Herding, Contrarianism and Delay in Financial Market Trading

A Lab Experiment

Andreas Park & Daniel Sgroi

University of Toronto & University of Warwick

Classic Herding Example: Two Restaurants

- People have private information about which of two restaurants (A or B) is better.
- They arrive in sequence and can observe predecessors' actions. The first follows his signal (say A). The second knows the first's signal, and his own (say A, hence goes for A). The third can disregard his own and will herd to restaurant A.
  1.
     - If he had a B this would cancel with the first signal, leaving agent 3 looking to agent 2, hence opting for A.
     - *A fortiori* if he had an A signal.
- Consequence: from agent 3 onwards herding is possible!

What About Prices?

- Sticking with the 2 state/2 action world of the restaurant example, let's consider traders deciding whether to buy or sell a stock.
- Informationally efficient prices automatically incorporate *public information* about actions, leaving only private information as a means of profit.
- For instance, with a single price: $p_t = E[V|H_t]$, so profit comes from $E[V|H_t, S_t] - E[V|H_t]$.
- [With a spread we need noise traders to allow profits since the market can take into account the action of the trader].
- We seem to have lost the potential for herding!

Basic Setup

- Asset value $V \in \{V_1, V_2, V_3\} = \{75, 100, 125\}$.
  $\Pr(V_1) = \Pr(V_2) = \Pr(V_3)$.
- Traders of two types:
  1. Informed (**subjects**, 75%: can buy, sell or hold as they wish);
  2. Noise (**computer traders**, 25%: buy or sell with equal probability).
- Informed receive private conditionally iid signal $S \in \{S_1, S_2, S_3\}$ about V wlog ordered $S_1 < S_2 < S_3$ and can observe the prior history of actions H_t.
- Optimal rational choice for informed (assuming indifferent agents buy) is buy if $E[V|H_t, S_t] \geq$ price, otherwise sell.

Market Maker

- Trade is organized by a market maker.
- In theory he posts a bid-price (at which he buys) and an ask-price (at which he sells).
- To keep it simple in the experiment we have a single price for all trades $p_t = E[V|H_t]$.
- Subjects know that he will adjust price upwards with a buy and down with a sell.

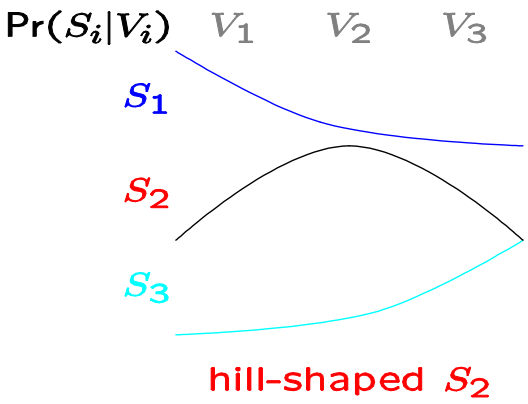
Definitions

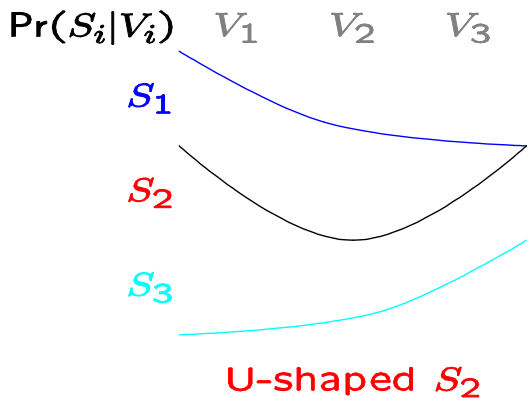
- A trader rationally engages in herd-buying (herd-selling) after a history of trade H_t iff:
  1. he would sell (buy) at the initial history H_1;
  2. he buys (sells) at history H_t;
  3. prices at H_t are higher (lower) than at H_1.
- A trader rationally engages in buy-contrarianism (sell-contrarianism) after a history H_t iff:
  1. he would sell (buy) at the initial history H_1;
  2. he buys (sells) at history H_t;
  3. prices at H_t are lower (higher) than at H_1.

