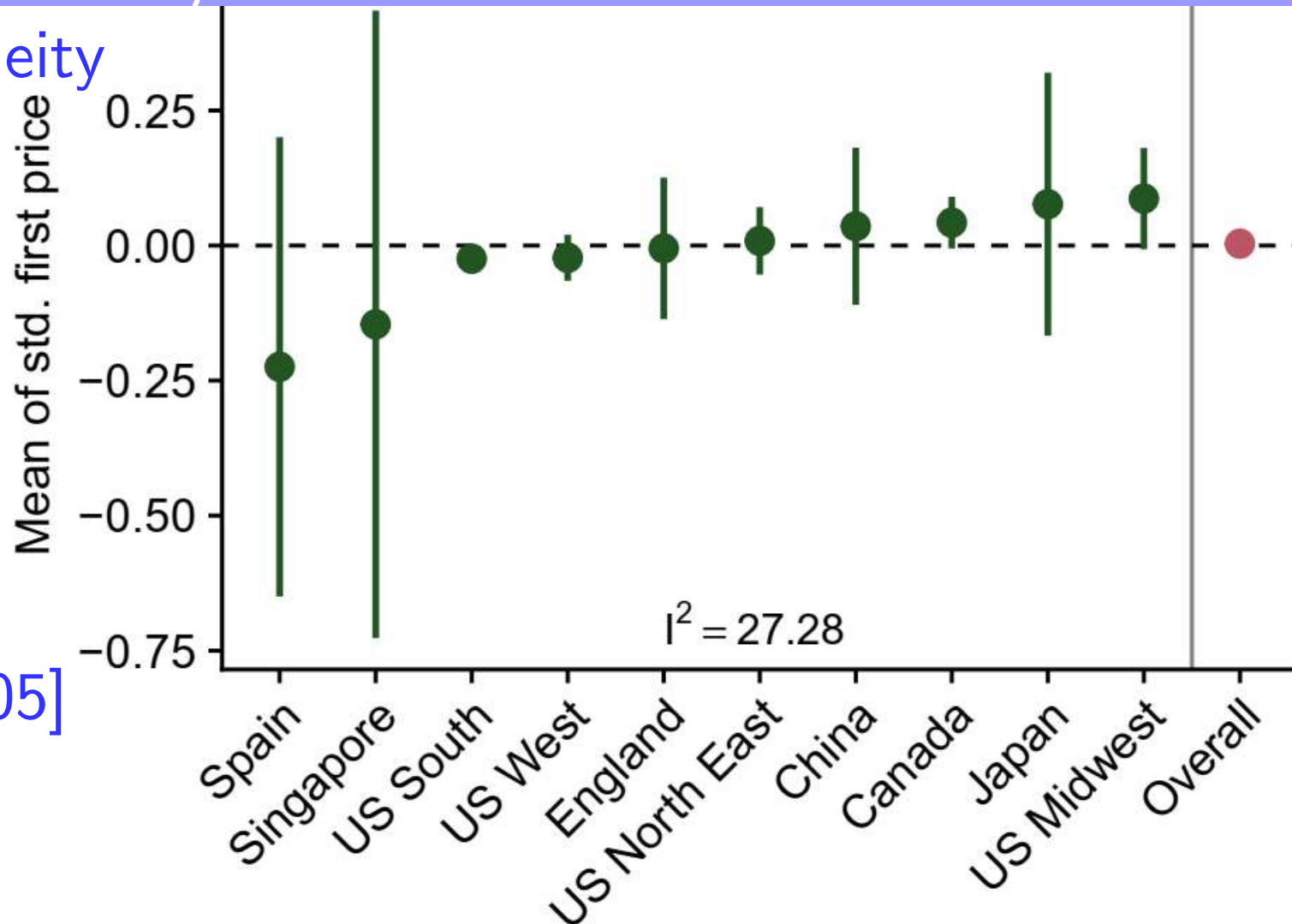
- ▶ Heterogeneity from variation between regions = 30.63%
- ▶ 95% CI: [0.00, 66.85]

Double Auction:

Heterogeneity – First Price

▶ Heterogeneity from variation between regions = 27.28%

▶ 95% CI: [0.00, 65.05]

