

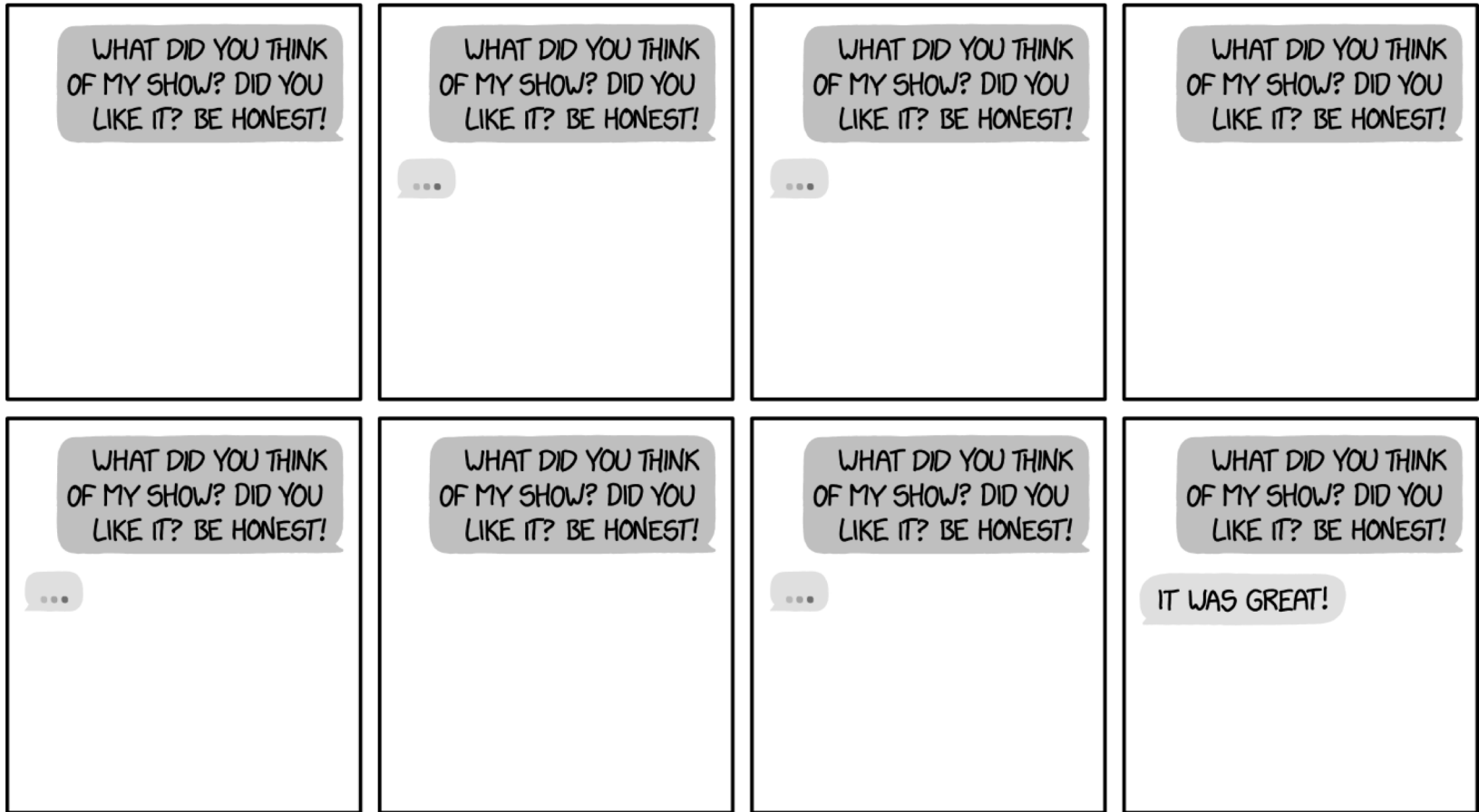
Response Times as an Indicator of Value in Individual and Strategic Choice

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(with Ian Krajbich)

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Typing notifications



MY LEAST FAVORITE ASPECT OF TYPING NOTIFICATIONS

Source: XKCD

Experiment chat

108: new people

107: yes

108: they are thinking hard

107: hopefully a good sign

...

107: I don't get why there taking so long if theyre picking A every time

...

108: if it runs out again on their side i say we do b next time

107: if the time runs out?

108: because they arent paying attention

Source: Kirby Nielsen

Example

- Which of the following options do you prefer - the 50/50 lottery on the left or the sure amount on the right?

+\$XX

\$0

-\$XX

Example

- Which of the following options do you prefer - the 50/50 lottery on the left or the sure amount on the right?

