Reading the Market?
Expectation Coordination and Theory of Mind

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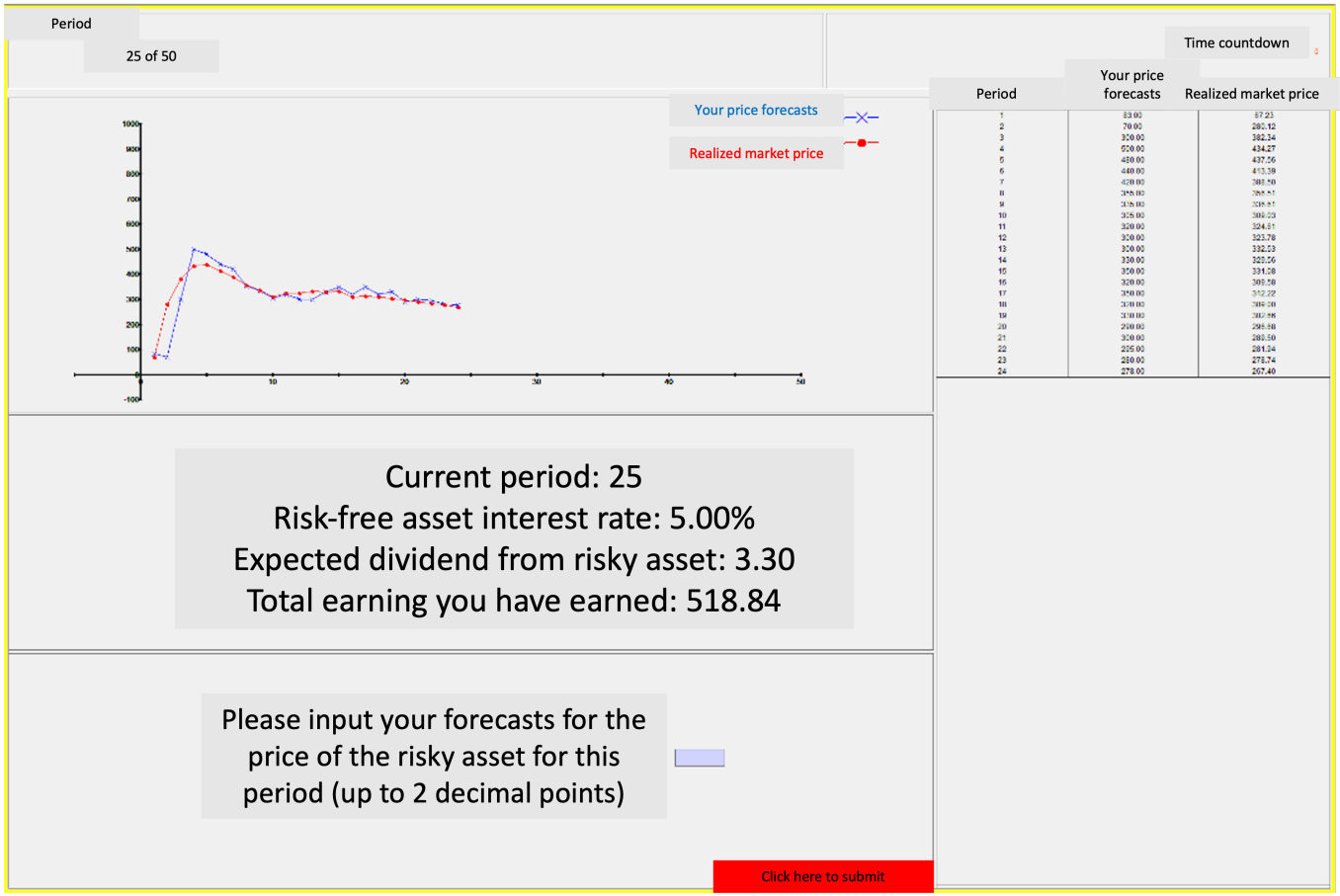
Motivation for Chapter 1

- Rational Expectation Hypothesis (REH): there shouldn't be any price bubbles/crashes.
  - narrow "rationality" definition: price forecast = FV
- We observe prolonged bubbles / crashes in financial market.
- Violation of REH?