Rational Herding and Contrarianism

- Consider exogenous-time (a strict sequence).
- If S_2 types have decreasing or increasing csds they cannot herd or be contrarian (they become similar to S_1 and S_3 types respectively).
- Herding candidates must receive information that makes their decisions more volatile and so they distribute weight to the tails of their beliefs - we call this **U-shaped** information.
- Contrarian candidates behave in a stabilizing manner, distributing weight towards the centre of their beliefs - we call this **hill-shaped** information.

Conditional Signal Distributions





Theorem

- From Park & Sabourian (2008), for exogenous-time (strict sequences) we have:
  - Types S_1 and S_3 never herd or act in a contrarian manner.
  - Type S_2 buy(sell)-herd iff his csd is negative(positive) U-shaped.
  - Type S_2 buy(sell)-contrarian iff his csd is negative(positive) hill-shaped.

Timing

- So far (and in all existing theoretical and expermental studies into financial herding) we require that traders wait in line until it is their turn to trade.
- That's not what happens in reality — they choose both how and *when* to trade.
- This is especially important since timing and herding may be linked.
- For the static decision of how to trade we continue with the exogenous-time theory, for the dynamic decision we have some further observations.
- They are both part of a single problem but we separate them for expositional clarity.

One Trade

- Smith (AER 2000) has a single trader setup and shows that trade immediately if information is either good or bad news (="monotonic" signals in our language); also has example of U-shaped signal which mandates delay.
  - Hypothesis 1: S_1 and S_3 should trade immediately when markets open, S_2 should trade later.
  - Hypothesis 2: (weaker) S_1 and S_3 should trade before the S_2.
  - Hypothesis 3: Hill-shape (= more convinced) trades before U-shape (= less convinced).

Two Trades

- With two trades there is really **no theory!** Best guess:
  - Hypothesis 4: S_1 and S_3 should trade before the S_2.
  - Hypothesis 5: No speculative trading (=buy-sell)?

Objectives

- We will run an experiment to test:
  - whether the informational structure matters (theorem);
  - whether timing matters (hypoheses 1-5).

