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Eizo Akiyama† Nobuyuki Hanaki‡ Ryuichiro Ishikawa§

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Abstract

We conducted asset market experiments where one experienced subject (EH) interacts with five inexperienced subjects (1EH5H) to investigate how EHs change their price forecasts and trading strategies when faced with strategic uncertainty caused by inflows of inexperienced subjects. Only half the EHs initially forecasted prices deviating more from the fundamental values in 1EH5H than in the final round of the experiment in which they had previously participated. Furthermore, the majority of our EHs did not change their trading behaviour. Many EHs act as price stabilisers when the inflow of inexperienced subjects is not associated with other changes in market conditions.

Keywords: Strategic uncertainty, Experience, Heterogeneity, Experiment, Asset markets

JEL Code: C90, D84

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†Faculty of Engineering, Information and Systems, University of Tsukuba. E-mail: eizo@sk.tsukuba.ac.jp

‡Aix-Marseille University (Aix-Marseille School of Economics), CNRS & EHESS, and IUF. Corresponding author. GREQAM, Université dAix-Marseille, 3, Avenue Robert Schuman, 13628 Aix-en-Provence, Cedex 1, France. E-mail: nobuyuki.HANAKI@univ-amu.fr

§Faculty of Engineering, Information and Systems, University of Tsukuba. E-mail: ishikawa@sk.tsukuba.ac.jp

1 Introduction

Kindleberger and Aliber (2005) report many spectacular examples of "bubbles" and "crashes" throughout history. However, clearly identifying a price "bubble" in a real financial market, i.e., proving that the price of an asset far exceeds its fundamental value, is difficult because of the challenges associated with measuring the fundamental value. As a result, scholars disagree over whether a particular episode was a bubble.[1] To overcome this difficulty and to gain a better understanding of the causes behind price bubbles, economists have resorted to the experimental paradigm pioneered by Smith et al. (1988).

Smith et al. (1988) conducted a set of laboratory experiments in which a group of subjects traded assets over T periods. Subjects were informed that (1) the market would close after T periods, (2) each unit of asset would pay a dividend, d_t, at the end of each period, (3) the value of the dividend payment in each period would be determined uniformly randomly from a known pre-specified set of values, and (4) the asset would have no value after the final dividend payment. Since there is no intrinsic value to the asset other than the stream of dividend payments, under these conditions the fundamental value, FV_t, of a unit of asset in period $t \in \{1, 2, ..., T\}$ is the sum of its expected remaining dividend payments, that is,

$$FV_t = \sum_{s=t}^{T} E(d_s).$$

The surprising experimental results, contrary to what is predicted by a model assuming risk neutral rational traders and common knowledge of rationality, were that subjects traded this asset at prices that deviated substantially from the fundamental values. In particular, contrary to the constantly declining fundamental values of the asset, observed price dynamics showed what is often called a "bubble" and "crash" pattern. Many studies have replicated the findings of Smith et al. (1988) under various experimental setups with a variety of subject pools.[2] These experimental

[1] See, for example, Garber (1989) who argues that the Dutch tulip-mania in 1634-1637 was not a bubble except for the last month of speculation.

[2] While most of the studies, including (Smith et al., 1988), considered continuous double auction markets, van Boening et al. (1993), Haruvy et al. (2007), and Akiyama et al. (2013) considered call markets. They reported that prices deviated substantially from the fundamental values in call markets as well. Both Porter and Smith (1995) and Akiyama et al. (2013) eliminated the uncertainty over dividend payments. Even under known dividends, substantial mispricing was observed. King et al. (1993) investigated the effects of short-selling, margin-buying, equal endowment, and circuit breakers. They also conducted experiments with corporate executives and stock market dealers to see the effect of different subject pools. "Bubbles" and "crashes" were observed in most of their experiments, except those in which transaction fees were introduced or where subjects had experienced the same market conditions twice. Haruvy and Noussair (2006) showed that allowing short-selling can cause prices to deviate substantially below the

findings are complemented by recent empirical findings by Xiong and Yu (2011) who investigated "bubbles" in a subset of China's warrant market, which is "unique in that the underlying stock prices make warrant fundamentals publicly observable and warrants have predetermined finite maturities" (Xiong and Yu, 2011, p. 2723) exactly as in this experimental paradigm.

Apart from the initial "bubbles" and "crashes", another more robust finding from the literature is that if the same set of subjects trade in the same market conditions a number of times, by the third time, the subjects have learned to trade the asset at prices close to their fundamental values. The literature suggests that, in the beginning, prices deviate from the fundamental values not only because of inexperienced subjects' confusion regarding the declining fundamental values (Huber and Kirchler, 2012; Kirchler et al., 2012) or some non-profit related motivation (Lei et al., 2001) but also owing to the strategic uncertainty, i.e., uncertainty about others' behaviour, these subjects face (Akiyama et al., 2013; Cheung et al., 2012). These initial feelings of confusion (or bounded rationality) and strategic uncertainty diminish over time as all subjects in a market adaptively learn and adjust their price expectations and trading behaviour based on the commonly observed prices (Haruvy et al., 2007). As a result, after several rounds, both the subjects' price expectations and the market prices converge to their fundamental values.[3]

However, as Kindleberger and Aliber (2005) note, historical episodes of bubbles are often characterised with euphoria and an inflow of new investors. Xiong and Yu (2011) also pointed out "the importance of inflow of new investors in understanding prolonged asset bubble" (Xiong and Yu, 2011, p. 2752). Therefore, to gain a better understanding of markets outside the laboratory, in particular, how experienced investors react to the inflow of new and inexperienced traders, it is not sufficient to study experimental markets consisting solely of inexperienced or experienced traders. One needs to study markets in which both experienced and inexperienced traders co-exist.

Dufwenberg et al. (2005) studied such markets by letting subjects trade three times in a 10-period experimental asset market consisting of six traders, and then replacing two (or four) of the six experienced subjects with the same number of inexperienced subjects. Except for this change in the composition of traders, the experimental conditions in these new markets remained the same as

fundamental values. Noussair et al. (2001) reported bubbles in markets with a constant fundamental price, i.e., the expected value of the dividend per period is zero and an asset is converted into a fixed sum of money at the end of the final trading period. See (Stöckl et al., 2010) and the references therein for details of other experiments.

[3]Hussam et al. (2008) have shown that a "bubble" re-emerges when experienced subjects, who have learned to trade at prices close to the fundamental values in certain market conditions, face new market conditions (characterised by a higher variance in dividend payments and a higher cash/asset ratio). This finding raises an interesting question about what subjects have "learned" in the first environment.

before. Dufwenberg et al. (2005) found that the magnitude of mispricing was significantly smaller in mixed markets consisting of both experienced and inexperienced subjects than in those consisting of inexperienced subjects only (i.e., the first round for the initial set of subjects). They did not, however, find any significant difference in mispricing in markets consisting only of the twice-experienced subjects (i.e., the third experiment for the initial set of subjects) or in mixed markets.

The absence of significant differences in mispricing in the three kinds of markets involving experienced subjects is quite surprising.[4] This is so because, from the point of view of *experienced* subjects, a large inflow of *inexperienced* subjects introduces strategic uncertainty into the market, and it has recently been shown that strategic uncertainty leads not only to large deviations of the price expectations from the fundamental values among inexperienced subjects (Akiyama et al., 2013), but also to large mispricing in markets consisting exclusively of extensively trained inexperienced subjects (Cheung et al., 2012).[5] Thus, we would like to better understand how *experienced* subjects react, by changing their price forecasts and trading strategies, to strategic uncertainty caused by a large inflow of *inexperienced* subjects. This is the main research question we set out to answer in this paper. Since the literature provides a great deal of results regarding how inexperienced subjects change their forecasts and trading behaviour in these markets (see, for example, Haruvy et al., 2007; Akiyama et al., 2013, among many others), our focus on the response of experienced subjects to the inflow of new traders is a natural building block to better understand the effect of such inflows.

To answer our research questions, we build on the experiments reported in Akiyama et al. (2012, 2013) identifying the magnitude of the effect of strategic uncertainty and bounded rationality (or confusion) among *inexperienced* subjects. They achieved this goal by comparing the price forecasts submitted by inexperienced subjects in two markets consisting of six traders: one in which all six traders were inexperienced subjects (6H), and the other in which one inexperienced subject interacted

[4]It should be noted, however, that unlike many studies that reported convergence of prices toward the fundamental values after two rounds of experiments, large mispricing persisted even in the third round in the experiment reported by Dufwenberg et al. (2005).

[5]Cheung et al. (2012) investigated the effect of strategic uncertainty, which can be caused by uncertainty regarding how well others have understood the nature of fundamental values, in experimental asset markets by (1) training subjects extensively on the nature of fundamental values, and (2) manipulating the subjects knowledge about whether all the other players in the same market have undergone the same extensive training. The latter manipulation can be achieved by implementing the following two treatments: (a) training everyone in the room and ensuring that they all know that everyone in the room has been trained, and (b) training only half the subjects in the room and telling everyone that not everyone in the room has been trained. In (b) however, the subjects are not told that groups are created in such a way that either all the subjects in a group are trained or none of them is. Treatment (b), therefore, makes trained subjects believe that not all the other subjects in their group understand the declining nature of fundamental values when, in fact, their group consists only of trained subjects. The authors found that the magnitude of mispricing is substantially smaller when all the subjects are trained and know that they are all trained than when all subjects are trained but do not know that they are all trained. They also reported that, in the latter case, the mispricing is as great as in the case where training is absent.

with five computer traders placing orders at the fundamental values (1H5C). To eliminate as much uncertainty as possible, other than strategic uncertainty in the experiment, Akiyama et al. (2012, 2013) assumed fixed dividend payments and symmetric initial endowments. In all the experiments, subjects were told about the composition of the six traders in their market. In addition to the composition of traders, subjects in 1H5C were informed how computer traders behave.[6] Since the behaviour of all the other five traders is known, strategic uncertainty is absent in 1H5C, and therefore, a rational subject should expect the prices to follow the fundamental values in 1H5C. Thus, any deviations of the price expectations from the fundamental values in 1H5C are due to the subjects' bounded rationality or confusion. On the other hand, a rational subject may not expect the prices to follow the fundamental values in 6H because of strategic uncertainty. Therefore, the deviations of price expectations from the fundamental values in 6H are due to both strategic uncertainty and bounded rationality. By subtracting the former from the latter, one can identify the effect of strategic uncertainty.[7] Akiyama et al. (2013) found that (a) both strategic uncertainty and bounded rationality play a significant part in explaining forecast deviations, and (b) the magnitude of the effect of strategic uncertainty is positively correlated with subjects' scores in the Cognitive Reflection Test (Frederick, 2005). Akiyama et al. (2013) also reported that many subjects in their experiment (especially those in 1H5C) learned to expect the prices to follow the fundamental values at the beginning of the third round of the experiment.

We investigate how *experienced* subjects react, in terms of changing their price forecasts and trading strategies, to strategic uncertainty caused by an inflow of new and *inexperienced* subjects. This is done by recruiting subjects who have experienced either the 1H5C or 6H market on three occasions, and letting them trade in a market where all the other traders are subjects who have never participated in a similar experiment (we call this market 1EH5H, denoting one experienced human, EH, and five inexperienced humans, H). Also, except for the composition of the traders, the experiment is identical to that in Akiyama et al. (2013) to minimise the confusion for the *experienced*

[6]Akiyama et al. (2013) is a revised version of Akiyama et al. (2012), with results obtained from an improved experimental setup. The main difference between the two is the description of the behaviour of computer traders. In Akiyama et al. (2012) subjects were told that computer traders aimed to maximise their expected profits without making any mistakes, assuming that all the other traders did the same. In Akiyama et al. (2013), on the other hand, subjects were told that the computer traders placed orders at the fundamental values. While the initial forecast deviations in 1H5C and 6H are significantly different in Akiyama et al. (2013), this is not the case in Akiyama et al. (2012). This difference can be ascribed to the difficulties subjects faced in understanding how the profit maximising computer traders behaved.