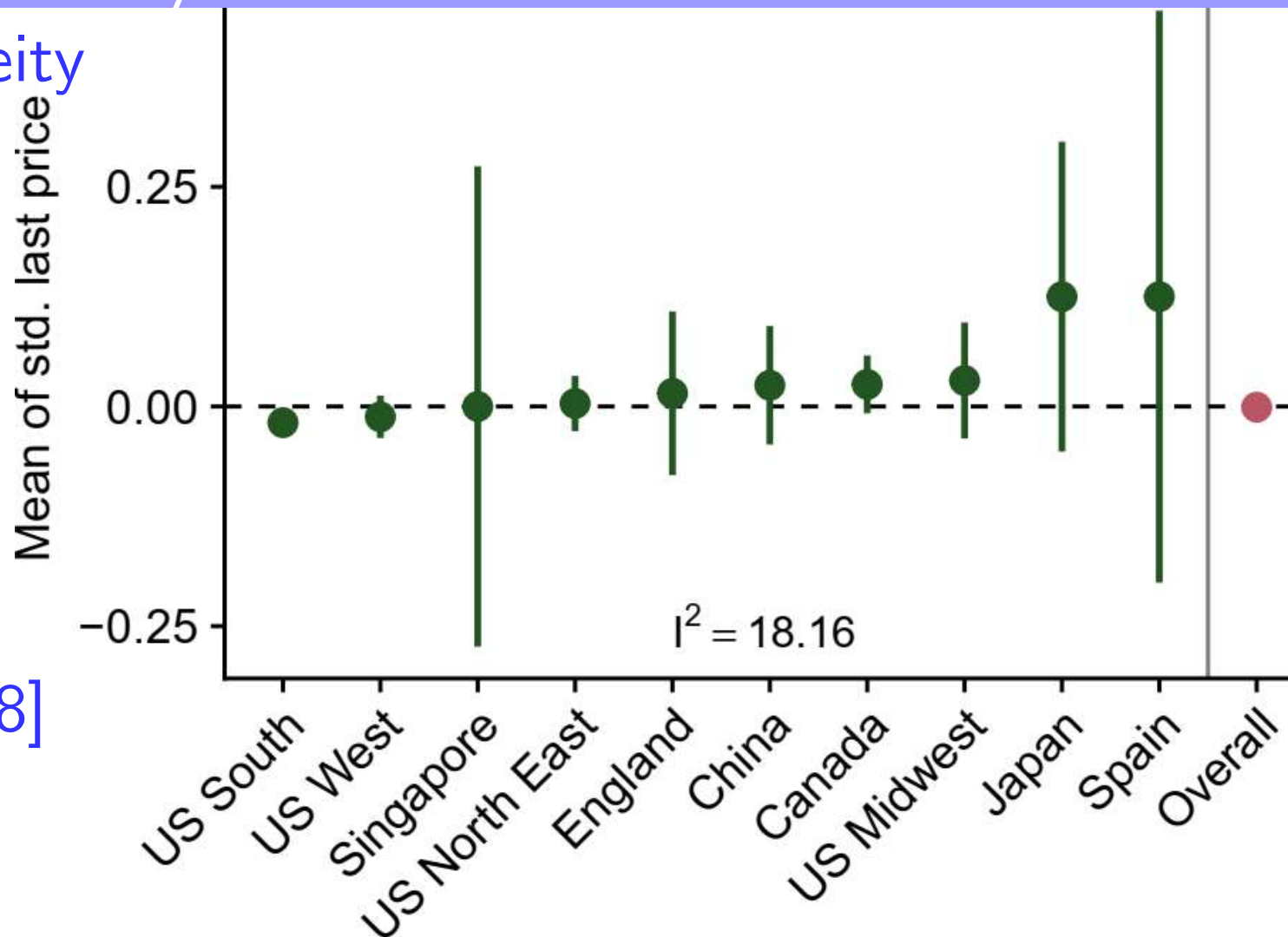


Double Auction:

Heterogeneity – Last Price

▶ Heterogeneity from variation between regions = 18.16%

▶ 95% CI: [0.00, 59.08]



Conclusion

- ▶ MobLab: Standard Design, Many Places
 - ▶ But Obscure Incentives
 - ▶ Data from 2000 Classroom Experiments
- ▶ Ultimatum Game:
 - ▶ Extremely high frequency at equal-split
 - ▶ Offer at 10s (Natural Focal Points)
- ▶ At 50-50:
 - ▶ Acceptance jumps 20% (to 94%)
 - ▶ Response time on average 8.9 seconds (shortest)

Conclusion

- ▶ Double Auction Markets:
 - ▶ Converge to CE prediction for MED, Smith's alpha and Efficiency
 - ▶ Negative price change autocorrelation (-0.457)
 - ▶ Transactions happen in order of Values/Costs
- ▶ Heterogeneity: Use meta-analysis techniques
- ▶ Higher between-region variance
 - ▶ In proposal offer than acceptance
 - ▶ In ultimatum than double auction

Robustness Checks That Matter!!