Treatements

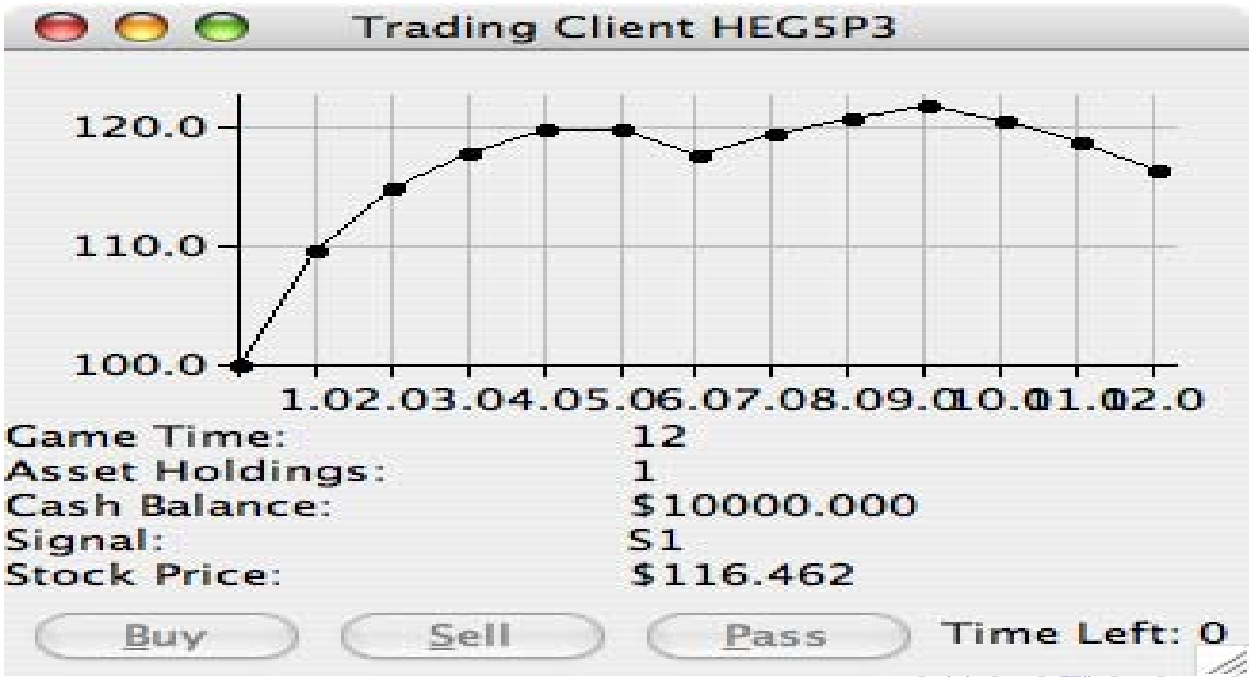
- negative U-shape $\Rightarrow$ buy-herding;
- negative hill-shape $\Rightarrow$ buy-contrarianism;
- positive U-shape $\Rightarrow$ sell-herding;
- negative hill-shape + two trades $\Rightarrow$ buy-contrarianism;
- positive U-shape + two trades $\Rightarrow$ sell-herding;
- negative U-shape + two trades $\Rightarrow$ buy-herding.

Time-line

- Initial instructions including hand-outs that could be viewed at any time. The existence and proportion of noise-trades explained, and subjects are told what S_1, S_2 and S_3 signals mean prior to each treatment (so they "understand" all the signals not just the ones they receive).
- For each treatment they are given the full signal matrix and the posterior for each signal at H_1 and then signals handed out via the computer.
- Subjects can act whenever they wish within a 3 minute time period, with regular announcements of time available. Noise traders act at random times.

The Trading Software

- Traders can always see their signal, current price and the history of prices (actions).



Numbers

- We ran 13 sessions in total (3 at UCambridge, 6 at UWarwick, 4 at UToronto).
- Group sizes were 13-25.
- 1993 trades. By type: 623 (S_1), 786 (S_2), 584 (S_3); Single trade: 683 with 197 S_1, 276 S_2 and 210 S_3; Two trades: 1310 with 426 S_1, 510 S_2 and 374 S_3.

Overall Fit

- The rational (exoegnous-time) model explains about 73% of trades (comparable to other herding studies, even those without prices).
- [In a sister paper focusing on exogenous-time in the lab this number was 75%].
- Herding candidates are less well explained by the rational model (54%).
- Assuming different levels of risk aversion doesn't improve fit $\Rightarrow$ risk neutrality a fair assumption.

Herding vs Contrarianism

- We check whether U-shape/hill-shape significant source for herding/contrarianism:

$$\begin{aligned} \text{herd}_{i,t} &= \alpha + \beta \text{u-shape}_{i,t} + \text{fixed}_i + \epsilon_{i,t}, \\ \text{contra}_{i,t} &= \alpha + \beta \text{hill-shape}_{i,t} + \text{fixed}_i + \epsilon_{i,t} \end{aligned}$$