[7]Akiyama et al. (2012, 2013) computed the magnitude of the deviations of price forecasts from the fundamental values by eliciting subjects' price forecasts for all the remaining periods at the beginning of each period as in Haruvy et al. (2007).

subjects in 1EH5H. We made it clear to all the subjects that of the six traders in their market, one had participated in a similar experiment[8] either with all human traders or with five computer traders in the morning of the same day, whereas the other five traders were participating in this experiment for the first time. Unlike the experienced subjects in the 2EH4H or 4EH2H markets studied by Dufwenberg et al. (2005), a single *experienced* trader in the 1EH5H market faces the maximum strategic uncertainty that can be caused by the inflow of new and inexperienced traders because all the other traders are such traders.[9]

We measure the effect of the strategic uncertainty an *experienced* subject faces as a result of the inflow of five inexperienced subjects by differentiating the magnitude of his/her initial forecast deviations from the fundamental values in 1EH5H and those at the beginning of the final (third) round of the market in which s/he was participating (either 1H5C or 6H). We also compare the orders experienced subjects submitted in the first round of 1EH5H and the final round of either 1H5C or 6H to see how their orders change when faced with an inflow of inexperienced subjects in 1EH5H. We complement our analyses by running additional experiments in which subjects, who had completed 6H or 1H5C, were asked to forecast the prices observed in (the first round of) a randomly chosen 1EH5H market (we refer to these experiments as FO, denoting forecast-only) and measure the differences in the magnitude of forecast deviations between the first period of FO and the beginning of the third round of 1H5C or 6H.

We find that the mispricing observed in 1EH5H markets is significantly larger than that observed in the third round of the 6H markets (where all the traders are experienced). Thus, a significant inflow of inexperienced traders causes prices to deviate from the fundamental values. But this is not because of the responses of experienced subjects to the strategic uncertainty generated by the inflow of new traders. Rather, it is mainly due to the behaviour of the inexperienced traders. Our results suggest that experienced subjects act as price stabilisers, instead of destabilisers, when faced with an inflow of inexperienced subjects. As a result, the mispricing observed in the first round of 1EH5H is significantly smaller than that in the first round of the 6H market (where all the traders were inexperienced).

In terms of price forecasts, only half of our experienced subjects in 1EH5H (regardless of whether

[8] In fact, this experiment is identical to 6H, except that everyone was inexperienced in the latter.

[9] Akiyama et al. (2012) also reported a set of results obtained from 1EH5H, where the experienced subjects were those who had participated in the version of 1H5C reported in Akiyama et al. (2012). The experiment as well as the results reported in the paper, however, are based on the more recently conducted experiments.

they had gained experience in 1H5C or 6H) responded to the strategic uncertainty caused by the extreme inflow of inexperienced subjects by initially forecasting prices that deviated more from the fundamental values than in the final round of 1H5C or 6H. Furthermore, most of the other experienced subjects whose initial price forecasts did not change in response to the inflow of inexperienced subjects initially forecast prices that follow the fundamental values. This was also the case in the FO experiments where experienced subjects from 1H5C and 6H tried to forecast the prices in a 1EH5H market.

The price forecasts submitted by inexperienced subjects in 1EH5H markets did not deviate significantly more from the fundamental values than those in 6H markets. Thus, being aware that one of the six traders in the market is experienced did not significantly affect the initial forecasts of the inexperienced subjects.

In terms of trading strategies, the majority of our experienced subjects learned to submit buy orders no greater than the fundamental values and sell orders no less than these values by the beginning of round 3 of 1H5C or 6H. The inflow of inexperienced traders did not significantly change the kind of orders submitted by these experienced subjects in 1EH5H; in fact, these orders acted as a price stabilising, rather than destabilising, force in the face of the inflow of inexperienced subjects. In a recent closely related study conducted independently to ours, Xie and Zhang (2012) reported very similar results. Instead of allowing experienced traders to face inexperienced subjects after three rounds, Xie and Zhang (2012) considered a constant and steady inflow of inexperienced traders after each round. That is, after the first round, 1/3 (or 2/3) of the six traders in the market were replaced with inexperienced traders. They showed that mispricing does not differ significantly between the first round (where everyone is inexperienced) and the later round (where 1/3 or 2/3 of the traders are experienced). Their analyses show, similar to ours, that this is mainly because inexperienced subjects destabilise the prices by submitting buy orders above and sell orders below the fundamental values, and not because experienced traders respond strategically to the inflow of inexperienced traders.[10]

1EH5H is clearly an extreme situation because, suddenly, the market is dominated by inexperienced traders. If the initial response by experienced subjects to such an extreme change is quite small as we have seen in our experiments, we expect, it will be even more limited in the face of smaller inflows of inexperienced subjects. Thus, for the inflow of new traders to have a substantial impact

[10] Xie and Zhang (2012), however, did not gather the subjects forecast data as we do in this paper.

on the occurrence of a bubble, it must be of sufficient magnitude so that the price destabilising force introduced by the new traders is stronger than the price stabilising force of the experienced traders as in our experiments and those by Xie and Zhang (2012), and/or it must introduce additional changes in the market conditions besides the composition of traders, for example, increased liquidity in the market (Deck et al., 2011).[11] It has been shown that increased liquidity, combined with increased uncertainty about dividend payments, can re-generate the bubble even in markets consisting only of experienced traders (Hussam et al., 2008). Therefore, we would expect that inflows of new traders associated with such changes in market conditions are very likely to cause a bubble to emerge.

The rest of this paper is organised as follows. Section 2 describes in detail, the experimental design of the 1EH5H experiment. Section 3 summarises the results from 1EH5H. The explanation and results of the additional forecast-only experiments are reported in Section 4. The final section summarises the paper.

2 Experimental design

We set up an experimental *call* asset market consisting of six traders, one *experienced* (1EH) and five *inexperienced* (5H). Inexperienced traders are subjects who have not previously participated in a similar experiment, while experienced traders are those who participated in the same experiment—except for the composition of the six traders—in the morning of the same day. Half the experienced traders had participated in a market in which all six traders, including themselves, were inexperienced (6H). The other half had participated in a market where the five other traders were computer programs (1H5C). In both the 6H and 1H5C markets, subjects were informed of the composition of the six traders in their market. Moreover, those in 1H5C markets were explicitly told how the five computer traders would behave. The details as well as the results of the 6H and 1H5C experiments are reported in (Akiyama et al., 2013).

Depending on the market in which an experienced subject has participated, we set up two

[11] Deck et al. (2011), instead of repeating the same experiment by changing the composition of experienced and inexperienced traders from one round to the next, allowed inexperienced subjects to enter into and experienced subjects to exit from the market during a single 25-period market. In other words, in one experimental session Deck et al. (2011) separated their 18 subjects into three groups of six subjects with each group entering and exiting the market at different points in time. The first group of six, who were endowed with both assets and cash, were active in the market from period 1 to 10, the second group, who were endowed with cash only, entered the market in period 6 and remained active until period 20, while the third group, who were also endowed with cash only, entered the market in period 16 and remained active until the end. Deck et al. (2011) reported M-shaped price dynamics, i.e., double occurrences of bubbles and crashes, during the 25 periods. Prices increase when a new group of traders inject cash into the market, and collapse when an old group of traders exit taking cash out of the market.

versions of 1EH5H markets: $1EH_{6H}5H$ and $1EH_{1H5C}5H$ where the EH has participated in a 6H and 1H5C market, respectively. In what follows, we denote the former as $1E_{6H}$ and the latter as $1E_{5C}$. We clearly informed all subjects that one of the traders in their group had participated in an experiment with the same setup[12] (in $1E_{6H}$) or a similar experiment where s/he traded with five computer traders ($1E_{5C}$) in the morning of the same day, whereas the other five were participating in the experiment for the first time.

In each market, traders can trade an asset with a life of 10 periods. A unit of the asset pays a dividend of 12 ECU (called Marks in the experiment) at the end of each period for a duration of 10 periods. We selected a fixed dividend to eliminate uncertainty, other than strategic uncertainty, as much as possible from the market. After the final dividend payment at the end of period 10, the asset has no value. Thus the fundamental value of a unit of the asset at the beginning of period t, FV_t, is $FV_t = 12 \times (11 - t)$. We distributed a table showing the sum of the remaining dividends after the dividend for each period has been paid, a value we call the "next value" in the experiment. Thus, subjects had access to a table showing FV_t for $t = 1, 2, ..., 10$ and could refer to this any time during the experiment.

Initially, each trader was given four units of the asset and 520 ECU cash. Traders could use these endowments, as well as the cash they received from dividend payments, to trade. At the beginning of each period and before they submitted their orders, subjects were also asked to submit their expectations about the prices of a unit of the asset in all the remaining periods.

The call market rule we employ is very similar to that of van Boening et al. (1993) and Haruvy et al. (2007). In each period, each trader can submit at most one buy order and one sell order.[13] An order consists of a pair of values: a price and a quantity. When submitting a buy order, a trader must specify the *maximum price*, PD, at which s/he is willing to buy a unit of asset, and the *maximum quantity*, QD, s/he is willing to buy. In the same manner, when submitting a sell order, a trader must specify the *minimum price*, PS, at which s/he is willing to sell a unit of asset, and the *maximum quantity*, QS, s/he is willing to sell. We attached three constraints: the admissible price range, a budget constraint, and the relationship between PD and PS in the case that a subject submits both buy and sell orders. The admissible price range is set so that, when $QD \geq 1$ ($QS \geq 1$),

[12] The experiments are identical except that everyone was inexperienced in 6H

[13] Of course, a trader can choose not to submit any orders by specifying zero as the quantity to buy or sell. We imposed a 60 second, non-binding, time limit for submitting orders. When the time limit was reached, the subjects were simply informed, through a flashing message in the upper right corner of their screen, to submit their orders as soon as possible.

PD (PS) must be an integer between 1 and 2000, i.e., $PD \in \{1, 2, ..., 2000\}$ ($PS \in \{1, 2, ..., 2000\}$). The budget constraint simply means that neither borrowing of cash nor short-selling of an asset is allowed.[14] The final constraint is such that when a trader is submitting both buy and sell orders, i.e., $QD \geq 1$ and $QS \geq 1$, the maximum buying price must not be greater than the minimum selling price, i.e., $PS \geq PD$. Once all the traders in the market have submitted their orders, the price that clears the market is calculated,[15] and transactions take place at that price among traders who submitted a maximum buying price no less than, or a minimum selling price no greater than, this market clearing price.[16]

At the beginning of each period, subjects were asked to submit their price forecasts for all the remaining periods in the market.[17] In other words, in period t, each subject submitted $10 - t + 1$ forecasts.[18] Therefore, subjects submitted a total of 55 price forecasts over the 10 periods. Subjects were informed that they would receive the following bonus payment based on how accurate their forecast prices were:

$$\begin{aligned}\text{Bonus (in ECU)} = 0.5\% & \\ & \times \text{(number of forecasts that were within } \pm \text{ 10 \% of the actual market price)} \\ & \times \text{final cash holding in period 10.}\end{aligned}$$

Therefore, if all 55 forecasts were within 10% of the realised prices, the subject would receive 27.5% of his/her final cash holding as a bonus payment. This incentive scheme for accurate forecasts was chosen to reduce subjects' attempts to influence prices to move closer to their forecasts by making losses.[19] When submitting price forecasts, all previous market clearing prices are shown on the

[14]Thus, the budget constraint implies (i) $QD \times PD \leq$ cash holding at the beginning of the period, and (ii) $QS \leq$ units of asset on hand at the beginning of the period.

[15]When there are several such prices, the lowest one is chosen as the market clearing price. This is important to ensure the price does not increase in the absence of transactions at the market clearing price.

[16]Any ties among the last accepted buy or sell orders are resolved randomly. It is possible that no transaction will take place given the computed market clearing price.

[17]Although this was not stated explicitly in the instructions, each price forecast takes the form of an integer value between 0 and 2000. We set this range to match the admissible values of orders. If subjects tried to submit a value outside this range, an error message stating that the forecast must be in the above range would be displayed on their computer terminal.

[18]We imposed a 120 second, non-binding, time limit for submitting price forecasts. When the time limit was reached, the subjects were simply told, through a message flashing in the upper right corner of their screen, to submit their forecasts as soon as possible.

[19]As noted by Haruvy et al. (2007), there is a trade-off between an incentive for accurate transactions and an incentive for maximising profit from trading. In other words, because we asked subjects to submit their forecasts before submitting their orders, it is possible that if the incentive for accurate forecasts was too high, subjects would potentially submit loss-making orders to influence the prices to move closer to their forecasts. In our design, since the bonus for accurate forecasts is a fraction of the final cash holding, this possibility is reduced. It is, of course, best to

screen. Our design is closely related to that used by Haruvy et al. (2007), who showed substantial deviations of both realised price and price forecasts from the fundamental values.