- ▶ UG: Do Incentives Matter?
 - ▶ Found 58 Syllabi online (out of 490 sessions)
 - ▶ Separate Real Money from
 - ▶ No Incentives / Participation / Course Points
 - ▶ More 50-50, High Acceptance, Can't see 49 vs. 50
- ▶ DA: Does # of Traders Matter?
 - ▶ Similar ΔP Auto-Corr.
 - ▶ Transaction Order closer to ZI in Large markets
 - ▶ Transaction Order closer to MA/AN in small ones

Thanks for Your Attention!

Robustness Checks That Don't Matter

- ▶ DA: Experience (Little Learning Across Periods)
 - ▶ ΔP Auto-Corr., Transaction Order, # of Trades
- ▶ DA: Loss Trades (No Effect)
 - ▶ ΔP Auto-Corr., B/S Rank-Order Corr.
- ▶ DA: Accepted Bids/Asks (No Effect)
 - ▶ ΔP Auto-Corr., B/S Rank-Order Corr.
- ▶ UG: Regional Difference?
 - ▶ Little Difference Across 10 Regions/Countries in Proposal Offers, Acceptance Rates, etc.

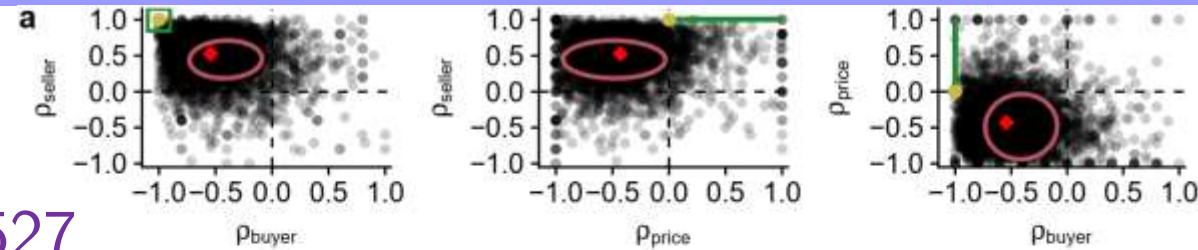
Robustness: Some Learning?

Learning Across Periods? Somewhat?!

Period 1 (N = 5,498)

▶ $\rho_{\text{Buyer}} = -0.543$

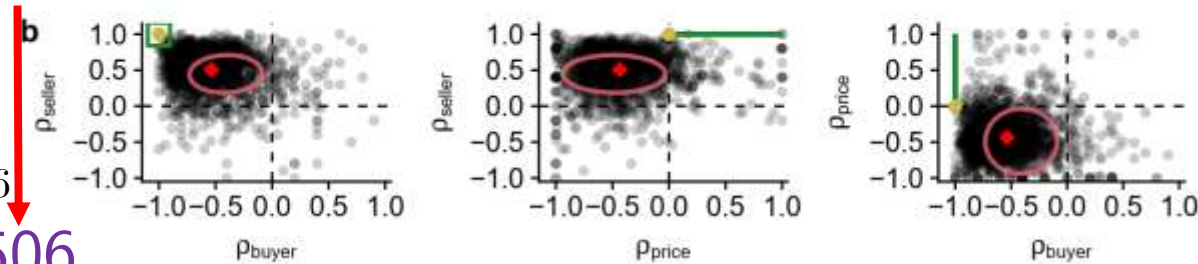
▶ $\rho_{\text{Seller}} = 0.527$



Period 2 (N = 1,868)

▶ $\rho_{\text{Buyer}} = -0.536$ $p = 0.006$

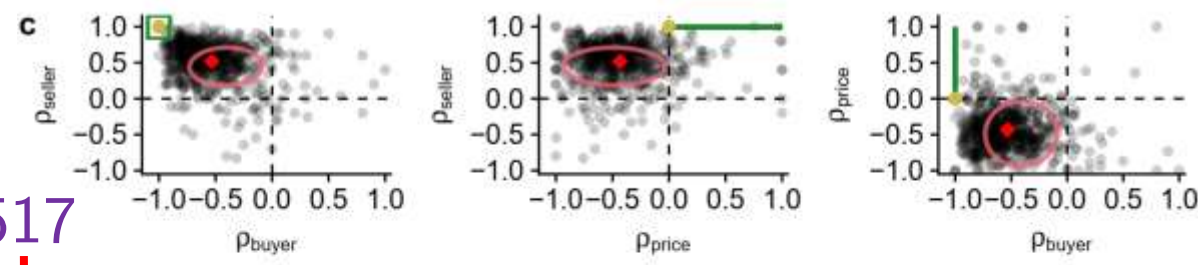
▶ $\rho_{\text{Seller}} = 0.506$



Period 3 (N = 686)