Herding

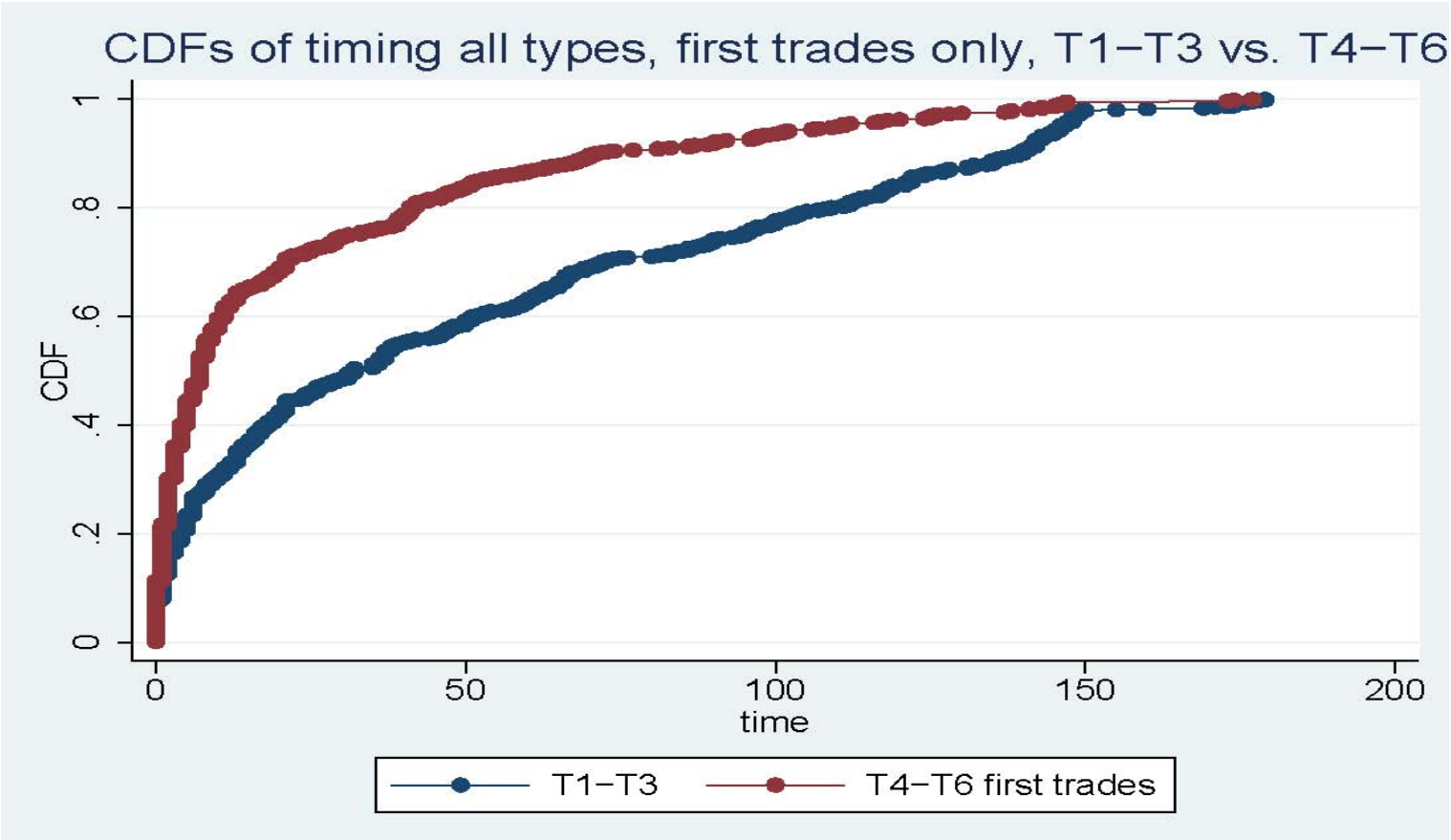
Herding	all types	T1-T3	T4-T6	first trade T4-T6	second trade T4-T6
Logit	**0.292****	**0.114****	**0.397****	**0.228****	**0.446****
	(-0.022)	(-0.032)	(-0.032)	(-0.025)	(-0.05)
OLS	**0.378****	**0.138****	**0.495****	**0.293****	**0.552****
	(-0.025)	(-0.039)	(-0.031)	(-0.03)	(-0.043)
OLS fixed effects	**0.352****	**0.081**	**0.434****	**0.276****	**0.545****
	(-0.027)	(-0.042)	(-0.038)	(-0.032)	(-0.057)
Observations	1172	391	781	805	367