At the end of each period, subjects were informed of the market clearing price for the period, the units of asset they had traded,[20] their cash and asset holdings, the number of price forecasts that were within 10% of the actual market prices up to that period, and the next value of a unit of the asset.[21]

As noted above, each trader was given an endowment of 520 ECU cash and four units of the asset before the market opened in period 1. The same group of traders, with identical initial endowments of cash and assets, repeated the same 10-period market three times as one experiment. We call a 10-period market a round. Thus, the experiment consisted of three rounds of a 10-period market with identical initial endowments and the same group of subjects.[22]

At the end of the experiment (after participating in all three rounds of the 10-period market), subjects were paid in cash the sum of their final cash holdings (including the bonus payment for accurately predicting future market prices) for each round plus a participation fee of 500 yen. We used an exchange rate between ECU and Japanese yen of 1 ECU = 1 Japanese yen. The experiment lasted about two and a half hours including the explanation of the instructions and completion of a questionnaire after the experiment.[23] The questionnaire consisted of the Cognitive Reflection Test (CRT) proposed by Frederick (2005)[24] and a question asking each subject to explain why s/he made

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have both accurate forecasts and high profit from trading.

[20]In the presentation of this information, a positive (resp. negative) number denotes that they had bought (resp. sold) a certain number of units of asset.

[21]The next value of an asset at the end of period t is $12 \times (10 - t)$.

[22]Before entering round 1, there was a practice period to allow subjects to familiarise themselves with the user interface of the software. Subjects were given their initial endowment of cash and assets, and asked to enter their price forecasts for the 10 periods and their orders for period 1. Information regarding the resulting market clearing price and so on were not shown to the subjects.

[23]See Appendix A for an English translation of the instructions.

[24]The Cognitive Reflection Test consists of the following three simple questions, structured in such a way that intuitive or "impulsive" (Frederick, 2005, p. 26) answers are incorrect:

1. A bat and a ball cost $1.10 in total. The bat costs $1.00 more than the ball. How much does the ball cost? ___ cents.
2. If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets?___ minutes.
3. In a lake, there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half the lake? ___ days.

In translating the first question into Japanese, we changed $1.10 and $1.00 to 11,000 and 10,000 yen, respectively. The score for this test, computed simply as the number of correct answers to these three questions, has been shown to correlate with several behavioural "anomalies." For example, it correlates negatively with lower incidences of the conjunction fallacy and conservatism in updating probabilities (Oechssler et al., 2009), the deviation of a chosen number from the Nash equilibrium in beauty contest games (Brañas-Garza et al., 2012). Corgnet et al. (2013) reported that subjects with low CRT scores tend to buy (sell) an asset at prices above (below) fundamental values while the opposite is true for those with high CRT scores.

Date	Treatment	No. of subjects (EH)
May 26, 2013 (PM)	$1E_{5C}$ (EH from 1H5C)	48 (8)
June 1, 2013 (PM)	$1E_{6H}$ (EH from 6H)	48 (8)
June 2, 2013 (PM)	$1E_{5C}$ (EH from 1H5C)	42 (7)
June 15, 2013 (PM)	$1E_{6H}$ (EH from 6H)	48 (8)

Table 1: Summary of experimental sessions.

the forecasts s/he did during the experiment by showing on the computer screen all the forecasts the subject has submitted during the experiment. Subjects earned on average about 4000 yen.

3 Results

A set of computerised experiments was conducted at the University of Tsukuba between May and June 2013.[25] One hundred fifty-five subjects who had never participated in a similar experiment were recruited as *inexperienced* subjects from across the campus via e-mails and flyers.[26] In total, 31 subjects who had participated in either 1H5C or 6H experiments in the morning of the same day as inexperienced subjects were recruited as participants in the 1EH5H experiment as *experienced* subjects. Table 1 summarises the experimental sessions.[27]

Our main interest is to understand the changes, if any, in the price forecasts and the orders submitted by *experienced* subjects in response to the inflow of inexperienced subjects at the beginning of 1EH5H. Thus, in this section, we first discuss the initial forecast deviations by experienced subjects. We then move on to a discussion of the initial forecast deviations by inexperienced subjects and show that knowledge of the existence of one experienced subject (out of six) in the market does not affect their price forecasts significantly compared with the markets where all six traders are inexperienced. After comparing the realised prices in the 1EH5H and 6H markets, we show that the difference is

[25] The experiments were implemented with z-tree (Fischbacher, 2007).

[26] Subjects had to register on our database before the experiment. We confirmed their lack of participation in past experiments by checking their names, student ID numbers, and e-mail addresses.

[27] As noted in (Akiyama et al., 2013), after conducting in-depth analyses of the data for 1H5C from the May 26th and June 2nd sessions, we realised that there was an error in a parameter value regarding how subjects were grouped in these sessions. As a result of the error, the subjects in these 1H5C sessions were grouped in such a way that four (or three) humans were combined with 20 (or 15) computer traders, and not one human with five computer traders as intended. The only way that subjects would realise that they were grouped differently from how they were instructed was to submit a buy order $\{PD_t, QD_t\}$ such that $PD_t > FV_t$ and $QD_t > 24 - q_t$ where q_t is the amount of stock held by the trader at the beginning of period t. Such an order would result in a market price of PD_t and the subject buying all the assets (so that s/he would hold all 24 units of the asset after the transaction) in 1H5C. However, given that the market price was FV_t, the subject ended up holding more than 24 units of the asset in these sessions. There were six subjects who experienced such an outcome at least once during these sessions, one of whom was recruited as an experienced subject in $1E_{5C}$. We omitted the data associated with the group to which this experienced subject belonged from our analysis. This is the reason for the small number of subjects for the June 2nd session.

mainly due to the orders submitted by experienced subjects. The dynamics of forecast deviations, for both experienced and inexperienced subjects, are discussed at the end of this section.

3.1 Initial forecasts of experienced subjects

One of our main interests in this paper is the price forecasts initially submitted by *experienced* subjects. We summarise the magnitude of forecast deviations from the fundamental values for each subject by modifying the measure of price deviations from the fundamental values, that is, the relative absolute deviation (RAD) proposed by Stöckl et al. (2010).

For subject i in treatment $z \in \{1H5C, 6H, 1E_{6H}, 1E_{5C}\}$,[28] the magnitude of the deviations of the forecasts submitted in period t of round r from the fundamental values is measured as the relative absolute forecast deviation ($RAFD^i_{t,r}$) defined as:

$$\text{RAFD}^{i\in z}_{t,r} = \frac{1}{T-t+1}\sum_{p=t}^{T}\frac{|f^{i\in z}_{t,p,r} - FV_p|}{|\overline{FV}|}$$

where T is the number of periods ($T = 10$ in our experiments), $f^{i\in z}_{t,p,r}$ is the forecast of asset price in period p submitted by subject i in period t of round r of treatment z, FV_p is the fundamental value of the asset in period p, and $|\overline{FV}|$ is the absolute value of the average fundamental value of the asset over all periods.[29] Henceforth in this paper, we replace superscript $i \in z$ by z or simply suppress it whenever the treatment is clear.

Before investigating the initial price forecasts of experienced subjects in two 1EH5H treatments, we summarise the evolution of their forecasts in 1H5C and 6H treatments. Figure 1 shows the cumulative distribution of $RAFD$ for our experienced subjects in two 1EH5H treatments, that is, when they first participated in 1H5C (left) or 6H (right) treatments as inexperienced subjects. In

[28] Only experienced subjects in $1E_{6H}$ and $1E_{5C}$ participated in two treatments. All the others participated in only one of the four treatments.

[29] We omit subscript r for FV_p, $|\overline{FV}|$, and T because these values remain constant in all three rounds of our experiment. One could also consider normalising the measure using the average fundamental value of the asset over the remaining periods after period t. We avoid this to keep the denominator constant for all t. Another measure could also be defined by modifying the relative deviation (RD) proposed by Stöckl et al. (2010). This measure, called the relative forecast deviation ($RFD^{i\in z}_{t,r}$), is defined as

$$\text{RFD}^{i\in z}_{t,r} = \frac{1}{T-t+1}\sum_{p=t}^{T}\frac{f^{i\in z}_{t,p,r} - FV_p}{|\overline{FV}|}.$$

The only difference between $RAFD$ and RFD is the numerator. The former uses absolute values, while the latter does not. As noted by Stöckl et al. (2010), these two measures are complementary in that, whereas $RAFD$ shows the magnitude of the forecast deviations, RFD shows the direction of these deviations. Where necessary we refer back to RFD, but most of our discussion on the effect of strategic uncertainty is based on $RAFD$.

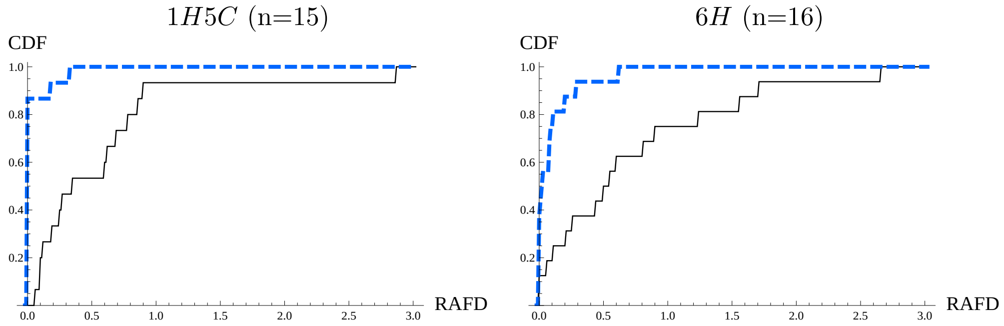


Figure 1: Empirical cumulative distribution of $RAFD^z_{1,1}$ (thin black line, first period of the first round) and $RAFD^z_{1,3}$ (blue dashed line, first period of the third round) in 1H5C (left) and 6H (right) for those subjects recruited as experienced traders in the 1EH5H experiments.

both panels, the thin curve shows the distribution of $RAFD_{1,1}$ for the first period of the first round, while the thick dashed curve shows the distribution of $RAFD_{1,3}$ for the first period of the third (final) round of the respective treatments.

As can be seen in both the 1H5C and 6H treatments, but especially in 1H5C, the subjects have learned to expect the prices to be very close to the fundamental values after participating in the market twice (i.e., the beginning of the third round, dashed line), compared with what they expected at the very beginning of the experiment (thin line). That is, 13 out of the 15 experienced subjects in $1E_{5C}$ learned to forecast prices that follow the fundamental values exactly over 10 periods by the beginning of round 3 when participating in 1H5C. On the other hand, of the 16 experienced subjects in $1E_{6H}$, only six actually forecast prices that follow the fundamental value over 10 periods by the beginning of round 3 when participating in 6H.[30] This difference between the two treatments can easily be understood by considering the differences in prices observed by the subjects in these two treatments: those in 1H5C observed prices that follow the fundamental values exactly in each period from round 1, whereas those in 6H observed prices that deviate quite substantially from the fundamental values.

The impact of the strategic uncertainty (uncertainty about the behaviour of others) these experienced subjects faced in the 1EH5H treatment when they were informed that all the other traders in their market were inexperienced traders can be measured by $\Delta RAFD^i$, that is, the difference in magnitude of their initial forecast deviations in $1E_{5C}$ or $1E_{6H}$, and their forecast deviations at the

[30] Whereas more than 90% of the subjects who participated in 1H5C markets learned to do so by the beginning of round 3, more than 80% of subjects in 6H forecast prices that differed from the fundamental values even at the beginning of round 3. For further details see (Akiyama et al., 2013).

beginning of the final round of 1H5C or 6H. That is, for each experienced subject i, we can define, based on the treatment in which s/he is participating,

$$\Delta RAFD^{i\in 1E_{5C}} \equiv RAFD_{1,1}^{i\in 1E_{5C}} - RAFD_{1,3}^{i\in 1H5C},$$
$$\Delta RAFD^{i\in 1E_{6H}} \equiv RAFD_{1,1}^{i\in 1E_{6H}} - RAFD_{1,3}^{i\in 6H}.$$

When $\Delta RAFD^{i} > 0$, subject i's forecasts deviate more from the fundamental values owing to his/her uncertainty about the behaviour of inexperienced subjects in the 1EH5H treatment. For subjects with $\Delta RAFD^{i} \leq 0$, the adaptive force (i.e., subjects' tendency to anchor their price forecasts to observed past trends) identified by Haruvy et al. (2007) is so strong that their price forecasts do not react to the new information regarding the change in the composition of the trading group.

This within-subject measure of the effect of strategic uncertainty complements the between-subjects measure of the effect of strategic uncertainty proposed by Akiyama et al. (2013). Akiyama et al. (2013) measured the effect of strategic uncertainty by differentiating the initial $RAFD$ in markets where all traders are human (6H) and those where one human trader interacts with computer traders whose behaviour is known (1H5C) to remove the effect of confusion. Here we do not consider possible confusion of the experienced subjects because we expect that the experience of trading in the same market environment three times would have substantially reduced the confusion these subjects may initially have felt regarding the experiment.