Learning to Forecast Experiments

- Cleanly elicit expectation formation in the Lab
  - Direct elicitation on price forecasts (not quantity decision)
  - incentivized: earning = inverse function of prediction error
    - $profit = max\{100 - \frac{1300}{49}(e_t^2), 0\}$
- Price is a function of expectation
  - financial market (positive feedback): price expectation $\uparrow \rightarrow$ realized price $\uparrow$
  - production market (negative feedback): price expectation $\rightarrow \uparrow$ production $\rightarrow$ realized price $\downarrow$

Typical Interface of a Positive-Feedback LtFE



- 6-10 subjects in each market, 40-65 consecutive periods
- subject play the role of professional forecasters, payoff function is a inverse function with prediction error
- no knowledge on DGP (e.g., $p(t) = \frac{1}{1+r}(\bar{p}^e(t) + d) + e_t$) : know d, r but not $\bar{p}^e(t)$ = play with the market

Main Results

- They do not start from REE.
- Whether they learn the REE depends on the feedback system.
  - robust against several deviations from the aforementioned baseline design
  - #participants in each market (e.g., 100), price vs. quantity prediction, SR vs. LR predicion, price vs. return prediction

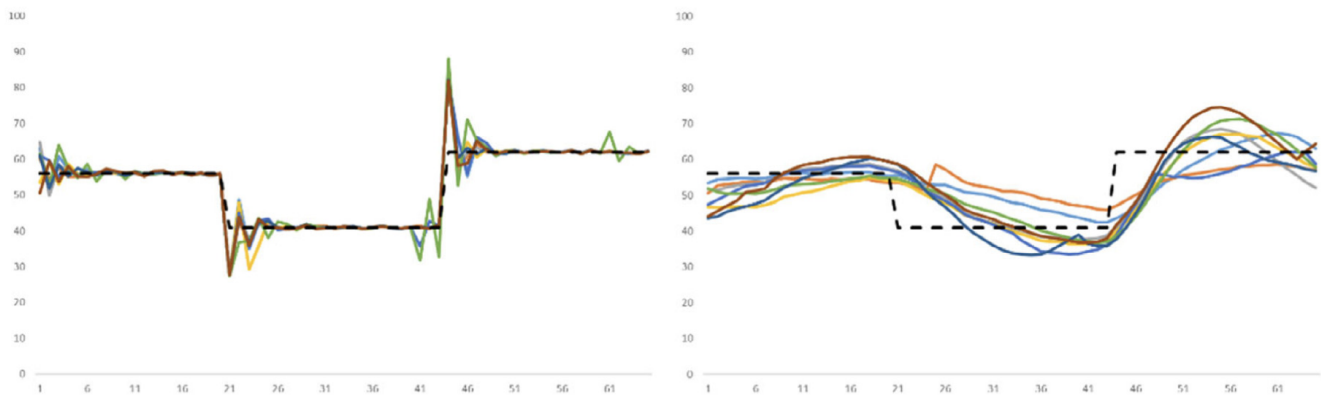


Fig. 1. Price dynamics in negative (left panel) and positive feedback (right panel) markets in the LtFE by Bao et al. (2012).

Motivation for Chapter 2

Is there any way to reduce bubbles/volatility in the positive-feedback markets?

- One primary difficulty for financial forecasting (Thaler, 2015)
  - "This game is identical to Keynes's beauty contest: you have to guess what other people are thinking that other people are thinking."
  - Theory of mind: the capacity to infer the intentions of others or 'the market'
- In human language
  - Why REH does not hold?: Analogy of Centipede game.
    - Mistakes leads to Pareto improvement: We all benefit from making such mistakes.
    - Things that really matter: get out of it before others decide to "quit".
    - **when?**
  - Ability to infer others' intention are supposed to matter here!
    - strong case: high ToM $\rightarrow$ smaller bubble, refer to DGP
    - weak case: at least high ToM $\rightarrow$ better coordination in forecasts

What we do

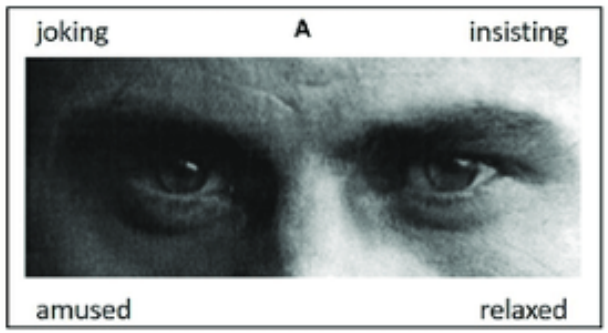
- Position: clean identification on whether high ToM = better asset market
- When a market is filled with all High-ToM forecasters, will there be:
  - Less bubbles / Crashes
  - A less volatile market
  - better coordination

The role of ToM found in literatures (all good!)