+\$12

-\$7.5

\$0

Example

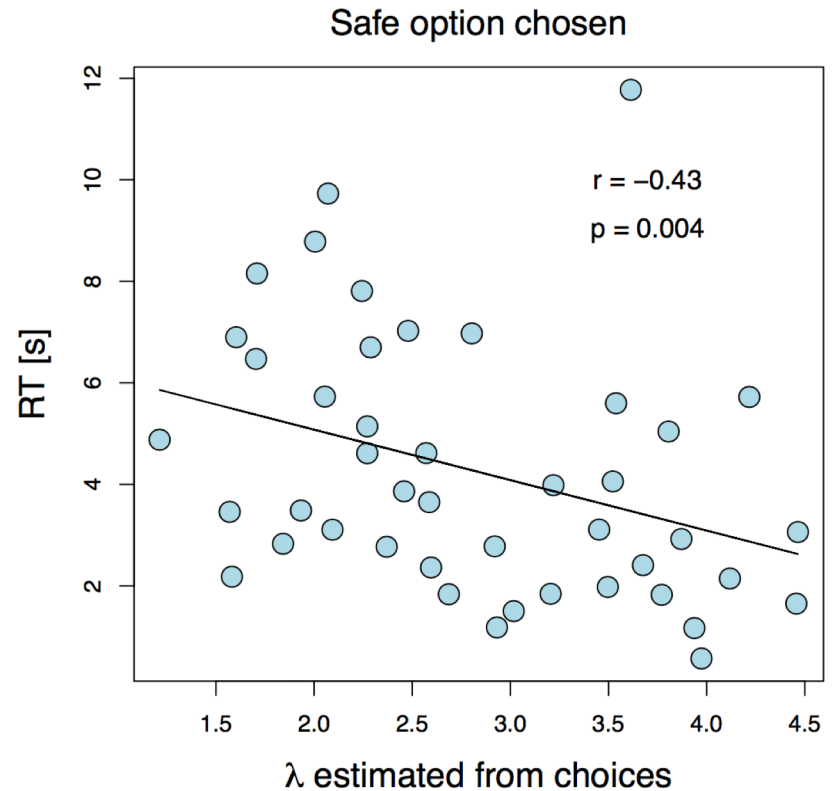
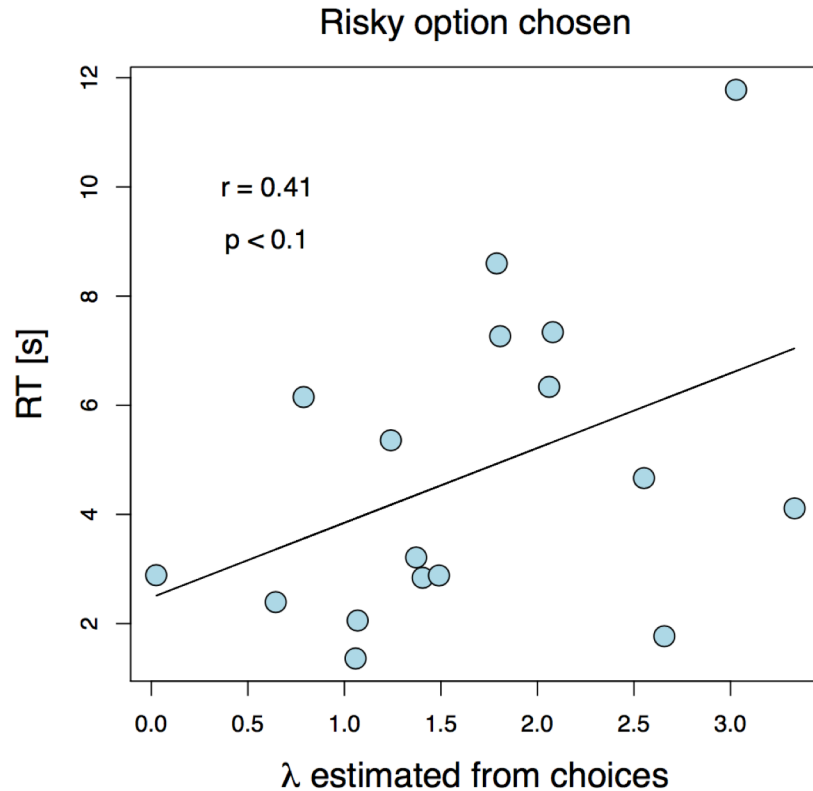
- Which of the following options do you prefer - the 50/50 lottery on the left or the sure amount on the right?

+\$12

\$0

-\$7.5 · λ

Ranking using one question

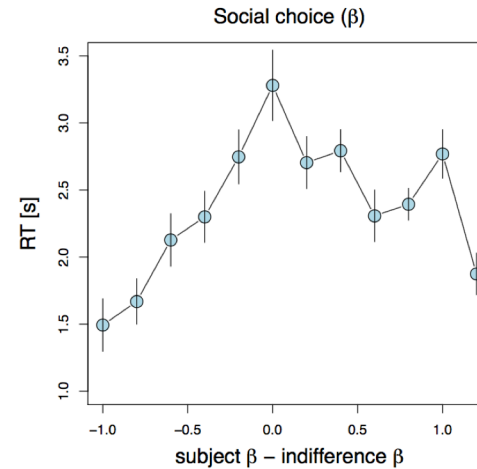
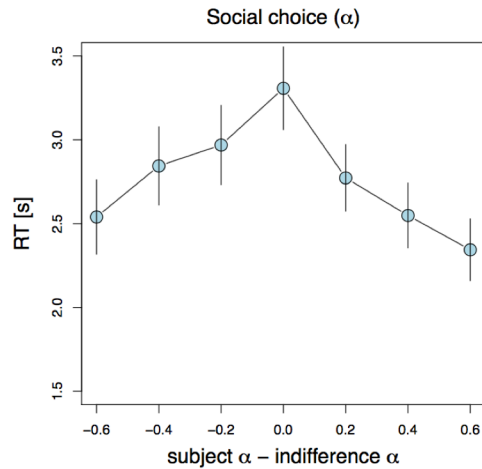