The top panel of Figure 2 shows the empirical cumulative distributions of $\Delta RAFD$ for experienced subjects in $1E_{5C}$ (left) and $1E_{6H}$ (right). As seen from the two distributions, only half of our experienced subjects demonstrated $\Delta RAFD > 0$. Providing additional information about forecast deviations, the bottom panel of Figure 2 shows the scatter plots of $RAFD_{1,3}^{z}$ (x-axis) vs. $RAFD_{1,1}^{1E_z}$ (y-axis) for $z = (1H)5C$ (left) and $z = 6H$ (right) used to compute $\Delta RAFD$. Each point in the figure represents a single experienced subject. Please note that several points lie on top of each other (particularly at the origin). The points above the 45 degree line in the bottom two panels correspond with those subjects with $\Delta RAFD > 0$.

Let us now consider the detailed results for the experienced subjects in $1E_{5C}$ shown in the left panel of Figure 2. As noted above, of the 15 experienced subjects in the $1E_{5C}$ treatment, 13 had $RAFD_{1,3}^{i} = 0$, i.e., they forecast prices following the fundamental values over 10 periods at the beginning of round 3 in 1H5C. Of these 13, seven initially gave the same forecasts when faced with

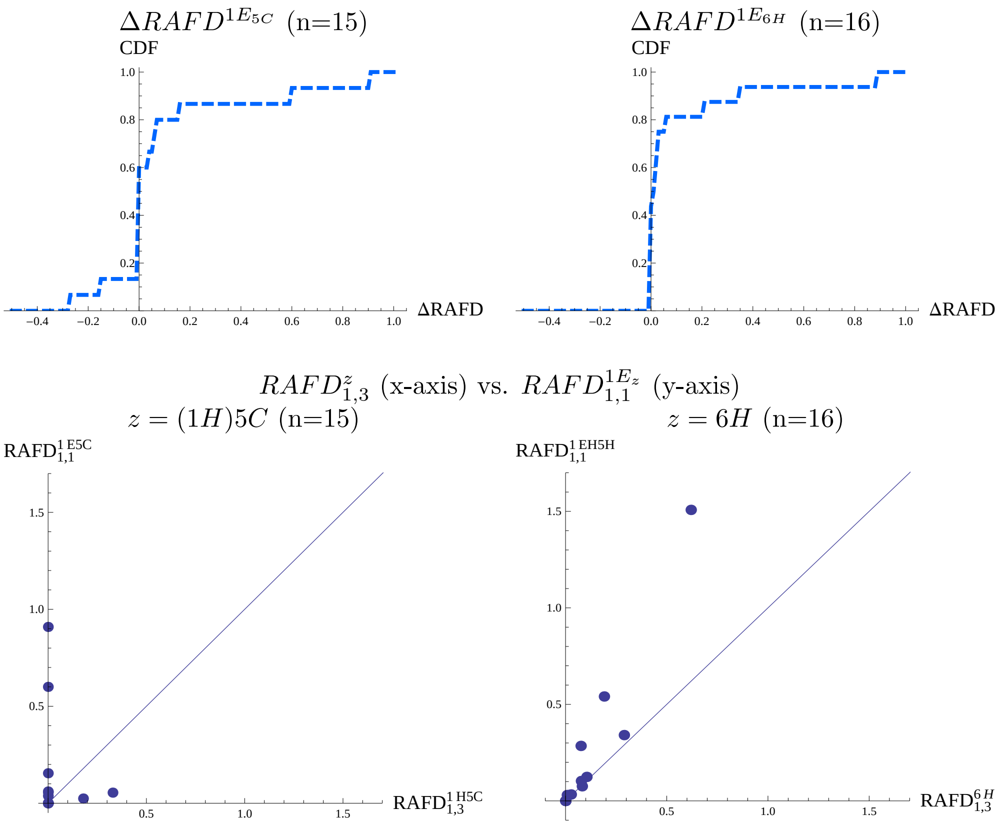


Figure 2: TOP: Empirical cumulative distribution of $\Delta RAFD^{1E_{5C}}$ (left) and $\Delta RAFD^{1E_{6H}}$ (right). BOTTOM: Scatter plot of $RAFD^{i\in z}_{1,3}$ (x-axis) vs. $RAFD^{1E_z}_{1,1}$ (y-axis) for $z = (1H)5C$ (left) and $z = 6H$ (right). Each point in the figure represents a single experienced subject.

five inexperienced subjects in $1E_{5C}$. That is, there are seven points on top of each other at the origin in the bottom left panel of the figure. (These subjects are depicted with $\Delta RAFD^i = 0$ in the top left panel.) Thus, almost half of the subjects who observed that the prices follow the fundamental values every period in 1H5C retained the same expectations when told that the other traders were all inexperienced human traders and not computers. The other six out of these 13, with $RAFD^{1H5C}_{1,3} = 0$, reacted to the change in composition of the other traders in the market by initially expecting the prices to deviate from the fundamental values in $1E_{5C}$, i.e., $RAFD^{1E_{5C}}_{1,1} > 0$. The remaining two subjects, who are depicted below the 45 degree line in the bottom left panel, forecast greater price deviations at the beginning of round 3 of 1H5C than at the beginning of the first round of $1E_{5C}$ (shown as negative $\Delta RAFD$ values in the top left panel). Thus, these two subjects continually adjusted their forecasts towards the fundamental values ignoring the new information

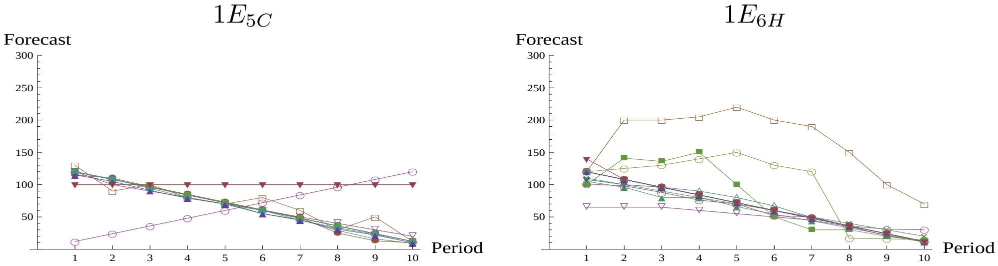


Figure 3: Initial price forecasts (in round 1, period 1) submitted by experienced subjects in $1E_{5C}$ (left) and $1E_{6H}$ (right).

regarding the inflow of inexperienced subjects.

Now we turn to the results from $1E_{6H}$ shown in the right panel of Figure 2. Of the 16 subjects who had experienced 6H markets, six forecast that prices would follow exactly the fundamental values at the beginning of round 3 of the 6H market. The same six subjects also made the same forecasts at the beginning of $1E_{6H}$, i.e., six points lie on top of each other at the origin in the bottom right panel. These six subjects did not react to the new information that all the other traders were inexperienced subjects. The magnitude of the forecast deviations of two of the remaining 10 experienced subjects was the same at the beginning of round 3 of 6H and the beginning of $1E_{6H}$ as depicted by the two points that are on the 45 degree line in the bottom right panel of Figure 2. These subjects also had $\Delta RAFD = 0$. The other eight experienced subjects expected the prices to deviate more, some only slightly and others substantially, from the fundamental values at the beginning of $1E_{6H}$ than at the beginning of round 3 in $6H$. Thus, they reacted to the uncertainty regarding the behaviour of the inexperienced subjects by forecasting prices that deviate more from the fundamental values.

These observations show that reaction to the strategic uncertainty introduced by the inflow of inexperienced traders varies across subjects, with some not showing any reaction to this information. Akiyama et al. (2013) also showed that the effect of strategic uncertainty varies across subjects, and is positively correlated with their scores in the CRT. Grouping the 31 experienced subjects in the 1EH5H treatments according to their CRT scores would not be very informative owing to the small sample size. Thus, we follow up on this heterogeneity in subjects reaction to strategic uncertainty with analyses based on the additional FO experiments involving a larger number of subjects in the next section.

While neither the two distributions of $\Delta RAFD$ shown in the top panel of Figure 2 nor the two distributions of the magnitude of the initial forecast deviations, $RAFD_{1,1}$, for experienced subjects in the two 1EH5H treatments are statistically significantly different,[31] the pattern of forecasts over the 10 periods initially submitted by these experienced subjects in the two 1EH5H treatments, shown in Figure 3, are quite different. In other words, when the experienced subjects in $1E_{6H}$, that is, those who had experienced trading with other human subjects in a 6H treatment, forecast prices deviating from the fundamental values, they did so in a way that was similar to the observed price patterns in a market where all traders were inexperienced. On the other hand, the forecasts of those experienced subjects in $1E_{5C}$ who had experienced trading with five computer traders and observed prices following the fundamental values, were either constant, monotonically increasing, or fluctuating around the fundamental values. No forecast initially submitted by the 15 experienced subjects in $1E_{5C}$ contained what we can call a "bubble and crash" pattern.

This difference may simply be due to the fact that those experienced subjects in $1E_{6H}$ had observed a "bubble and crash" pattern when everyone was inexperienced in the 6H treatment. In response to our post-experiment question on why they have forecast the way they did during the experiment, several subjects stated that they used what they had observed in early rounds of the 6H treatment as their benchmark. To verify this answer, we correlated the magnitude of price deviations from the fundamental values observed in 6H markets and the magnitude of forecast deviations from the fundamental values.

We measured the magnitude of price deviations from the fundamental values based on the relative absolute deviation, RAD, proposed by Stöckl et al. (2010). For group g in round r, the relative absolute deviation is defined as

$$\mathrm{RAD}_r^g \equiv \frac{1}{T}\sum_{p=1}^{T}\frac{|P_{p,r}^g - FV_p|}{|\overline{FV}|}.$$

We find that, as illustrated in Figure 4, the magnitude of initial forecast deviations submitted by the experienced subjects in $1E_{6H}$, $RAFD_{1,1}$, are highly correlated with the realised magnitude of price deviations, RAD_r, in rounds 1 and 2, but not in round 3, for the group in which these subjects had participated in the 6H treatment. The correlation between $RAFD_{1,1}$ of the experienced subjects in $1E_{6H}$ and RAD_r in the 6H treatments in which they had participated is 0.63, 0.66, and 0.17 for rounds 1, 2, and 3, respectively. In fact, if we restrict our attention to the 10 experienced subjects

[31] P-value = 0.859 and 0.507 for $\Delta RAFD$ and $RAFD_{1,1}$, respectively, using Kolmogorov-Smirnov (KS) two-tailed tests.

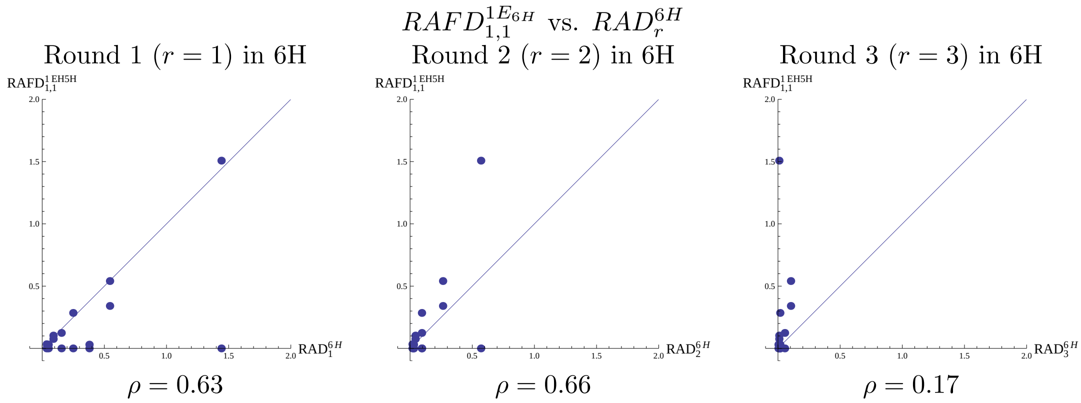


Figure 4: Distributions of the initial forecast deviations $RAFD_{1,1}$ in $1E_{6H}$ and the realised price deviations RAD_r in rounds 1 (left), 2 (middle), and 3 (left) of 6H in which experienced subjects participated.

with $RAFD_{1,1} > 0$, the corresponding correlation between $RAFD_{1,1}$ and RAD_r become much higher for rounds 1 and 2 (0.96 for $r = 1$, 0.97 for $r = 2$, and 0.09 for $r = 3$). Thus, these experienced subjects responded to the inflow of inexperienced subjects by referring to the similar situation they had experienced in the past.