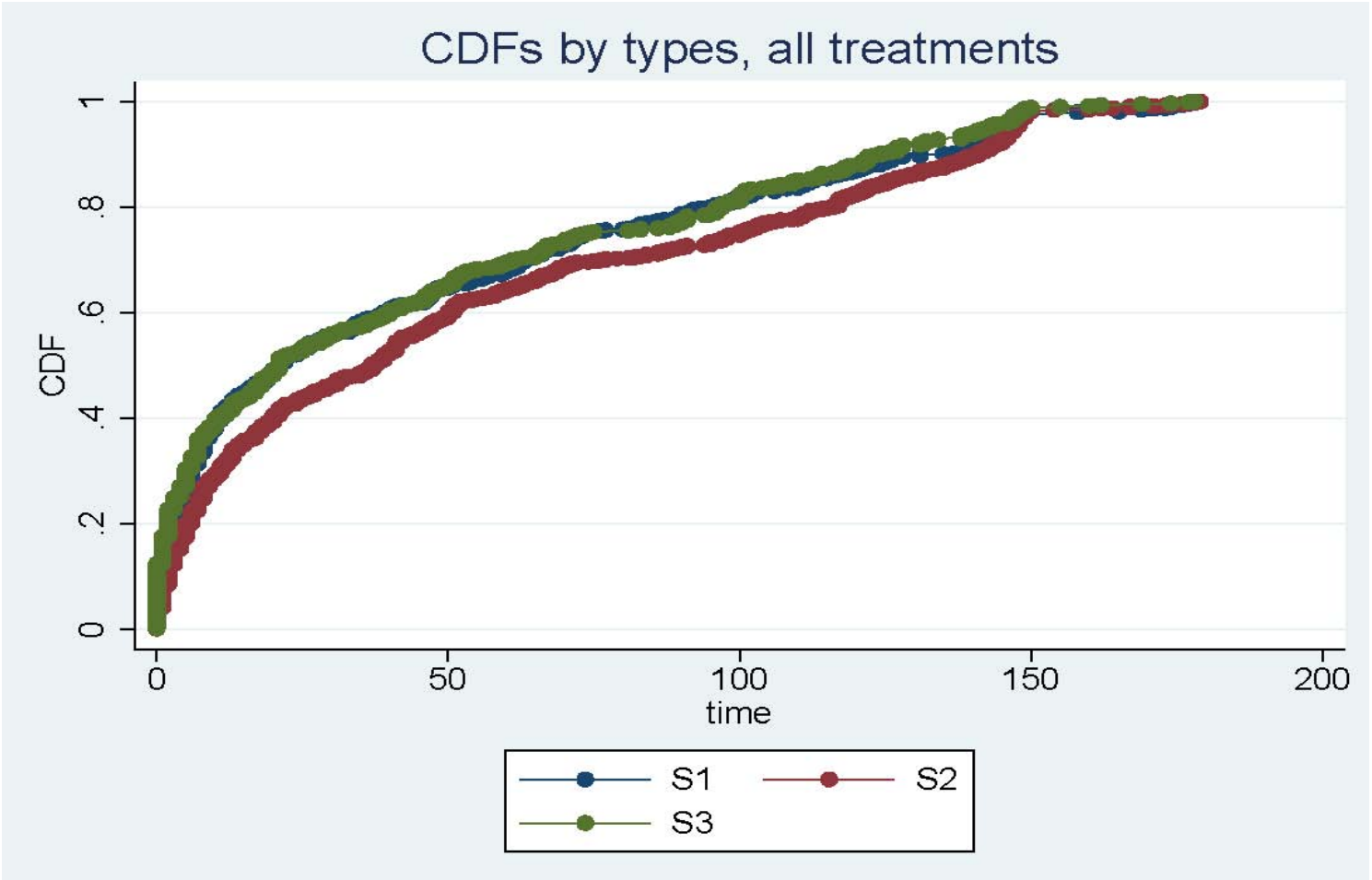
Contrarianism

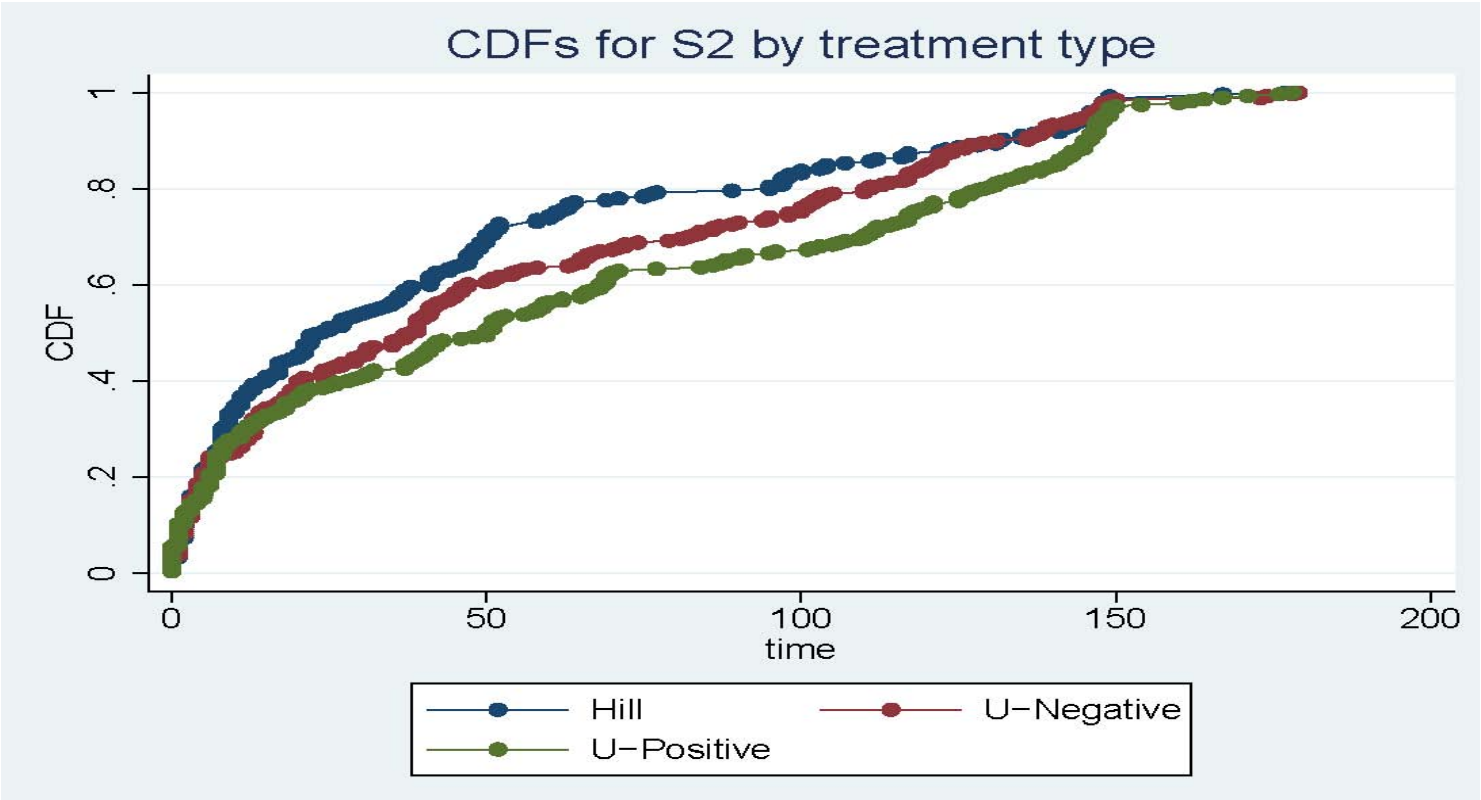
Contra	all types	T1-T3	T4-T6	first trade T4-T6	second trade T4-T6
Logit	**0.361****	**0.304****	**0.419****	**0.358****	**0.371****
	(-0.056)	(-0.081)	(-0.082)	(-0.064)	(-0.114)
OLS	**0.434****	**0.353****	**0.508****	**0.439****	**0.429****
	(-0.057)	(-0.085)	(-0.079)	(-0.066)	(-0.114)
OLS fixed effects	**0.406****	**0.300***	**0.473****	**0.405****	**0.655****
	(-0.063)	(-0.117)	(-0.108)	(-0.076)	(-0.177)
Observations	820	293	527	553	267