Slow indifference (DDM)

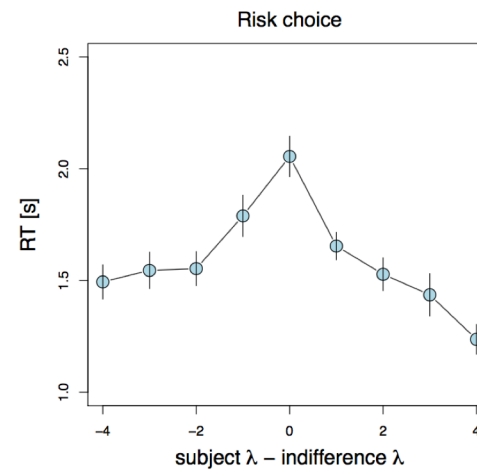
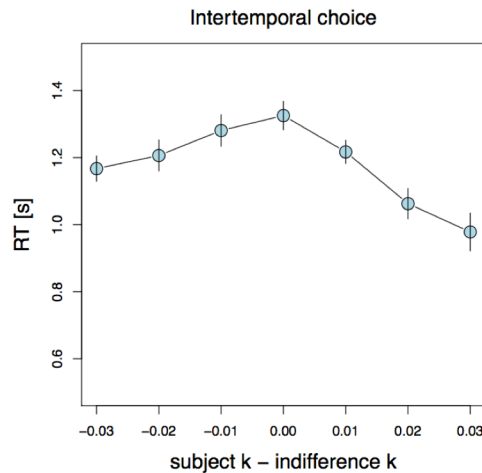
- **Food choice**
 - Krajbich et al. 2010, Mormann et al. 2010, Krajbich & Rangel 2011, Hare et al. 2011, De Martino et al. 2013, Krajbich et al. 2014, Polania et al. 2014, Oud et al. 2016, Enax et al. 2016, Woodford 2014, Fudenberg et al. 2016
- **Consumer choice**
 - Krajbich et al. 2012, Philiastides & Ratcliff 2013
- **Risk**
 - Busemeyer 1982, 1985; Busemeyer & Townsend 1993, Moffatt 2005, Gabaix et al. 2006, Fiedler & Glöckner 2012, Gluth et al. 2012, Hunt et al. 2012, Stewart et al. 2015
- **Uncertainty**
 - Cavanagh et al. 2014, Konovalov & Krajbich 2016
- **Intertemporal choice**
 - Chabris et al. 2009, Dai & Busemeyer 2014, Rodriguez et al. 2014
- **Social preferences**
 - Krajbich et al. 2015a-b, Hutcherson et al. 2015, Chen & Fischbacher 2015

Slow indifference

N = 30



N = 41



N = 39

Kononov & Krajbich (2016)

Strategic interactions

- Given this consistent relationship between strength-of-preference and RT can naïve agents understand these relationships and use them to their advantage?
 - inference and strategic manipulation with RTs

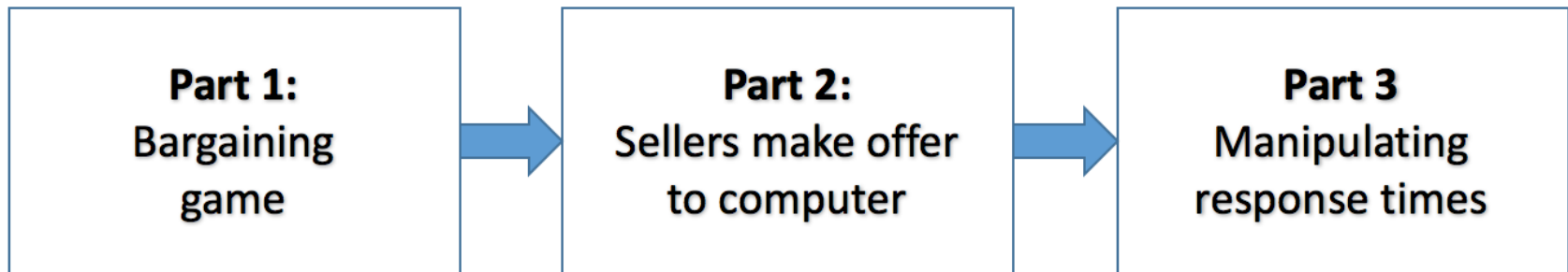
Two-stage bargaining game

- Based on Sobel & Takahashi, 1983; Reynolds, 2000
- Buyer has private information
 - how much he values a good [0 – 100]
- Seller's value is zero
 - she is simply trying to get the best price
- Seller makes an initial price offer [0 – 100]
 - If buyer accepts, game is over
 - If buyer rejects, seller makes a second offer
 - payoffs are reduced by a factor of 0.8
- Question: Can sellers use the speed with which buyers reject their offers to infer the buyers' values and make smarter second offers? Do buyers then choose to manipulate their RTs?

Challenge

- How to study RTs, with and without strategic manipulation, and sellers' response to RTs, in a single experiment, without deception?