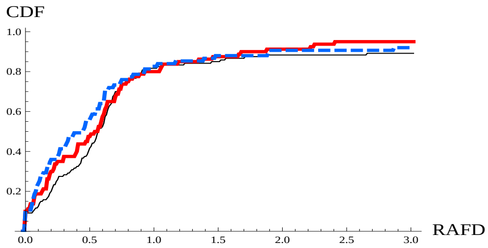
Before discussing the orders and dynamics of the forecasts submitted by these experienced subjects, we turn our discussion to the initial forecasts submitted by the inexperienced subjects who were informed that one subject (out of six) in their market had previously experienced the same experiment. The question that arises is whether knowledge of the existence of one experienced trader (out of six) significantly alters the initial price forecasts of inexperienced subjects.

3.2 Initial forecasts of inexperienced subjects

Figure 5 shows the distributions of $RAFD_{1,1}$ (in the first period of the first round) for *inexperienced* subjects in $1E_{6H}$ (solid red line) and $1E_{5C}$ (dashed blue line). The distribution of $RAFD_{1,1}$ in 6H (thin black line) is also shown. The distributions are ordered in such a way that the distribution of RAFD in $1E_{5C}$ (dashed blue line) lies to the far left, followed by those in $1E_{6H}$ (solid red line) and 6H (thin black line).[32] Thus, being informed about the presence of experienced traders seems to have some effect on influencing the initial price expectations of *inexperienced* subjects.

This effect, however, is not statistically significant. We fail to reject the null hypothesis that the

[32]Data for the 6H treatment comes from Akiyama et al. (2013) (with 72 subjects) as well as the sessions before the FO experiment (with 48 subjects) to be discussed later in this paper.



$p = 0.163$ (KW)

Figure 5: Distribution of $RAFD_{1,1}$ (in the first period of the first round) for *inexperienced* subjects in $1E_{5C}$ (dashed blue line), $1E_{6H}$ (solid red line), and 6H (thin black line). The numbers of subjects are: 80, 75, and 120 in $1E_{6H}$, $1E_{5C}$, and 6H, respectively.

three distributions are obtained from the same underlying distribution.[33] The most likely cause of this insignificant difference among the three treatments is that it is difficult for most inexperienced subjects to imagine how the behaviour of experienced subjects might differ from that of inexperienced ones and how the behavioural differences could influence the prices.[34]

Figure 6 shows the distributions of $RAFD_{1,1}$ (in the first period of the first round) for inexperienced subjects (solid red line) and experienced subjects (dashed blue line) in round 1 for the two 1EH5H treatments ($1E_{5C}$ on the left and $1E_{6H}$ on the right). As can easily be seen from the discussion thus far, experienced subjects expected the prices to be much closer to the fundamental values than inexperienced subjects. Later we show how these different forecasts of experienced and inexperienced subjects evolve as they interact in the same markets. Before doing so, we discuss the realised prices in 1EH5H markets because price forecasts evolve in response to the prices subjects observe.

[33] $P = 0.163$, using a Kruskal-Wallis (KW) test. The pairwise Kolmogorov-Smirnov test, however, rejects the null hypothesis for a 6H and $1E_{5C}$ pair with $p = 0.064$. For other pairs, however, the null hypothesis is not rejected: $p = 0.54$ for 6H vs. $1E_{6H}$ and $p = 0.58$ for $1E_{5C}$ vs. $1E_{6H}$.

[34] A similar interpretation could be made for the insignificant effect of lack of common knowledge of rationality reported by Akiyama et al. (2012). They conducted a 1H5C experiment in which subjects were told that "Each computer trader assumes that all traders maximise their profits without making any mistakes. Given this assumption about the others, the computer trader maximises its profits without making mistakes. If the computer trader is indifferent to trading or not trading, it prefers to trade." Similar to the distribution of $RAFD_{1,1}$ in this version of 1H5C and 6H, they failed to find a significant effect of strategic uncertainty. The difference between the findings reported by Akiyama et al. (2012) and Akiyama et al. (2013), where the latter study informed subjects that computer traders submitted orders at the fundamental values and found a significant effect of strategic uncertainty, indicates that inexperienced subjects have difficulty inferring the behaviour of profit maximising computers. Thus, it is not surprising that inexperienced subjects have difficulty imagining the behaviour of experienced subjects.

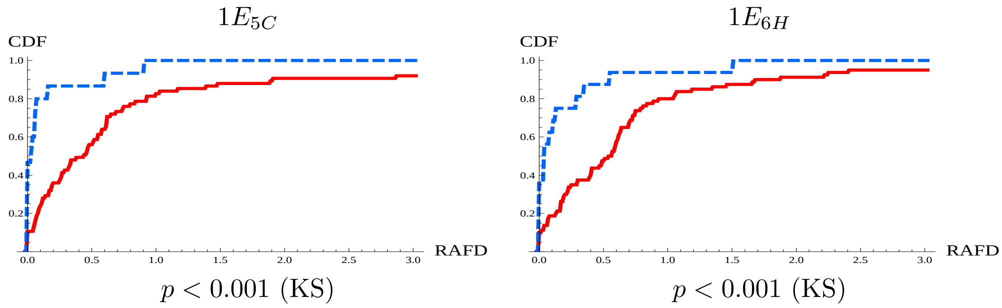


Figure 6: Distribution of $RAFD_{1,1}$ for inexperienced subjects (solid line) and experienced subjects (dashed line) in round 1 of $1E_{5C}$ (middle) and $1E_{6H}$ (right).

3.3 Realised prices

Figure 7 shows the dynamics of market prices in the three rounds of $1E_{5C}$ (first row), $1E_{6H}$ (second row), and $6H$ (third row). The outcomes for $6H$ are also reported here to see if the presence of one experienced trader (and being informed about the presence) changes the price dynamics.

The fourth row in Figure 7 also shows the distributions of RAD in the three rounds for the three treatments: 6H (thin black line),[35] $1E_{6H}$ (solid red line), and $1E_{5C}$ (dashed blue line). We reject the null hypothesis that the three distributions of RAD are generated from the same underlying distribution for rounds 1 and 2, but not for round 3.[36] It is clearly seen, that for round 1 the prices deviate more from the fundamental values in 6H than in the two 1EH5H treatments.[37] In addition, a comparison of the RAD distributions in round 3 of 6H and those in round 1 of the 1EH5H markets shows that mispricing is significantly greater in the latter than in the former.[38]

Dufwenberg et al. (2005) reported that in continuous double auction environments with stochastic dividend payments, the price deviates significantly less from the fundamental values in markets where two (or four) experienced subjects interact with four (or two) inexperienced subjects than in markets where all six traders are inexperienced. But they did not find significant differences in mispricing in mixed markets and markets consisting only of experienced subjects. Our results show that even

[35] Data for the 6H treatment comes from Akiyama et al. (2013) (12 groups) as well as the sessions before the FO experiment reported later in this paper (8 groups).

[36] P-values are 0.058, 0.096, and 0.632 for the first, second, and third rounds, respectively, based on Kruskal-Wallis tests.

[37] While pairwise Kolmogorov-Smirnov tests reject the null hypothesis that RAD distributions in round 1 are drawn from the same distribution for a (6H, $1E_{6H}$) pair ($p = 0.071$), the null hypothesis is not rejected for (6H, $1E_{5C}$) and ($1E_{6H}$, $1E_{5C}$) pairs (p-values are 0.500 and 0.402, respectively). A similar outcome is observed for round 2; p-values are 0.065, 0.348, and 0.743 for the pairs (6H, $1E_{6H}$), (6H, $1E_{5C}$), and ($1E_{6H}$, $1E_{5C}$), respectively.

[38] Pairwise Kolmogorov-Smirnov tests reject the null hypothesis that RAD distributions in round 3 of 6H and round 3 of $1E_{6H}$ or $1E_{5C}$ are drawn from the same distribution (p-values are 0.048 and 0.003, respectively.)

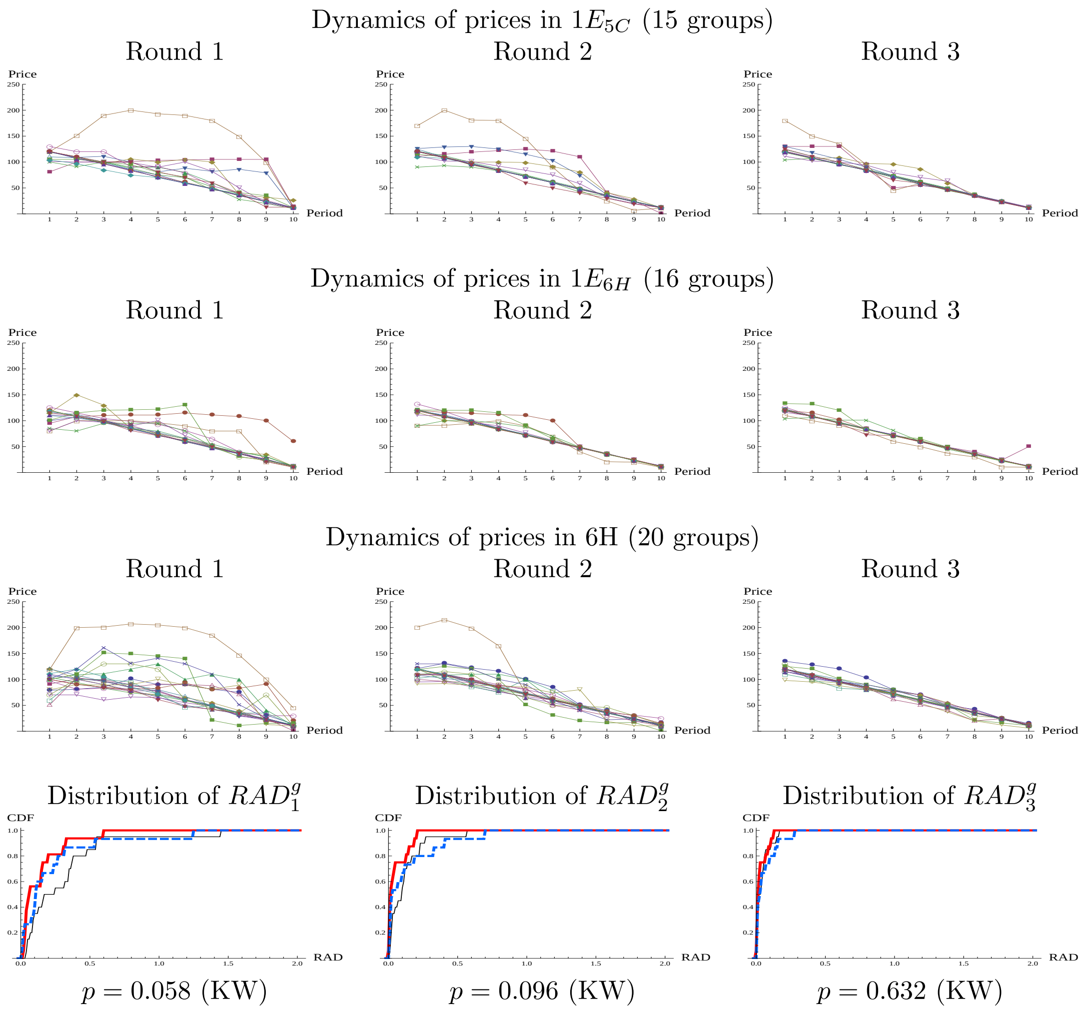


Figure 7: Dynamics of realised prices in $1E_{5C}$ (first row), $1E_{6H}$ (second row), $6H$ (third row) in the three rounds and the distribution of RAD (fourth row) in the three rounds for three treatments: 6H (thin black line), $1E_{6H}$ (solid red line), and $1E_{5C}$ (dashed blue line)

one experienced trader out of six can reduce the magnitude of mispricing, and at the same time, if there are five inexperienced subjects (out of six traders), prices deviate substantially more from the fundamental values than in a market consisting only of experienced subjects.