Absolute Timing

- Type S trading systematically before type S' can be interpreted that the distribution of trading times for type S is first order stochastically dominated by that of type S'.
- Graphically, the cdf of S lies above the cdf of S'.
- Stark example: if traders have two trades then the first trades typically occur before their first trade when they have only one trade:


CDFs of timing all types, first trades only, T1–T3 vs. T4–T6
CDF
0
.2
.4
.6
.8
1
0
50
100
150
200
time
T1–T3
T4–T6 first trades

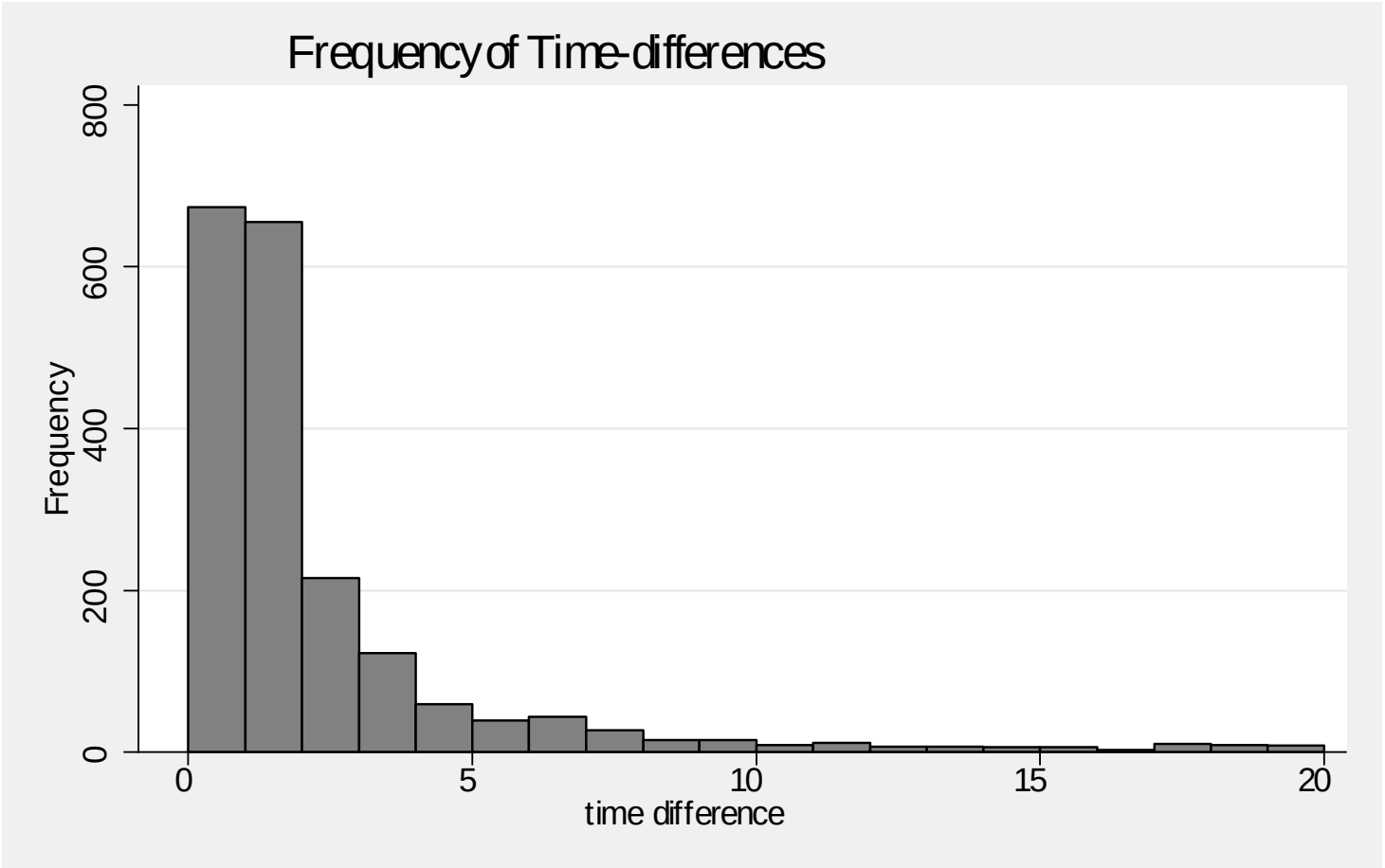

CDFs by types, all treatments
CDF
0
.2
.4
.6
.8
1
0
50
100
150
200
time
S1
S2
S3


CDFs for S2 by treatment type
CDF
0
.2
.4
.6
.8
1
0
50
100
150
200
time
Hill
U−Negative
U−Positive

Relative Timing

- Relative proximity: The percentage of trades that follow within 1.5 seconds of another.

	All	S1	S2	S3	hill	−ve U	+ve U
All times	67%	66%	63%	71%	64%	66%	61%
total time >5 sec	58%	56%	57%	62%	57%	60%	55%
total time >10 sec	54%	52%	53%	58%	55%	55%	50%
total time >20 sec	51%	48%	51%	55%	56%	50%	49%
total time >30 sec	50%	44%	50%	54%	56%	49%	46%


Frequency of Time-differences
Frequency
0
200
400
600
800
0
5
10
15
20
time difference

Behavioral Explanations

- Most alternative behavioral models tested did not add much to insight or fit, except one inspired by level K-belief (Costa-Gomes et al 2001) & QRE (McKelvey & Palfrey 1995) which add a *rational reaction to irrationality*.