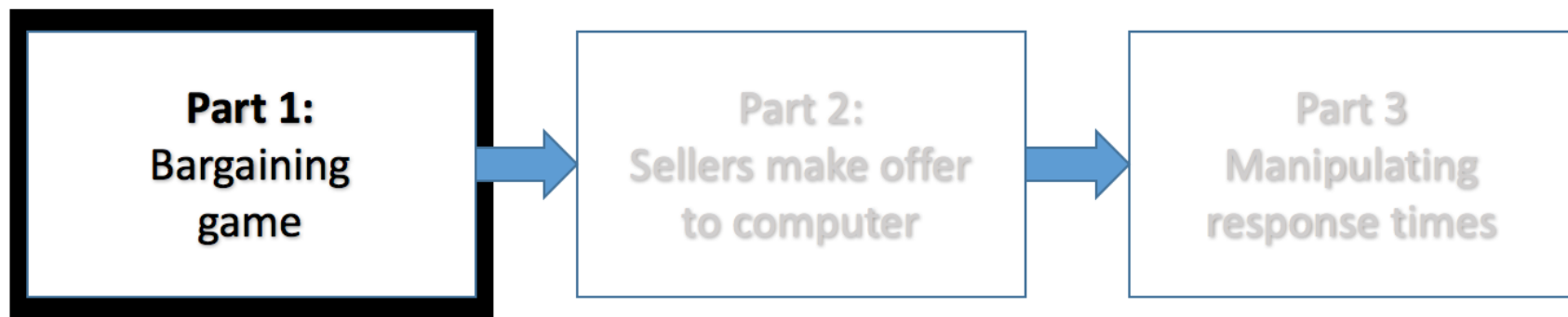
Three stage design



- **Part 1:** Standard two-stage bargaining (RT hidden)
 - Do buyers' RTs reveal their valuations?
- **Part 2:** Second offers against the database from Part 1 (RT visible)
 - Do sellers price discriminate using RT?
- **Part 3:** Buyers choose between offers made in Part 2
 - Do buyers choose to receive offers made to shorter RT?