3.4 Submitted orders

Analysing the orders submitted by both the experienced and inexperienced subjects allows us to better understand how the presence of experienced subjects influences prices. To do so, we utilised the measure of potential losses that can be generated by orders submitted by a subject over the 10 periods in one round. Akiyama et al. (2013) defined the potential loss for subject i in round r, PL_r^i, as:

$$PL_r^i \equiv \frac{1}{1000} \sum_t \left(d_{t,r}^i \max(pd_{t,r}^i - FV_t, 0) + s_{t,r}^i \max(FV_t - ps_{t,r}^i, 0) \right)$$

where $pd_{t,r}^i$ and $ps_{t,r}^i$ are the maximum price at which i is willing to buy and the minimum price at which i is willing to sell an asset, respectively, specified in subject i's orders submitted in period t of round r. $d_{t,r}^i$ and $s_{t,r}^i$ are the maximum quantities, demanded or supplied, associated with $pd_{t,r}^i$ and $ps_{t,r}^i$, respectively.[39] The potential loss is normalised by the value of the initial endowment (=1000) so that PL^i denotes the share of the initial endowment subject i would potentially lose if his orders were executed at the prices submitted.[40] Note that this measure does not take a subject's price forecasts into account.[41]

For the experienced subjects, we define the difference in the magnitude of their PL^i in the final round of 1H5C or 6H and the first round of 1EH5H, ΔPL^i, as follows:

$$\Delta PL^{i \in 1E_{5C}} \equiv PL_1^{i \in 1E_{5C}} - PL_3^{i \in 1H5C}$$
$$\Delta PL^{i \in 1E_{6H}} \equiv PL_1^{i \in 1E_{6H}} - PL_3^{i \in 6H}.$$

For most subjects, their PL values become smaller as they gain experience in trading over multiple rounds. Thus, $\Delta PL^i > 0$ can be interpreted as the deviation from the trend by an experienced

[39] The superscript indicating the treatment in which subject i participates is omitted for clarity of the exposition.

[40] It should be noted that submitting such orders may not result in any losses in our experiment because the actual trading prices can differ from those submitted by the subjects.

[41] Akiyama et al. (2013) also defined belief adjusted potential loss, which takes into consideration the subject's price forecast. This measure is not used in our study because (a) we have already seen that inexperienced subjects forecast prices that deviate more from the fundamental values than experienced subjects, and (b) the belief adjusted potential losses tend to be smaller for subjects whose forecasts deviate more from the fundamental values.

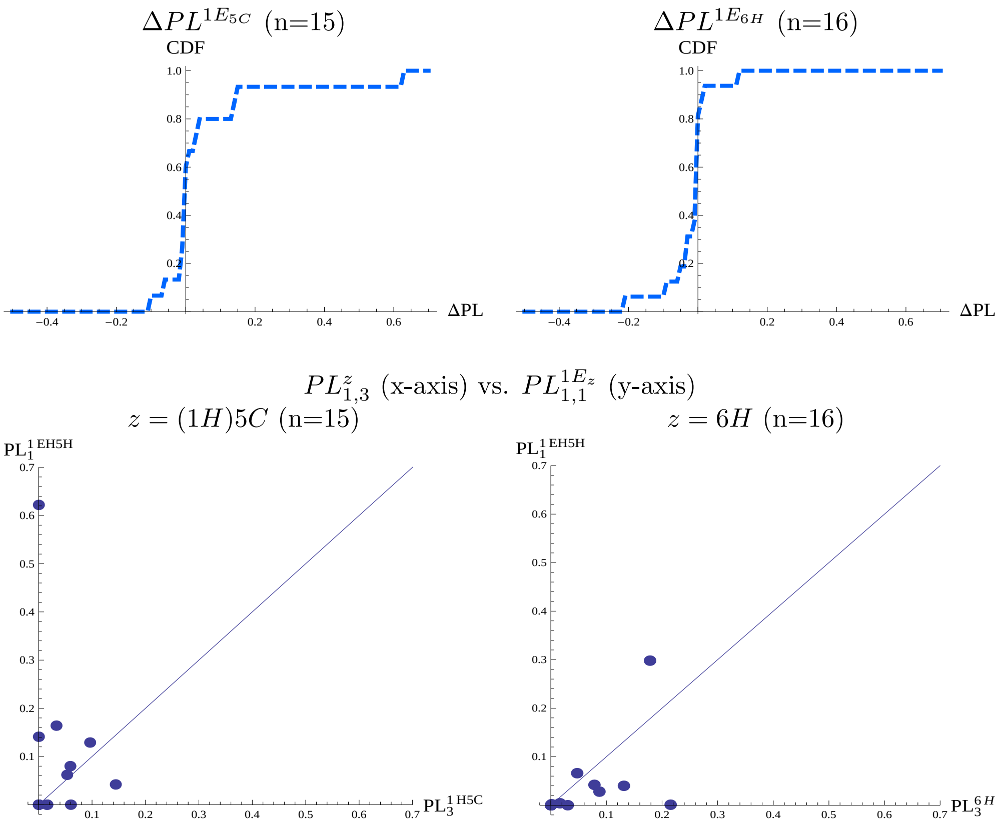


Figure 8: TOP: Empirical cumulative distribution of $\Delta PL^{1E_{5C}}$ (left) and $\Delta PL^{1E_{6H}}$ (right). BOTTOM: Scatter plot of $PL_3^{i \in z}$ (x-axis) vs. $PL_1^{1E_z}$ (y-axis) for $z = (1H)5C$ (left) and $z = 6H$ (right). Each point in the figure represents one experienced subject.

subject i in response to the inflow of five inexperienced subjects. If such responses by experienced subjects are not very common, and experienced subjects continue to submit buy orders no greater than the fundamental values and sell orders no less than these values, their presence will certainly act as a force to reduce mispricing.

The top panel of Figure 8 shows the empirical cumulative distributions of ΔPL for experienced subjects in $1E_{5C}$ (left) and $1E_{6H}$ (right). The bottom panel of Figure 8 also shows scatter plots of PL_3^z (x-axis) vs. $PL_1^{1E_z}$ (y-axis) for $z = (1H)5C$ (left) and $z = 6H$ (right), which are used to compute ΔPL. Each point in the figure represents one experienced subject. The points above the 45 degree line in the bottom two panels correspond to those subjects with $\Delta PL > 0$. As can be seen from the two distributions and two scatter plots, only about 40% (6 out of 15) of our experienced subjects in $1E_{5C}$ demonstrated $\Delta PL > 0$. For those in $1E_{6H}$, this fraction is less than 20% (2 out

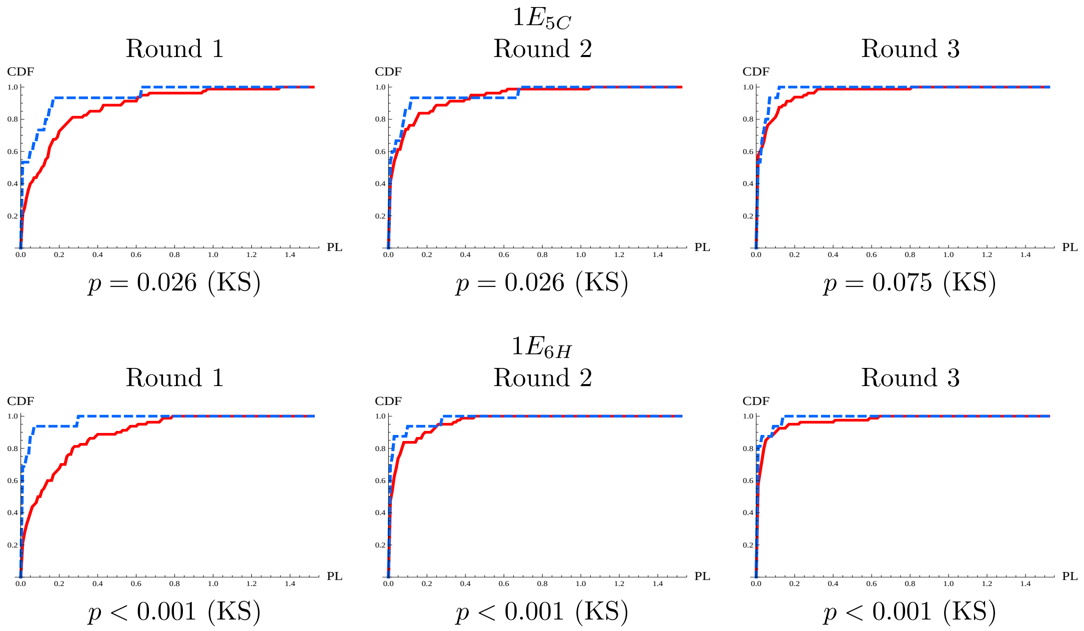


Figure 9: CDF of PL for inexperienced subjects (solid line) and experienced subjects (dashed line) in round 1 (left), round 2 (middle), and round 3 (right) of $1E_{5C}$ (top) and $1E_{6H}$ (bottom). P-values were computed by using within-group averages for inexperienced subjects.

of 16). Thus, not only do about half the experienced subjects not react much to the inflow of five inexperienced subjects by revising their initial price forecasts, but also the majority of experienced subjects continue to submit the same kind of orders they submitted in the market consisting only of experienced traders (6H) or computer traders (1H5C).[42]

Figure 9 shows the distribution of PL for inexperienced subjects (solid line) and experienced subjects (dashed line) in the three rounds (round 1 on the left, round 2 in the middle, and round 3 on the right) of two 1EH5H treatments ($1E_{5C}$ on the top and $1E_{6H}$ on the bottom). It is clear from the figure that experienced subjects submit orders that are potentially much less damaging than those of inexperienced subjects. Since the orders by experienced subjects reflect prices closer to the fundamental values than those by inexperienced subjects, we would expect that with more experienced subjects in the market, prices would be closer to the fundamental values. As the rounds proceed, inexperienced subjects also learn to submit orders that are potentially less damaging as is seen by comparing the top and the middle or bottom panels. This corresponds with the finding that observed prices move closer to the fundamental values in later rounds.

[42]Note that by submitting orders at the fundamental values, these traders will not lose their initial endowment, but they may not gain much either. This could be the reason why experienced subjects continue to behave in this way.

3.5 Dynamics of forecast deviations

We now turn to the dynamics of price forecasts between experienced and inexperienced subjects over time as inexperienced subjects gain experience trading in the market and observing prices. Figure 10 shows the dynamics of the median $RAFD$ for experienced (dashed line) and inexperienced (solid line) subjects in round 1 (first row) and round 2 (third row) in $1E_{5C}$ (left) and $1E_{6H}$ (right). It also shows the distribution of $RAFD$ for experienced and inexperienced subjects at the beginning of round 2 (second row) and round 3 (fourth row).

As observed above, at the beginning of round 1, there is a significant difference between the distributions of $RAFD$ for experienced and inexperienced subjects in both the $1E_{5C}$ and $1E_{6H}$ treatments. Initially, experienced subjects expect prices to be much closer to the fundamental values than inexperienced subjects. However, as the experienced subjects, especially in the $1E_{5C}$ treatment, observe prices deviating substantially from the fundamental values, their forecasts slowly start to deviate from the fundamental values as well. We observe a slight rise in the median $RAFD$ of the experienced subjects during round 1 of $1E_{5C}$. A similar increase in median $RAFD$ during round 1, which occurs in a much earlier period, is also observed for experienced subjects in $1E_{6H}$. On the other hand, inexperienced subjects adjust their forecasts so that the median $RAFD$ for these subjects decreases over time in round 1.

As a result, by the beginning of round 2, the distributions of $RAFD$ for experienced and inexperienced subjects are no longer significantly different in $1E_{5C}$.[43] Although the two distributions of $RAFD$ remain to be significantly different at the beginning of round 2 in $1E_{6H}$,[44] the difference becomes insignificant by the beginning of round 3. On the other hand, for some reason, the distributions of $RAFD$ for experienced and inexperienced subjects are significantly different at the beginning of round 3 of the $1E_{5C}$ treatment. Yet, the difference between the two distributions at the beginning of round 3, in terms of median magnitude, is much smaller than at the beginning of round 1.

As demonstrated by Haruvy et al. (2007), Heemeijer et al. (2009), and Bao et al. (2012), this shows that the subjects' expectations become more similar as they gain experience in the same market, observing the same prices and adjusting their forecasts based on the commonly observed prices in the past.

[43] $P = 0.184$ using a Kolmogorov-Smirnov two-tailed test. In conducting the statistical tests, we calculated within-group averages for the inexperienced subjects and used the averages as the independent sample.