- Quick summary on what have been done:
  - Corgnet et al. (2018): Individual level ToM vs. individaul trading profit in a Plott and Sunder (1988) setup
    - We look at whether a market with higher ToM will form smaller bubble.
  - Bruguier et al. (2010); Corgnet et al. (2018; 2020): forecasters' ToM vs. forecasting performance in other financial market experiment

Design: Markets contain subjects with similar ToM levels

- Eye gaze test (Baron-Cohen et al.,1997)
  - Used in Corgnet et al. (2018); Bruguier et al. (2010); Hefti et al. (2018)
  - Others use Heider's test or at least 23 different tests.
  - Eye gaze: easy to implement in zTree; follow the setup of the seminal work of Corgnet et al. (2018)



- Rank subjects by their ToM scores within each session and build four groups based on these scores.
- Compare the groups with the highest average scores (High-ToM group: rank 1-6) to the lowest average scores (Low-ToM group: rank 19-24).
  - Allow the interaction between the subjects with similar ToM levels
  - Such composition of markets has been applied on cognitive ability (Bosch-Rosa et al., 2018) or the propensity to speculate (Janssen et al., 2019)

Balance check

	Low-ToM	Middle-Low	Middle-High	High-ToM	Low ToM – High ToM	
					Rank-sum (z)	OLS coefficient
Season 2021 and 2022, N = 384						
ToM score	19.46	23.29	25.34	28.11	-4.83***	-8.66***
CRT score	1.96	1.90	2.01	1.92	0.29	0.04
Numeracy test	4.32	4.35	4.18	3.91	1.97**	0.42**
% Female	0.53	0.57	0.70	0.72	-2.35**	-0.19***
Season 2022, N = 240						
Self-monitoring test	13.55	13.28	13.92	14.05	-0.42	-0.50
Age	21.65	21.63	21.38	21.65	-0.15	0.00

- Cognitive Reflection Test (Frederick, 2005) and abbreviated Numeracy scale (Weller et al., 2013)
  - Analytical and mentalizing capabilities are critical to explaining the individual trading behaviour (Hefti et al., 2018).
  - CRT affect price/expectation dynamics in both LtOE (Bosch-Rosa et al., 2018) and LtFE (Zong et al., 2017) settings.
- Gender
  - Females have higher empathy than males and score higher in the Eye Tests (Baron-Cohen et al., 2005).
- Given balanced result
  - Only control the demographic variables when conducting individual-level analysis, but not on the market-level analysis.

Realized Market Price

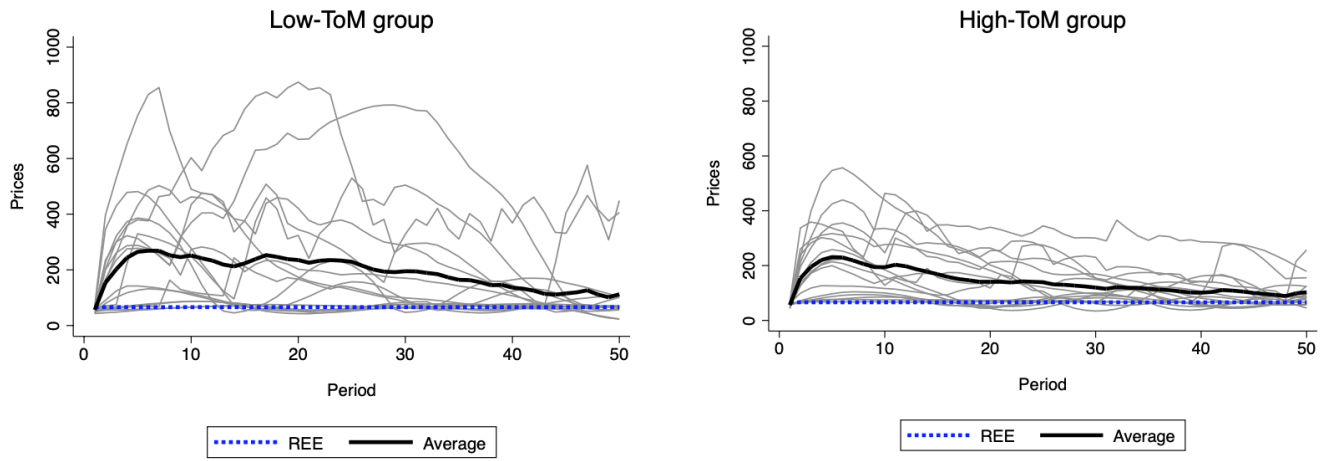


Figure 1: Realized market price in each of the individual markets in six sessions (grey lines), fundamental value (REE, in blue dotted line), and average value of realized market price (black line)

Result 1: "Bubble" Measures in Stöckl et al. (2010)

- On the aggregate level, Low-ToM group forms a 40% larger bubble than the High-ToM group; On the individual-market level, some heterogeneity of markets within the same treatment group is observed.