▶ $\rho_{\text{Buyer}} = -0.534$

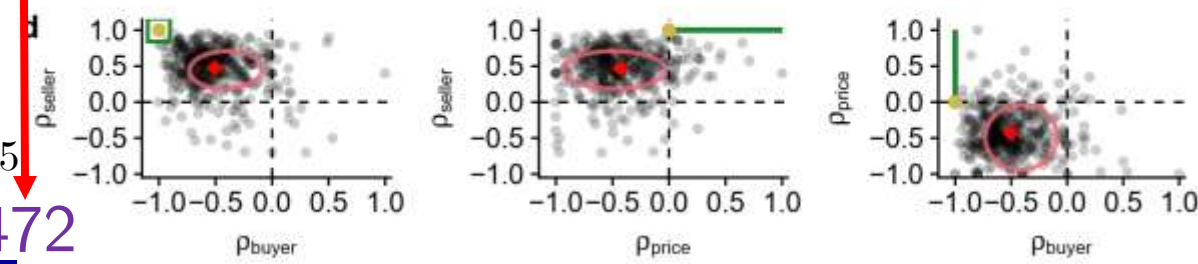
▶ $\rho_{\text{Seller}} = 0.517$



Period 4+ (N = 440)

▶ $\rho_{\text{Buyer}} = -0.506$ $p = 0.015$

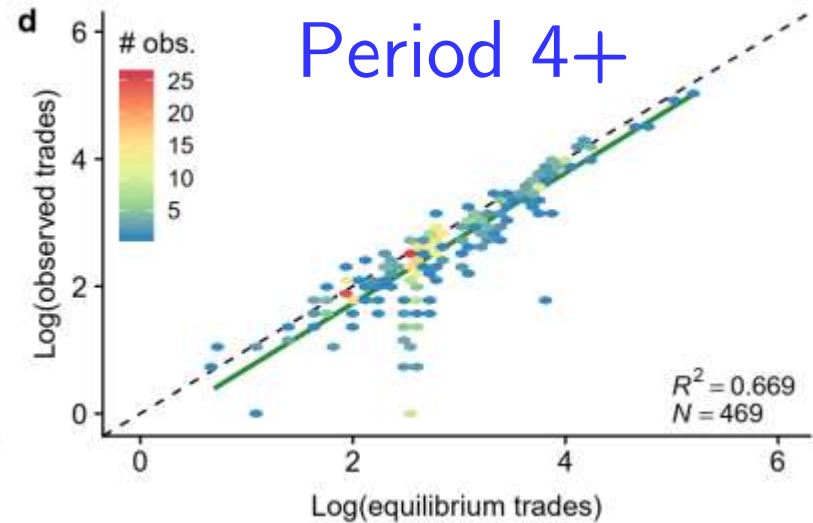
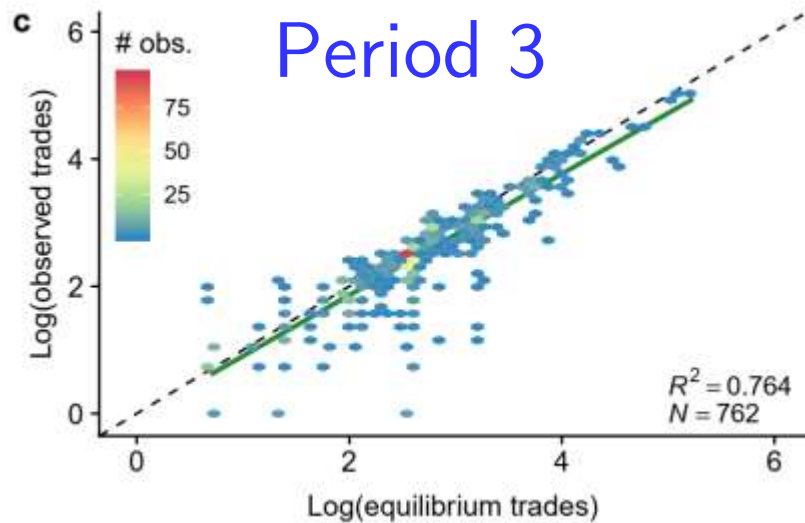
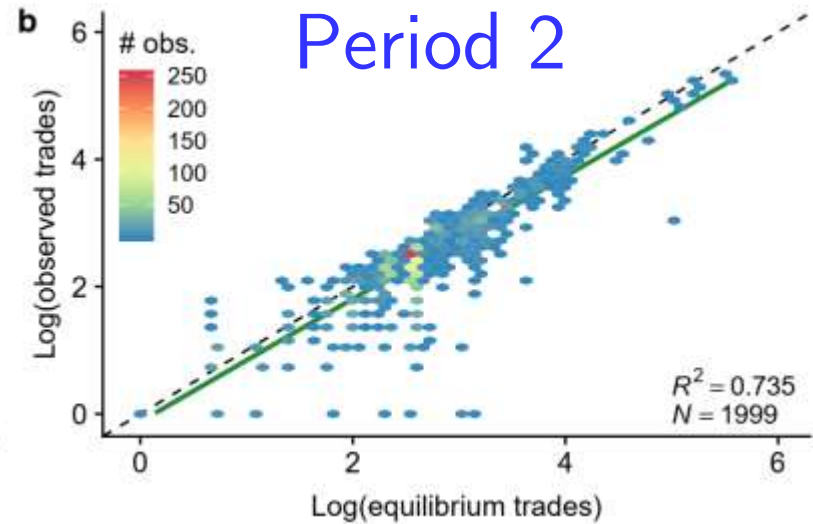
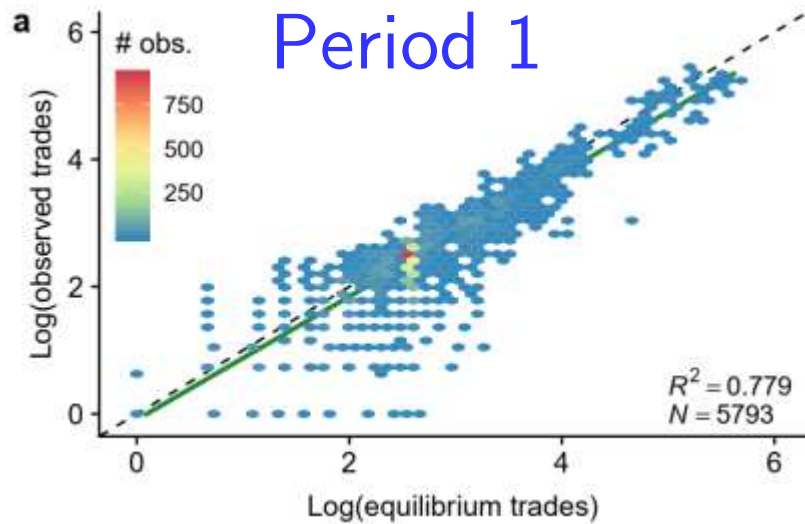
▶ $\rho_{\text{Seller}} = 0.472$