[44] $P = 0.003$ with a Kolmogorov-Smirnov two-tailed test

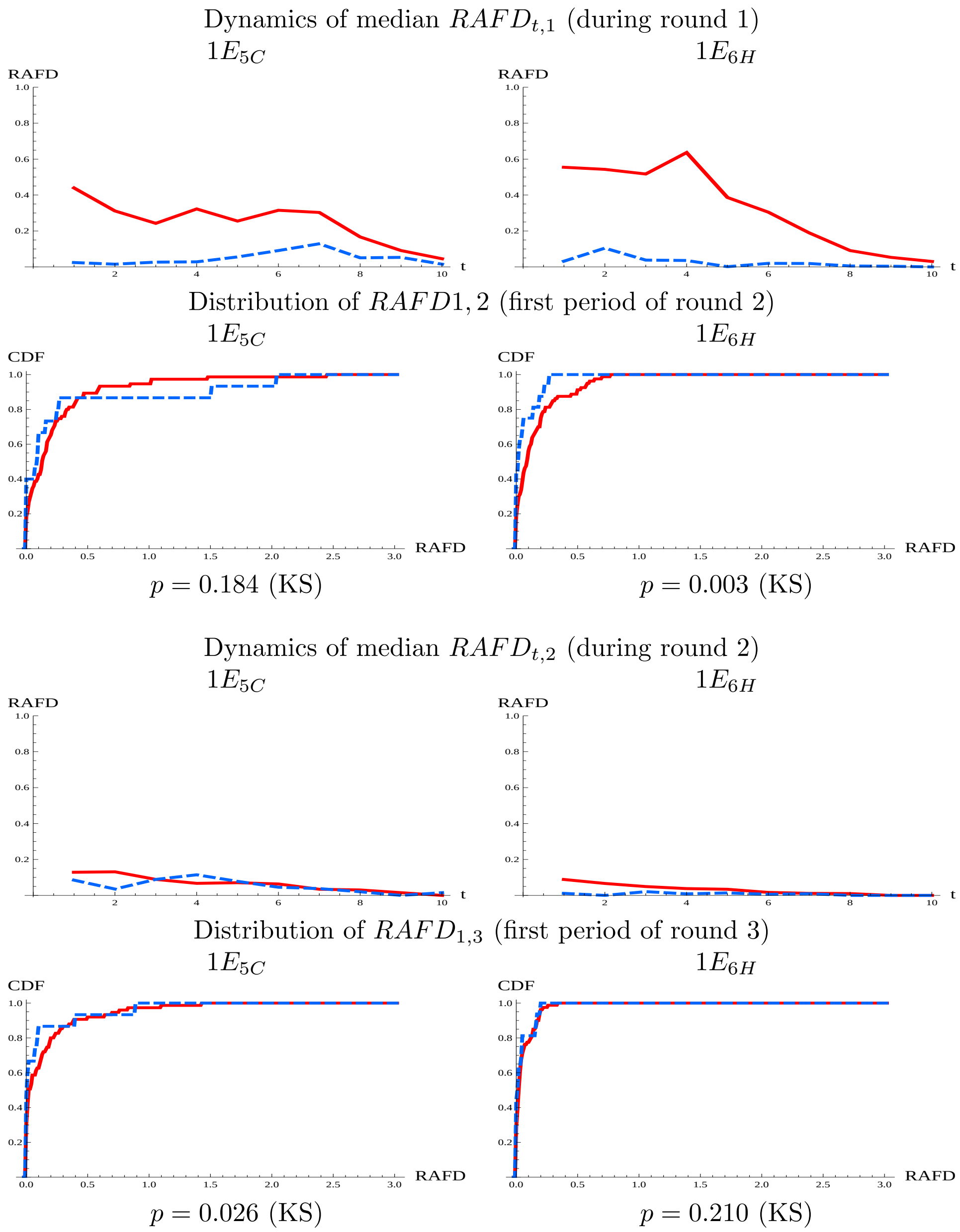


Figure 10: Dynamics of median $RAFD$ for experienced (dashed line) and inexperienced (solid line) subjects in round 1 (first row) and round 2 (third row) as well as the distribution of $RAFD$ for experienced (dashed line) and inexperienced (solid line) subjects at the beginning of round 2 (second row) and round 4 (fourth row). P-values reported below the second and fourth rows were computed using within-group averages for inexperienced subjects.

4 Additional Experimental Results for Heterogeneity, Experience, and Strategic Uncertainty

We have seen that only about half of the 15 or 16 experienced subjects in our 1EH5H experiments initially forecast prices that follow the fundamental values exactly, while the remaining experienced subjects forecast some deviations. These observations show that the reaction to the strategic uncertainty introduced by the inflow of inexperienced traders varies across subjects. Akiyama et al. (2013) also showed that the effect of strategic uncertainty varies across inexperienced subjects, and is positively correlated with their scores in the CRT. To investigate the relationship between the CRT scores and the effect of strategic uncertainty that experienced subjects faced after the introduction of inexperienced subjects into the market, we conducted a *forecast-only experiment* for subjects who had participated in the 1H5C and 6H experiments.

In the FO experiment, subjects, who had just completed three rounds of 6H and 1H5C and had answered the question explaining why they made the forecasts they did, were asked to forecast the prices that were observed in round 1 of one of our 1EH5H sessions. For those who had participated in 6H (FO_{6H}), the prices were chosen from one of the 16 $1E_{6H}$ sessions, while for those who had participated in 1H5C (FO_{5C}), they were chosen from one of the 15 $1E_{5C}$ sessions.[45] In the FO experiment, we gave subjects the following hypothetical scenario: "Imagine that you have been recruited to participate in a similar experiment in an hour from now. Imagine also that in this new experiment you are given the following instruction." We then explained the composition of the six traders in this market highlighting that "Of the six traders in the market, one has previously participated in a similar experiment while the other five are participating in this experiment for the first time."[46] We then proceeded by noting that the remaining instructions about earning money from dividend payments, trading, and forecasting were the same as those which they had heard earlier in the 6H or 1H5C treatment that had just finished.[47]

Subjects were informed that they did not need to submit orders, but only forecast the prices that were observed in an experiment with the same conditions. They were also told that forecasting

[45] These subjects were not told anything about this additional experiment until they had answered the question posed after the three rounds of stock market experiments.

[46] In the case of those who had participated in 1H5C, we stated that "... one has previously participated in a similar experiment and traded with five computer traders, while the other five ..." as we did in $1E_{5C}$ without explaining the behaviour of the computer traders.

[47] The instructions, apart from the information regarding the composition of the six traders, were identical in 6H and 1EH5H. Information about the behaviour of computer traders was included only in the instructions for 1H5C. We did not explicitly mention the behaviour of computer traders in either the 1EH5H or FO sessions.

Table 2: Summary of forecast-only sessions.

Date	Treatment	No. of subjects
July 7, 2013	FO_{5C}	45
Nov. 23, 2013	FO_{6H}	48

prices would be done in the same way as in the previous experiment (i.e., forecasting prices for all the remaining periods). The subjects were paid 10 ECU for each "accurate" forecast, i.e., they were rewarded according to:

$$\text{Reward} = 10 \times (\text{number of forecasts that were within } \pm \text{ 10 \% of the actual market price}).$$

After they had finished forecasting the observed prices in one of the 1EH5H markets, the subjects completed a questionnaire consisting of the CRT and reasons for their forecasts.

4.1 Results

An additional 93 subjects who had never participated in similar experiments were recruited to participate in the three rounds of the 1H5C or 6H experiment and the FO experiment. All the experiments were carried out at the University of Tsukuba. Table 2 summarises the FO sessions.

Figure 11 shows the results for the additional FO treatments in the same format as Figure 2. The solid red curve in the top panel depicts the empirical cumulative distributions of $\Delta RAFD^z = RAFD_{1,1}^{FO_z} - RAFD_{1,3}^z$ for experienced subjects in FO_{5C} (left) and FO_{6H} (right). The dashed blue curve shows $\Delta RAFD$ from the $1E_z$ sessions (as shown in Figure 2) for comparison. In the bottom panel of the figure, scatter plots of $RAFD_{1,3}^z$ (x-axis, beginning of the third round of $z = (1H)5C$ (left) and $z = 6H$ (right)) vs. $RAFD_{1,1}^{FO_z}$ (y-axis, beginning of the first round of forecast-only treatment FO_z) are depicted by red squares. The blue points in this figure show the outcomes from the $1E_z$ sessions (as illustrated in Figure 2). Each point in the scatter plot represents one subject.

The distributions of $\Delta RAFD$ in the FO experiments are very similar to those in the 1EH5H experiment. In other words, the initial forecast deviations for about half the experienced subjects in the FO experiment are not greater than their forecast deviations at the beginning of the third round in the 1H5C or 6H experiment. One noticeable difference between the FO and 1EH5H experiments is evident for those who had participated in 6H (shown on the right). About a quarter of the subjects who participated in the FO_{6H} experiment demonstrated $\Delta RAFD \leq 0$ whereas none did in $1E_{6H}$.

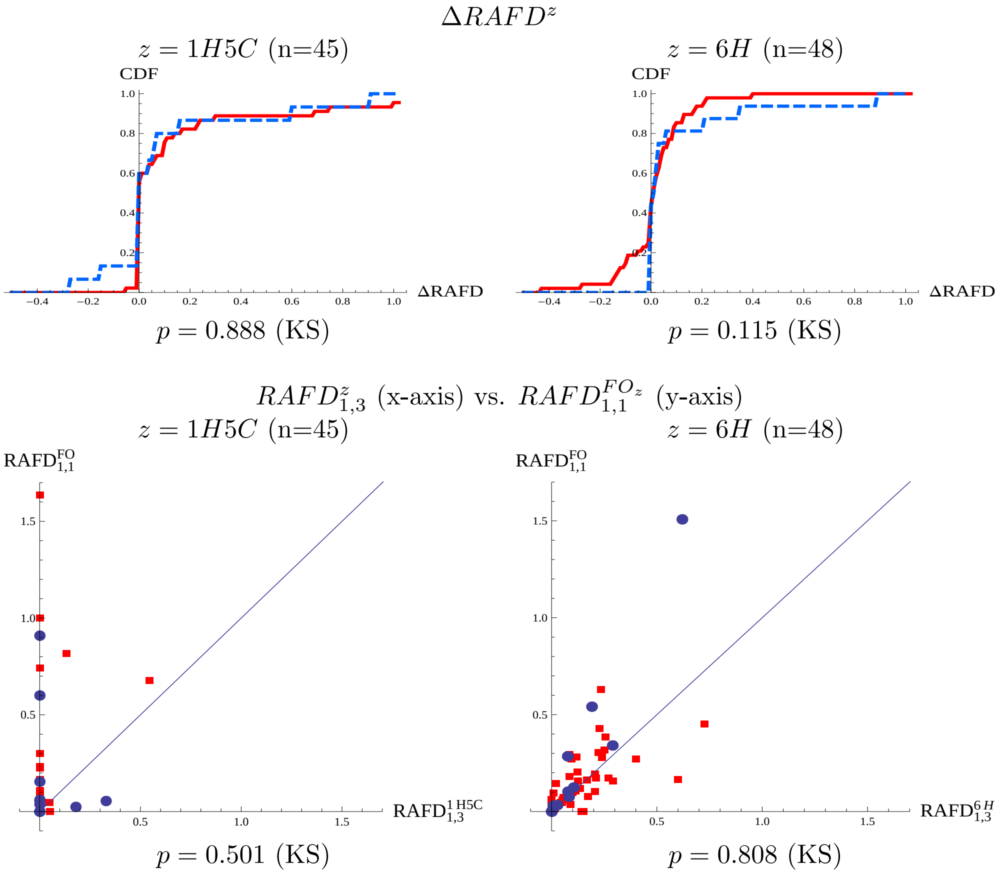


Figure 11: TOP: Empirical cumulative distribution of $\Delta RAFD^z$ for $z \in \{FO_{5C}, 1E_{5H}\}$ (left) and $z \in \{FO_{6H}, 1E_{6H}\}$ (right). The solid red curves correspond to the results from the FO sessions. The dashed blue curves are for the 1EH5H sessions (with n=15 for $1E_{5C}$ and n=16 for $1E_{6H}$). BOTTOM: Red squares represent the scatter plot of $RAFD^z_{1,3}$ (x-axis) vs. $RAFD^{FO_z}_{1,1}$ (y-axis) for $z = 1H5C$ (left) and $z = 6H$ (right). The blue points depict the results from the 1EH5H sessions.

The distributions of $\Delta RAFD$, however, are not significantly different for the FO experiment and its corresponding 1EH5H experiment.[48]

Just as in the case of $1E_{6H}$, we find that, as shown in Figure 12, the magnitude of the initial forecast deviations submitted by the experienced subjects in FO_{6H}, $RAFD_{1,1}$, is highly positively correlated with the realised magnitude of price deviations, RAD_r, of the group in which these subjects participated in the 6H treatment. The correlation with RAD in round 3, however, is higher in FO_{6H} than what was observed in $1E_{6H}$.[49] This result shows that when experienced subjects

[48] P-values are 0.888 for FO_{5C} vs. $1E_{5C}$ and 0.115 for FO_{6H} vs. $1E_{6H}$, based on a Kolmogorov-Smirnov two-tailed test.