	(RD in %)		(RAD in %)	
Session	**Low-ToM**	**High-ToM**	**Low-ToM**	**High-ToM**
1	395	138	395	142
2	154	117	164	117
3	60	56	60	75
4	-2	7	9	8
5	14	1	23	2
6	21	63	28	63
7	4	225	13	226
8	68	14	86	26
9	595	116	604	116
10	568	14	568	30
11	133	379	139	380
12	4	9	14	19
13	186	212	194	224
14	397	187	397	197
15	291	232	296	232
16	125	39	135	53
Average	188	113	195	119
Low ToM – High ToM [p-value]				
Rank sum	0.72 [0.491]		0.75 [0.468]	
OLS	34.37 [0.592]		36.96 [0.559]	
Cohen's d	0.46		0.48	

Observation 1: Although the High-ToM group forms a price bubble about 40% smaller on the aggregate level, there is no significant difference in price deviation from REE between Low- and High-ToM markets.

Result 2: Impact on Market Volatility

- On the aggregate level, Low-ToM group reveals a more considerable price variability;
- On the individual-market level, some heterogeneity of markets within the same treatment group is observed.
- Consistent result using only last 10 and 25 periods (i.e., allow for learning).

	Price Dispersion		Amplitude	
Session	**Low-ToM**	**High-ToM**	**Low-ToM**	**High-ToM**
1	111	67	465	247
2	74	25	259	144
3	44	63	182	222
4	8	4	32	22
5	22	1	86	4
6	25	17	90	75
7	10	74	33	275
8	127	35	534	207
9	252	79	768	296
10	257	20	817	67
11	124	73	427	411
12	11	13	41	41
13	149	158	458	523
14	192	113	783	357
15	135	60	425	255
16	99	48	341	169
Average	102	53	359	207
Low ToM – High ToM [p-value]				
Rank sum	1.62 [0.110]		1.66 [0.102]	
OLS	37.04* [0.090]		92.73 [0.164]	
Cohen's d	0.76		0.69	

Observation 2: Although the price variability is 35% smaller in the High-ToM group on the aggregate level, there is no significant difference in the price variability between Low- and High-ToM markets.

Takeaway

- Not much.
- We find the price bubbles are smaller and price are less volatile in high-ToM markets.
- ... but the difference is not statistically significant.
- Consistent result when including intermediate ToM groups.

Reply to Examiner

Possible extensions:

- Mix people with different ToM skills.
  - Market with $\uparrow$ heterogeneity in ToM are better: those with Low ToM may learn from those with high ToM
- Elicit ToM and CRT with different measures.

Result 3: Coordination of Price Expectation

- On the aggregate level, High-ToM group coordinates better; On the individual-market level, some heterogeneity of markets within the same treatment group is observed.

	Forecast Dispersion	
Session	**Low-ToM**	**High-ToM**
1	38	17
2	174	22
3	25	16
4	20	9
5	1	2
6	3	1
7	4	8
8	1	32
9	43	11
10	70	49
11	86	2
12	16	38
13	1	2
14	18	18
15	78	26
16	45	33
Average	188	113
Low ToM – High ToM [p-value]		
Rank sum	0.90 [0.381]	
OLS	8.96 [0.447]	
Cohen's d	0.59	

Observation 3: Although the High-ToM group coordinates better at about 75% on the price forecasts on the aggregate level, there is no significant difference in the coordination of price expectation between the Low- and High-ToM markets.

Reflection

Why ToM does not have impact on expectation coordination and price convergence to REE?

- Such that the ability to infer others' intention should *at least* lead to small dispersion in expectation?
- Hypothesis (proven later in chapter 3): the interface / design distracts them from inferring others' intention (**expectation**), but make their focus to switch to **price** movement / pattern recognition (they are paid on prediction accuracy of price!).