$p = 0.049$

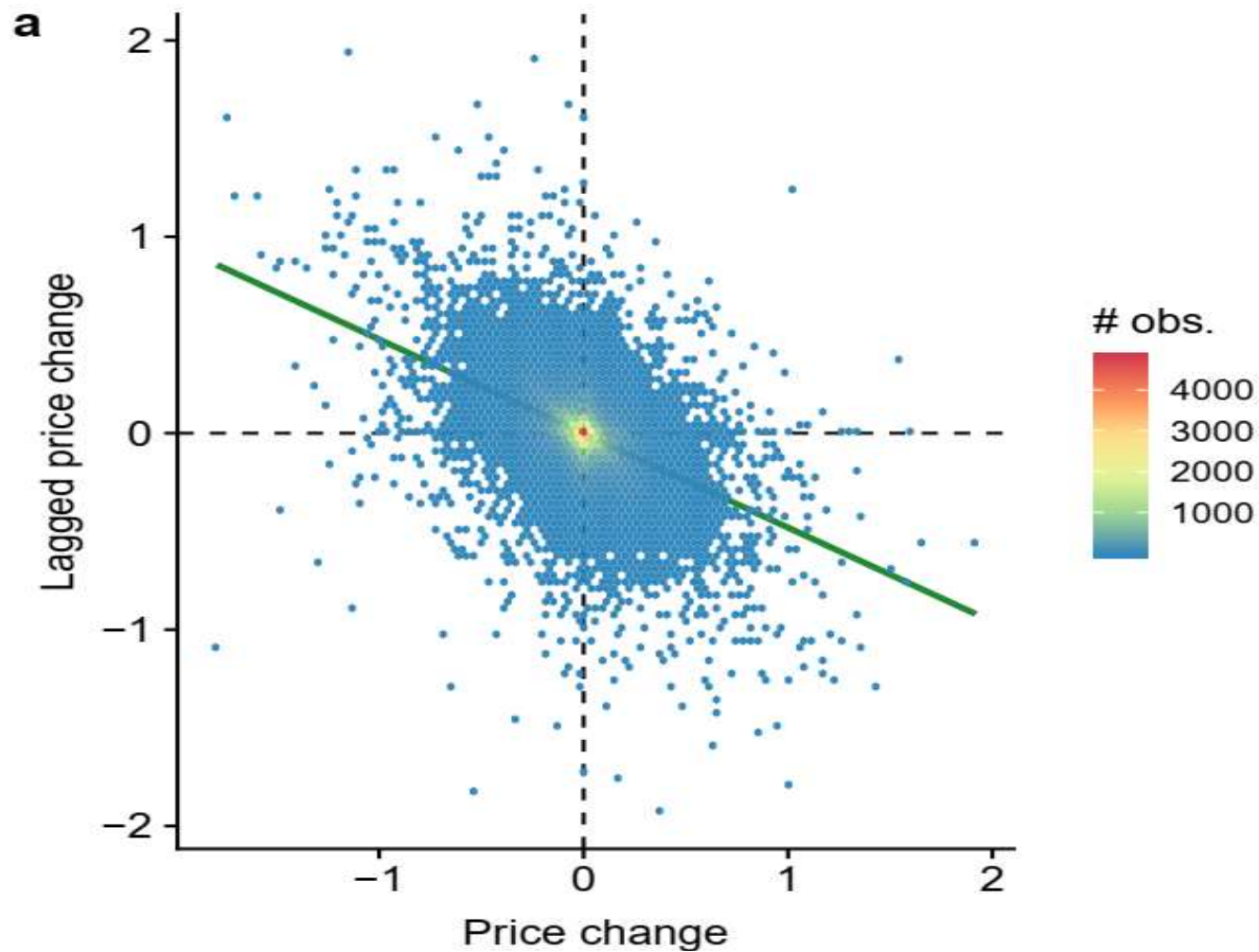
Robustness: Little Learning!

Persistent Under-Trade



Drop All Loss Trades? No Effect!

Price Change Autocorrelation = -0.427



Robustness:

Drop All Loss Trades? No Effect!

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

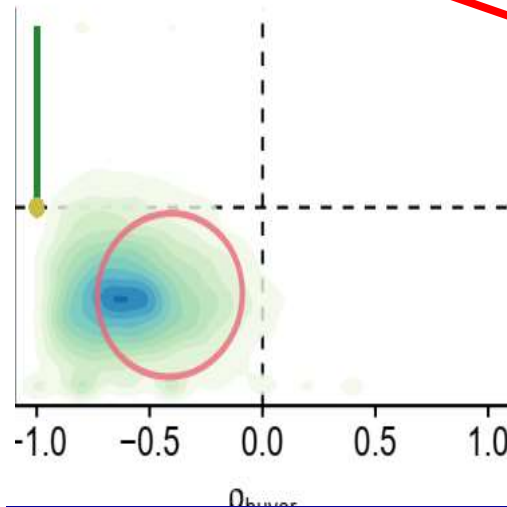
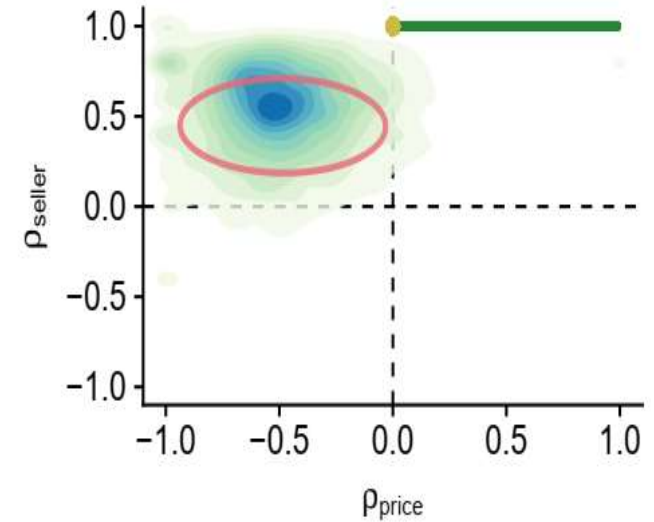
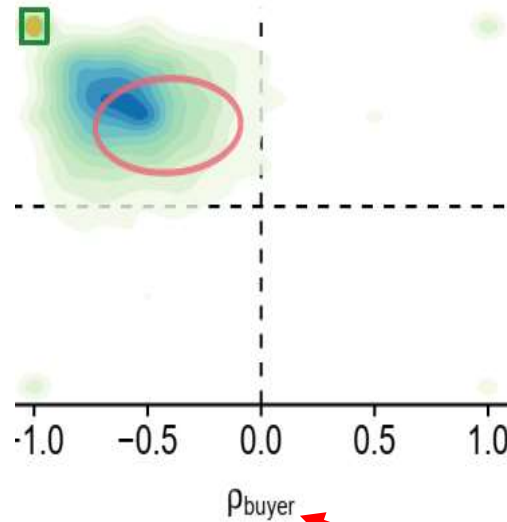
-0.435