[49] The correlation between the $RAFD_{1,1}$ of the experienced subjects in FO_{6H} and the RAD_r in the 6H treatments in which they participated is 0.68 for $r = 1$, 0.57 for $r = 2$, and 0.38 for $r = 3$.

$RAFD_{1,1}^{FO_{6H}}$ vs. RAD_r^{6H}

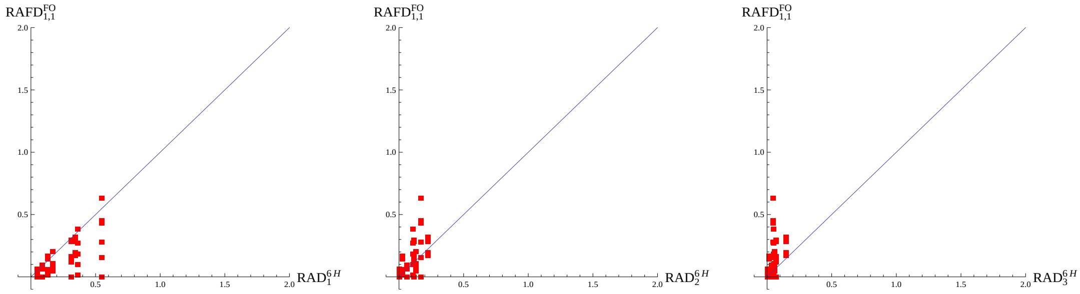


Figure 12: Distributions of the initial forecast deviations $RAFD_{1,1}$ in FO_{6H} and the realised price deviations RAD_r in rounds 1 (left), 2 (middle), and 3 (left) of 6H in which only experienced subjects participated.

who had participated in 6H responded to the inflow of inexperienced traders by adjusting their price forecasts, they based their initial forecasts in the FO experiment on the prices they had observed in the early rounds of 6H.

Is there a positive correlation between the magnitude of $\Delta RAFD$ (a measure of the effect of the strategic uncertainty faced by an experienced subject when all the other traders are inexperienced) and CRT score? Since the distributions of $\Delta RAFD$ from the FO and 1EH5H experiments were not significantly different, we pooled the data to increase the sample size.

The distribution of CRT scores for experienced subjects participating in the 1EH5H and FO treatments is given in Table 3. The average score for these 124 subjects is 2.0. Because the number of subjects with a CRT score of 0 or 1 is small, we grouped them into one group. We, therefore, had three groups of subjects based on their CRT scores. Figure 13 shows the distribution of $\Delta RAFD$ for each group of experienced subjects, $CRTS \leq 1$ (thick solid red line), $CRTS = 2$ (thin black line), $CRTS = 3$ (thick dashed blue line), in FO_{5C} and $1E_{5C}$ (left), and FO_{6H} and $1E_{6H}$ (right).

Figure 13 does not show any clear positive relationship between CRT score and $\Delta RAFD$. The

Table 3: Distribution of CRT scores for experienced subjects in four treatments.

Treatment	N	CRTS=0	CRTS=1	CRTS=2	CRTS=3
$1E_{5C}$	15	3	4	4	4
FO_{5C}	45	3	8	14	20
$1E_{6H}$	16	1	4	8	3
FO_{6H}	48	4	11	10	23

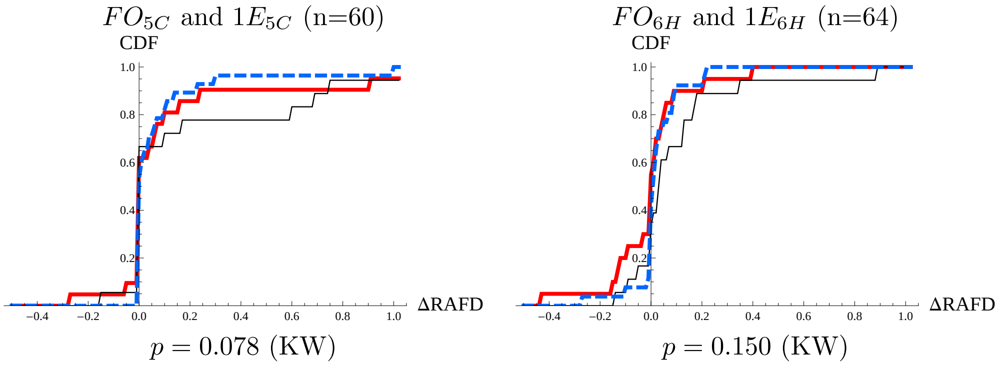


Figure 13: Distribution of $\Delta RAFD$ for subjects with $CRTS \leq 1$ (thick solid red line), $CRTS = 2$ (thin black line), $CRTS = 3$ (thick dashed blue line) for experienced subjects in FO_{5C} and $1E_{5C}$ (left) and FO_{6H} and $1E_{6H}$ (right). P-values are obtained by Kruskal-Wallis tests.

distribution of $\Delta RAFD$ for subjects with $CRTS = 2$ lies to the right of the other two distributions in both the left and right panels. For subjects who had experienced 6H (shown in the right panel of Figure 13), there are no significant differences among the three distributions of $\Delta RAFD$.[50] On the other hand, there are significant differences among the three distribution for subjects who had experienced 1H5C (left panel of the figure).[51] While the pairwise Mann-Whitney tests show that significant differences exist in the median of subjects with a CRT score 0 or 1 and those with a CRT score 3, the results are not supported by pairwise Kolmogorov-Smirnov tests.[52]

Thus, unlike the clear positive relationship between the effect of the strategic uncertainty in the initial forecast deviations from the fundamental values and CRT scores for inexperienced subjects reported by Akiyama et al. (2013), there is no clear relationship between the effect of strategic uncertainty (measured by $\Delta RAFD$) and CRT scores for experienced subjects. There seems to be more than just a difference in "willingness to reflect" among subjects measured by the CRT behind the heterogeneity in the effect of strategic uncertainty among experienced subjects.

5 Conclusion

In this paper, we investigated the possible effect of the strategic uncertainty experienced subjects faced as a result of the inflow of inexperienced subjects into an experimental asset market *a la*

[50] $P = 0.150$ using Kruskal-Wallis tests.

[51] $P = 0.078$ using Kruskal-Wallis tests.

[52] P-values for the pairwise Mann-Whitney two-tailed test are 0.150, 0.038, and 0.747 for (CRT$\leq$ 1 vs. CRT $= 2$), (CRT$\leq$ 1 vs. CRT $= 3$), and (CRT$=$ 2 vs. CRT $= 3$). P-values obtained from pairwise Kolmogorov-Smirnov tests are 0.231, 0.206, and 0.515 for (CRT$\leq$ 1 vs. CRT $= 2$), (CRT$\leq$ 1 vs. CRT $= 3$), and (CRT$=$ 2 vs. CRT $= 3$).

Smith et al. (1988). We constructed 10 period experimental call markets with six traders. One of the six traders was an experienced subject (EH), and the other five were inexperienced subjects (5H). Experienced subjects had participated in an experiment with the same market conditions (apart from the composition of traders, that is, one EH with either five other inexperienced subjects (6H) or five computer traders whose behaviour was made explicit (1H5C)), and had traded for three rounds in the morning of the same day. Inexperienced subjects, on the other hand, had never participated in a similar experiment. All the subjects in the 1EH5H experiments were informed about the composition of the group with one experienced and five inexperienced traders. It was obvious for the experienced trader that s/he was the only experienced trader in that group.

We measured the effect of the strategic uncertainty faced by experienced subjects as a result of the inflow of inexperienced traders by differentiating the deviation of price expectations from the fundamental values, initially submitted by these experienced subjects in the 1EH5H market, and those submitted at the beginning of the final round of the 6H or 1H5C market (by which time many traders had learned to forecast prices that closely follow the fundamental values). We found that the price expectations of half the experienced subjects did not respond to the inflow of inexperienced subjects. Similar results were also obtained for a larger number of experienced subjects who participated in our FO experiments (these subjects were asked to predict the realised prices in one of the corresponding 1EH5H treatments.)

Those experienced subjects who gained experience by trading with five other human subjects in the morning (6H) and did respond to the inflow of inexperienced traders by adjusting their price forecasts, did so by calibrating their initial forecasts in 1EH5H to the prices they have observed in the first or second round of the 6H market. We obtained similar results for the larger sample in our FO experiment.

Only about half the experienced subjects responded to the massive inflow of inexperienced subjects by adjusting their price forecasts, while far fewer responded by adjusting their trading strategies. The majority of our experienced subjects learned, after repeating the experiment twice in 6H or 1H5C before participating in 1EH5H, to submit buy orders equal to or below the fundamental values and sell orders equal to or above these values. The inflow of inexperienced traders did not significantly change the kind of orders submitted by experienced subjects, i.e., they continued to submit similar orders in 1EH5H.

These results indicate that experienced subjects responded conservatively and acted as price stabilisers, instead of destabilisers, in the face of significant inflow of inexperienced subjects. As a result, while the mispricing observed in the 1EH5H markets is significantly larger than that observed in the third round of 6H markets (where all the traders are experienced), the mispricing observed in the first round of 1EH5H is significantly smaller than that in the first round of the 6H market (where all the traders are inexperienced). The former is mainly due to the behaviour of inexperienced traders and not the strategic responses of experienced subjects to the strategic uncertainty caused by the inflow of new traders. Xie and Zhang (2012) reached a similar conclusion in an independent but closely related study.

Contrary to the positive correlation between the effect of strategic uncertainty faced by inexperienced subjects and their scores on the CRT identified by Akiyama et al. (2013), we did not find such a clear correlation between the test scores and the effect of strategic uncertainty among *experienced* subjects in our 1EH5H and FO experiments. Unfortunately, the data gathered during our experiments did not allow us to further investigate the potential sources of heterogeneity in the responses to the inflow of inexperienced traders by experienced subjects. Use of a more elaborate measure of cognitive ability, such as that used by Gill and Prowse (2013), could allow a better understanding of the relationship between learning and the responses to the strategic uncertainty caused by the changing market conditions.

The 1EH5H market is clearly an extreme situation because suddenly, the market is dominated by inexperienced traders. If the initial response by experienced subjects to such an extreme change is quite small as we have seen in our experiments, we expect that it will be even more limited when faced with smaller inflows of inexperienced subjects. Thus, for the inflow of new traders to have a substantial impact on the process of bubbles, the magnitude thereof should be such that the price destabilising force new traders introduce is stronger than the price stabilising force of experienced traders as seen in our experiments and those by Xie and Zhang (2012), and/or such inflows should introduce changes in the market conditions other than merely the composition of traders, such as increased liquidity in the market (Deck et al., 2011).

It has been shown that increased liquidity, in combination with increased uncertainty about dividend payments, can re-generate a bubble even in markets consisting only of experienced traders (Hussam et al., 2008). Thus, the inflow of new traders associated with such changes in market conditions is very likely to cause a bubble to emerge. Constructing a model of heterogeneous agents, including both sophisticated (those who try to act strategically given their belief about others) and naive (those who simply follow certain rules of thumb) agents, similar to those by Haruvy and Noussair (2006) and Baghestanian et al. (2013), and investigating whether such a model could provide deeper insight of the experimental data, would be fruitful future research.

Another issue that is not considered in our experiments but which has attracted much attention in a different strand of the literature, is increased uncertainty about the timing of the crash (see, Abreu and Brunnermeier, 2003; Brunnermeier and Morgan, 2010; Matsushima, 2013, among others) introduced into the market by the inflow of inexperienced traders in the middle of a boom and euphoria (Kindleberger and Aliber, 2005). Since different experiments would be needed to investigate this aspect, this is also left for future research.

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A Instructions

English translations of the instructions, the script and the slides shown, can be downloaded from:

- http://www.vcharite.univ-mrs.fr/~nobi/assetM2/slide1EH5H6H.pdf (slides for $1EH5H_{6H}$)
- http://www.vcharite.univ-mrs.fr/~nobi/assetM2/slide1EH5H1H5C.pdf (slides for $1EH5H_{1H5C}$)
- http://www.vcharite.univ-mrs.fr/~nobi/assetM2/slideFO6H.pdf (slides for FO_{6H})
- http://www.vcharite.univ-mrs.fr/~nobi/assetM2/slideFO1H5C.pdf (slides for FO_{1H5C})
- http://www.vcharite.univ-mrs.fr/~nobi/assetM2/textFO.pdf (script read for 1EH5H experiment)
- http://www.vcharite.univ-mrs.fr/~nobi/assetM2/textFO.pdf (script read for forecasting only (FO) experiment)

The set of instructions in Japanese is available upon request.