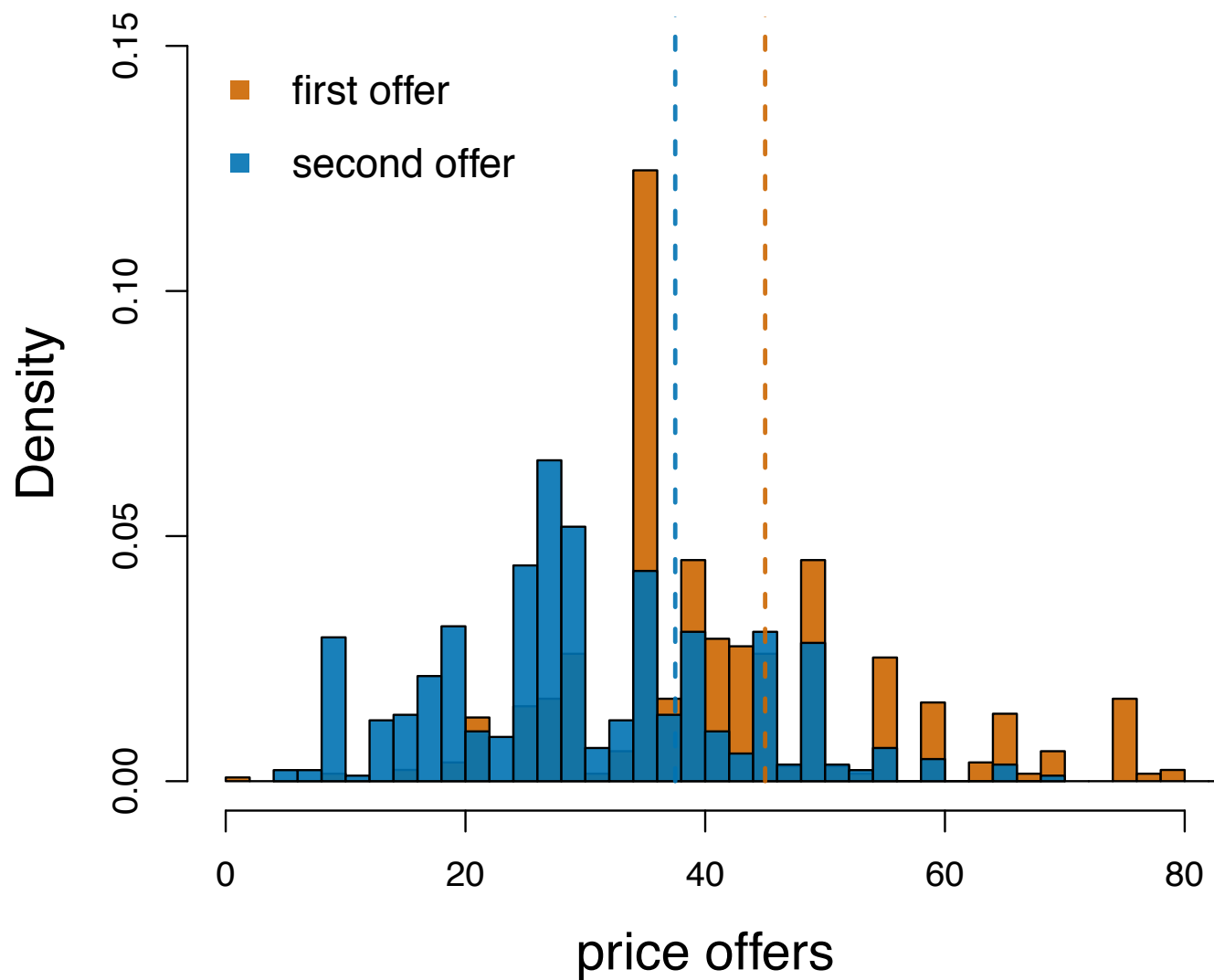
- N=66, split across 4 sessions

Three stage design

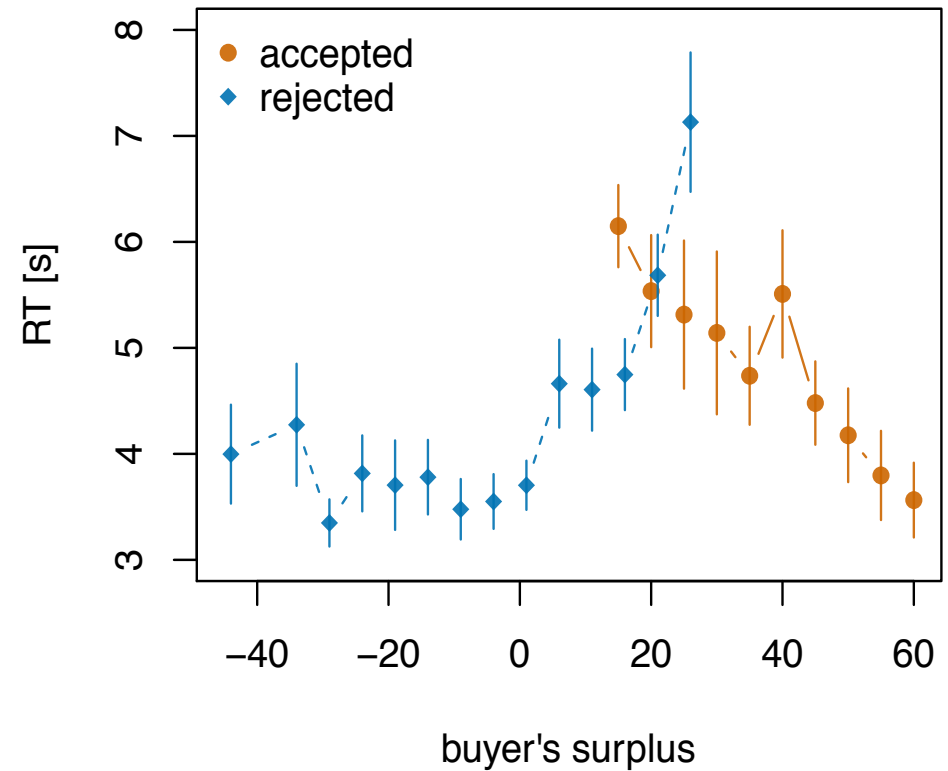
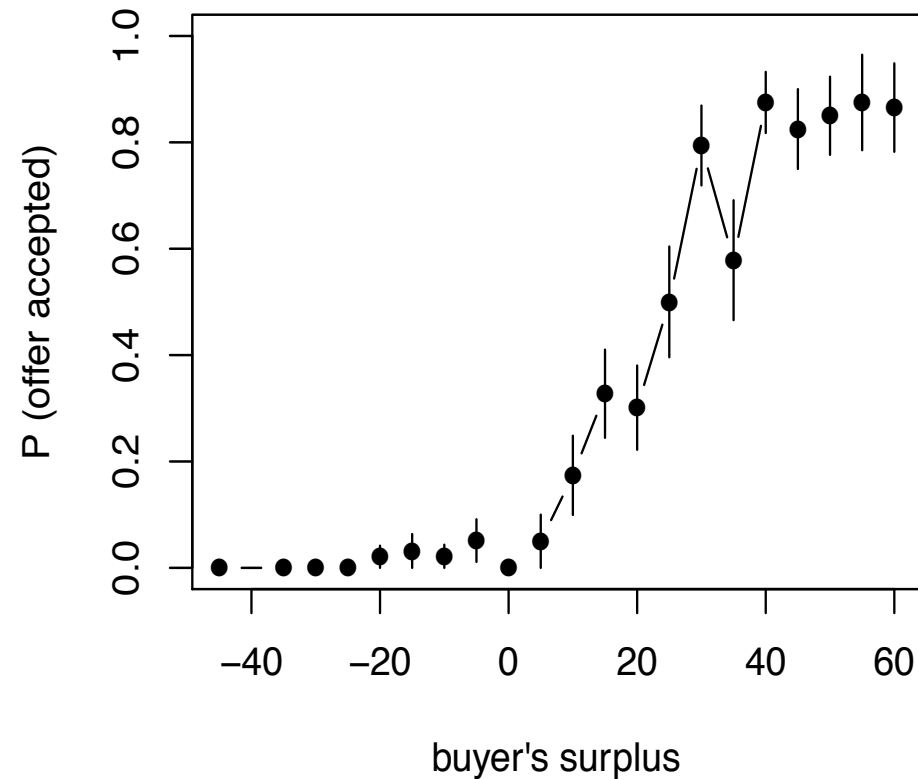


- Standard bargaining
 - subjects split evenly into buyers and sellers
 - 20 periods of bargaining with random re-matching
 - no observation of RTs
 - fixed 11s decision time
- Do buyers' RTs reflect their private values?