(P)

(C)

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

0.570

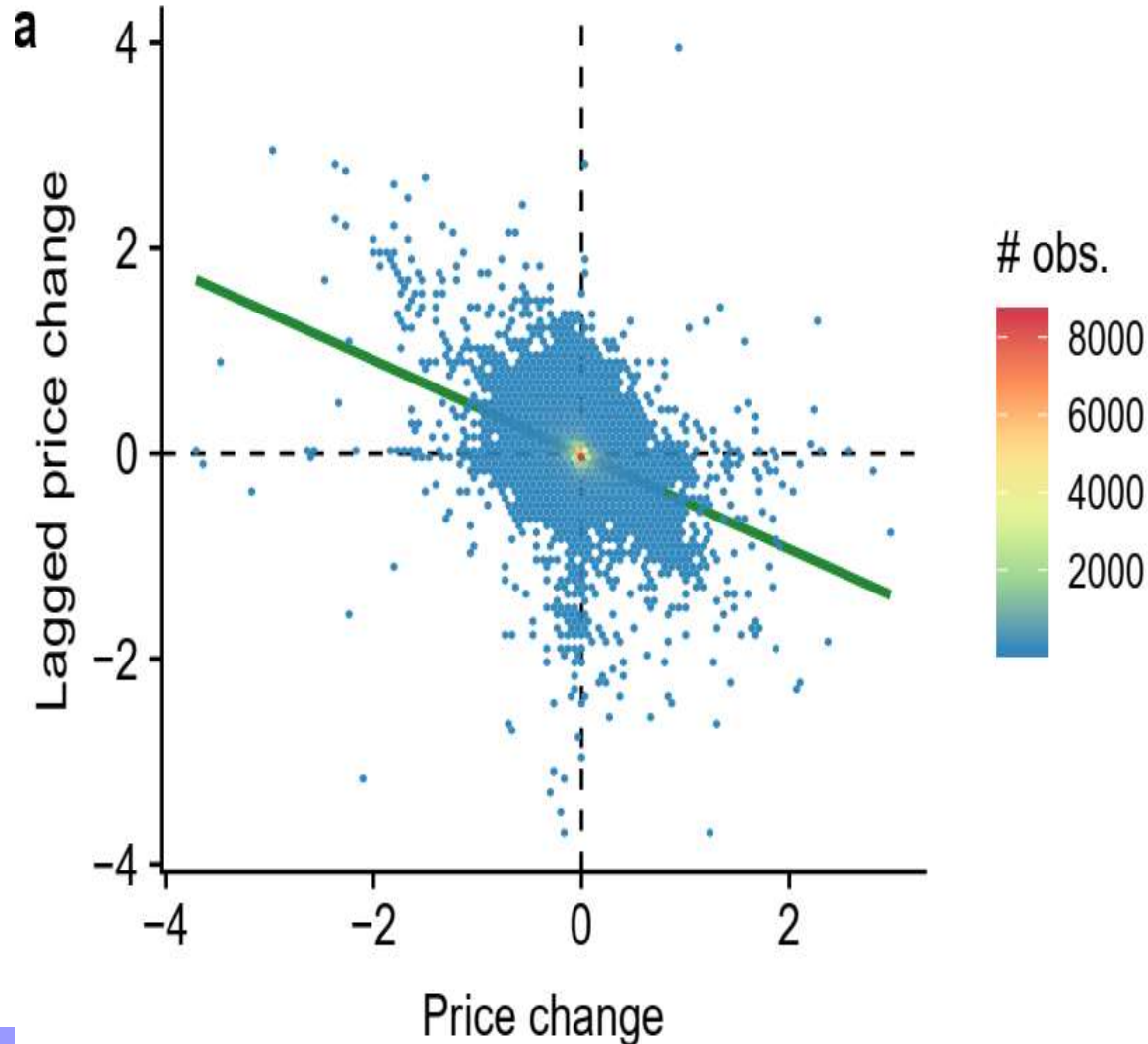


(V) $\rho_{\text{Buyer}} = -0.508$

- Against nature
- Mutual adjustment
- Zero intelligence

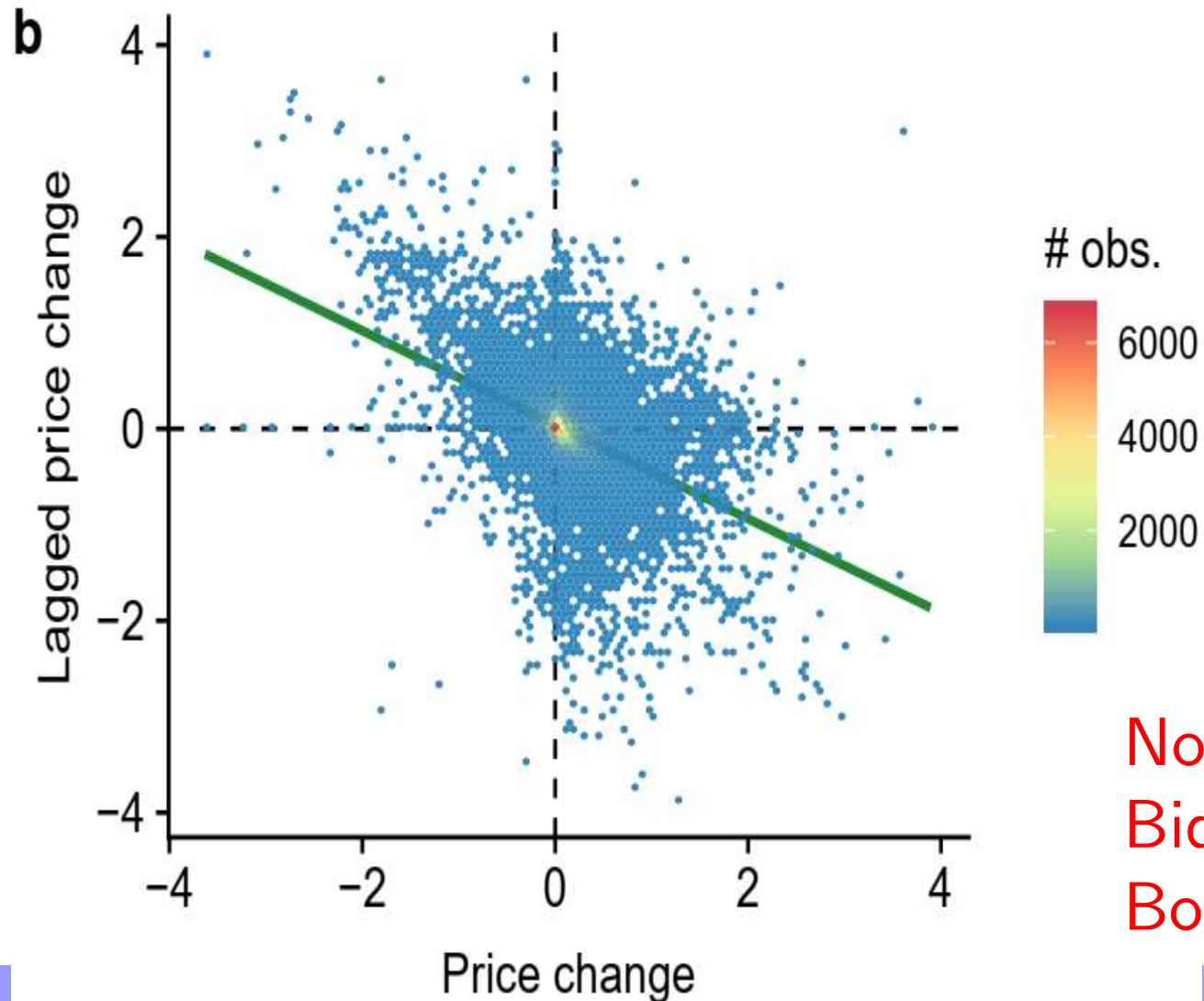
Look at only Accepted Bids? No Effect!

Price Change Autocorrelation = -0.412



Look at only Accepted Asks? No Effect!

Price Change Autocorrelation = -0.451



Not Due to
Bids-Ask
Bounce!

Regional Differences? Small!