- Step 1: Assume fraction δ of other subjects act rationally. $\delta^* = 2/15$ maximizes fit, increasing it from 70% ('pass'=wrong) to 73% (equiv. to actual noise level 90%).
- Step 2: Assume fraction $1-\delta$ of other subjects act irrationally and δ react rationally to the irrationality. Best fit for $\delta^* = 0$ (no updating); good fit from T1-T3 for $\delta = 0.22$. With 0.22 improvement from T1-T3 is 69.8% to 76.1%.

Conclusion

- Behavior is largely consistent with static (exogenous-time) theory for S_1 and S_3, less for S_2 so static models have something to offer for real-world predictions.
- Herding and contrarian signals are the significant source of herding and contrarianism. Having such a signal increases the chance of herding by 30% and 36% respectively (the effect of the Herd signal is much stronger than in exogenous time framework (a mere 6%)).
- Most behavioral theories don't greatly improve the fit, though a variation on level-k/QRE is useful.

Conclusion (continued)

- **Absolute timing**:
  - S_1 and S_3 trade systematically before the S_2.
  - Hill shape trades before U-shape.
  - With two trades allowed, trading occurs earlier.
- **Relative timing**: there is evidence of clustering, but does not depend on information.
- Other results:
  - Prices do have an effect: the larger the price, the less likely traders are to buy (end-point effect).
  - Return trading occurs.