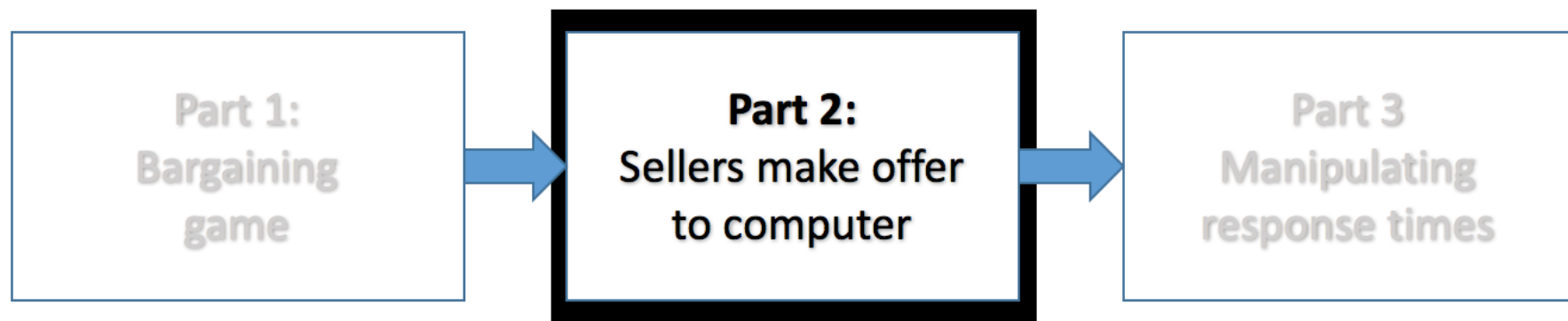
Seller behavior



Choice and RT in terms of buyer surplus



Three stage design

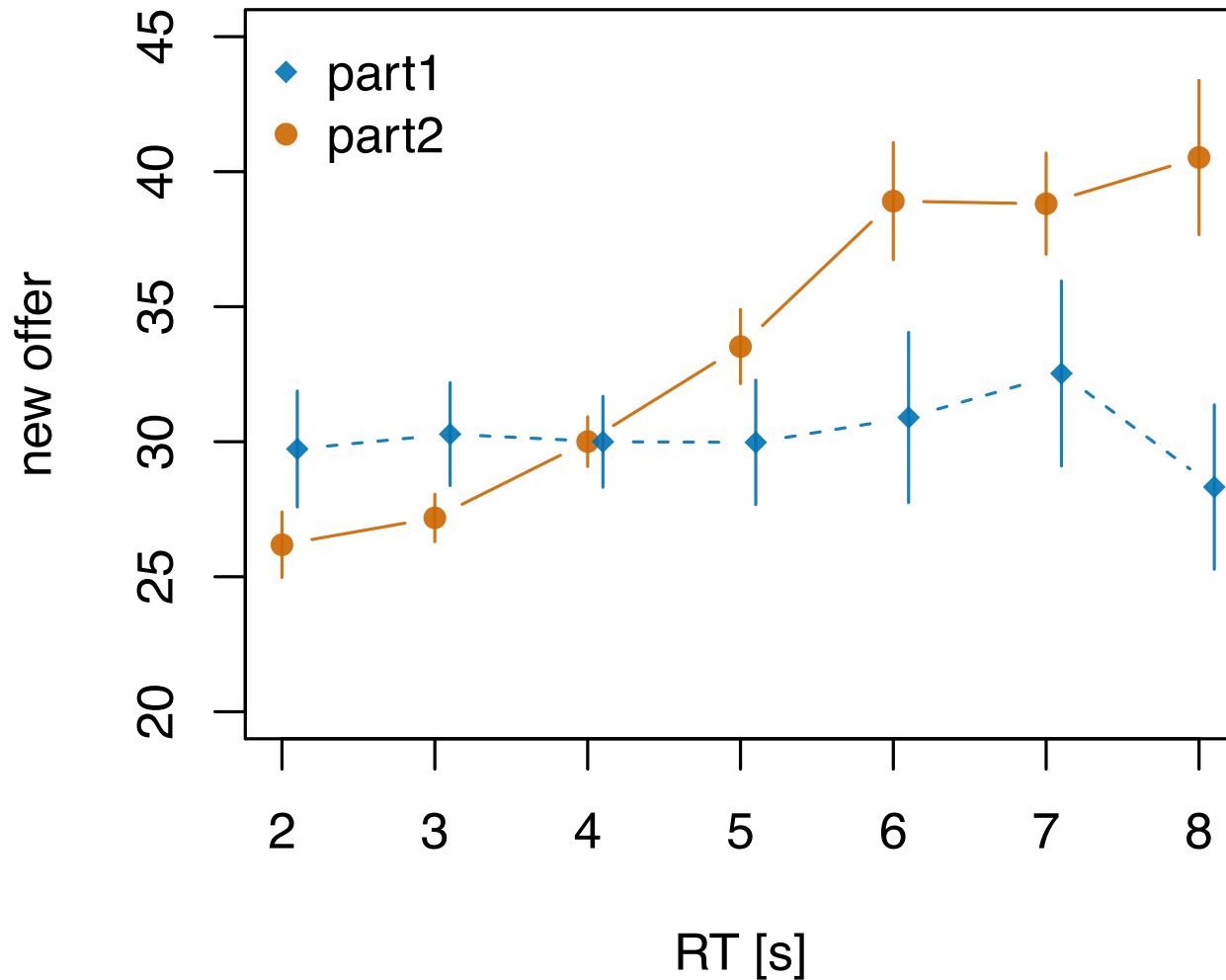


- RT-informed second offers
 - all subjects assigned the role of seller
 - make second-round offers in response to rejections from the first stage (with RT observed)
 - computer buyer automatically accepts if positive profit
 - 20 trials
- Do sellers make higher offers to longer RT?

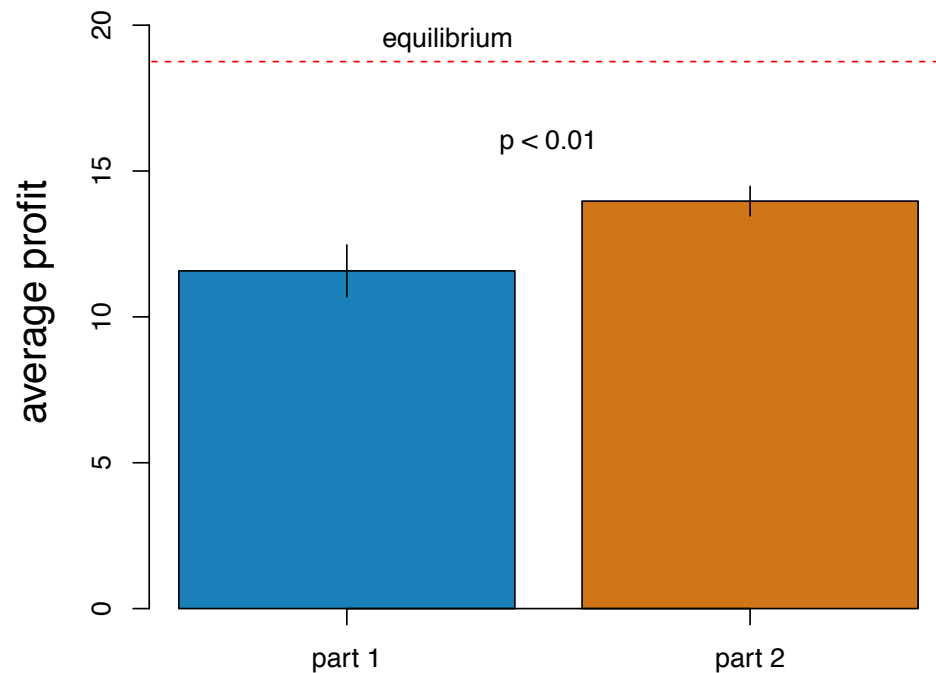
The first offer was 31.
The buyer rejected it in 3.40 seconds.
Your new price offer:

OK

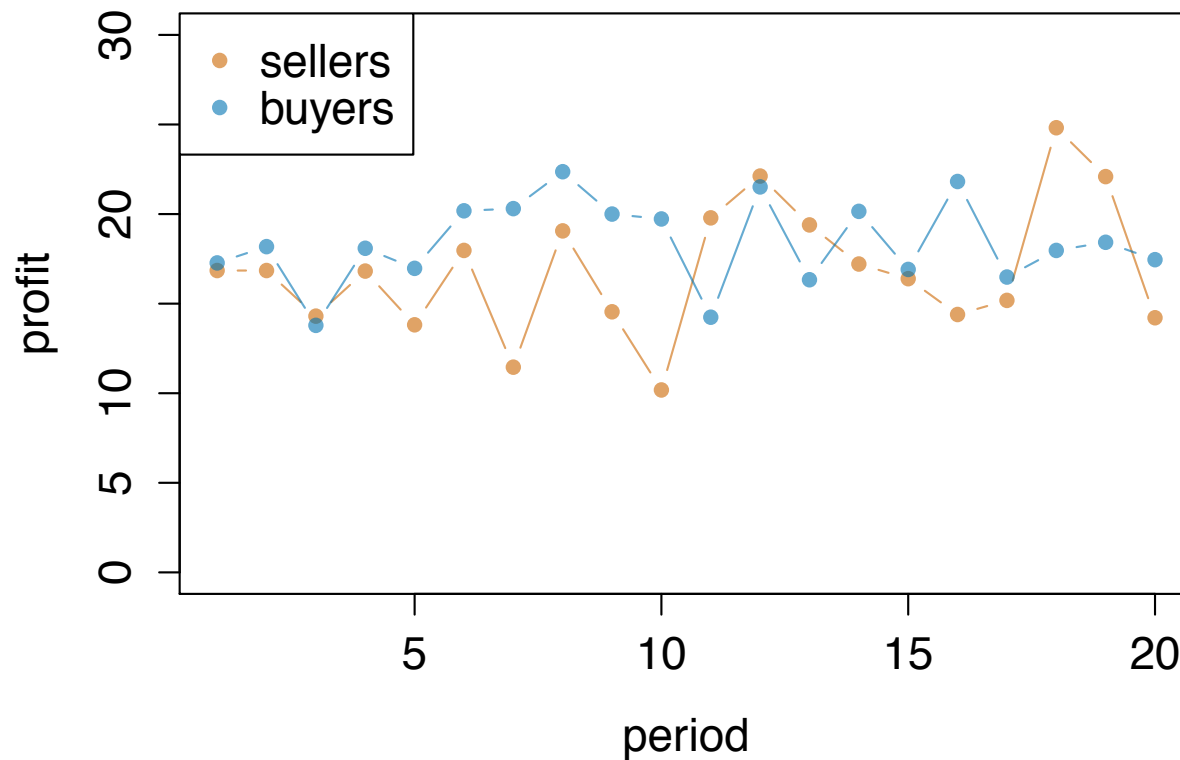
Slower rejection = Higher second offer



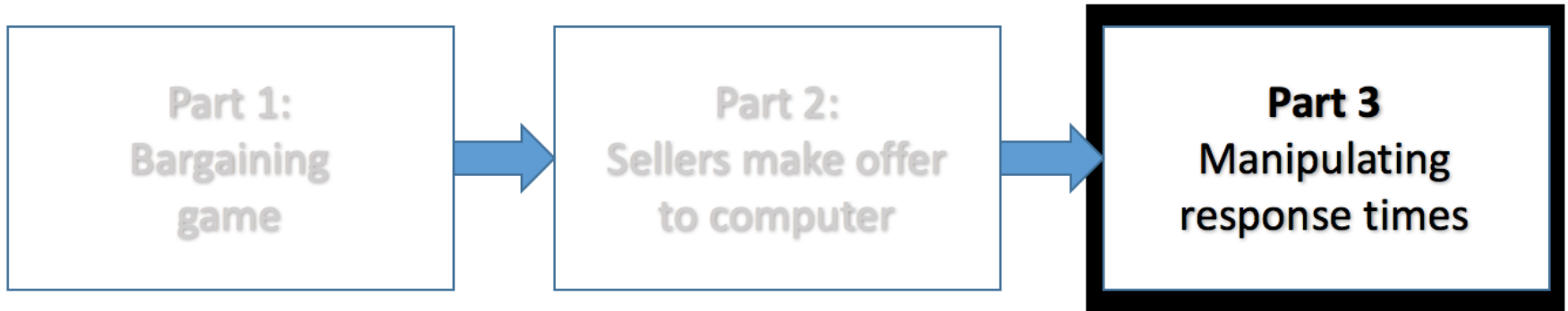
Sellers earn higher profits in Part 2 (conditional on initial rejection)



No increase in profits over time



Three stage design



- RT manipulation
 - all subjects assigned the role of buyer
 - binary choice between situations from the second stage, observing the buyer's value, the initial price offer, and the rejection RT
 - 30 trials
- Do buyers choose Part 2 offers made in response to fast rejections?

The value is 74.
The first offer was 31.
The buyer rejected it in 2.28 seconds.
A new offer was made.

Pick this offer

The value is 83.
The first offer was 66.
The buyer rejected it in 4.43 seconds.
A new offer was made.

Pick this offer

Buyers choose faster rejections

Choice (1 = left)

	Model 1	Model 2
(Intercept)	-0.01 (0.07)	-0.18 (0.16)
price left - right	-0.06*** (0.01)	-0.06*** (0.01)
value left-right	0.13*** (0.02)	0.13*** (0.02)
rt left - right	-0.08* (0.04)	-0.08* (0.04)
period		0.01 (0.01)

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

Potential issues with the experiment

- Explicit presentation of response time may not be realistic
 - Experiment 2: allow sellers to observe buyers' decisions in real time
- Response time manipulation was not really “manipulation”
 - Experiment 2: during Part 1 (bargaining) allow sellers to observe buyers' RTs
 - common knowledge

Experiment 2 design

Conditions		
Timeline	“Hidden first” 48 subjects	“Visible first” 42 subjects
1	Bargaining 1H: Bargaining game with RTs hidden from sellers	Bargaining 1V: Bargaining game with RTs visible to sellers
2	Selling 1H: Seller’s task with data from Bargaining 1H	Selling 1V: Seller’s task with data from Bargaining 1V
3	Bargaining 2V: Bargaining game with RTs visible to sellers	Bargaining 2H: Bargaining game with RTs hidden from sellers
4	Selling 2V: Seller’s task with data from Bargaining 2V	Selling 2H: Seller’s task with data from Bargaining 2H

Experiment 2 summary

- Do sellers make higher offers to longer RTs when RTs are observable?
 - Yes ($p < 0.01$), but only in the second half of experiment (learning?)
- Do buyers manipulate their RTs when they are observable?
 - Yes, buyers make faster decisions ($p < 0.05$)

Conclusions

- Private information can be (unintentionally) revealed through RT
- RT can be used strategically to
 - infer others' types
 - manipulate others' beliefs

Conclusions

- Important implications for
 - “real world” economics: bargaining, online retail
 - experimental design: need to control for RT observability in strategic settings
 - policy: duration of voting can reveal information on strength of preference

Open questions

- Theory: drift-diffusion model in strategic settings? Estimation of others attention?
- Using response times to improve choice models predictions?

Thank you!

Working papers:

<https://sites.google.com/site/arkadykonovalov/>