Preliminary
Please do not quote or
cite without authors' permission

House Money Effects in Experimental Asset Markets[*]

Debapriya Jojo Paul[†]
Julia Henker[‡]
Sian Owen[§]

April 23, 2013

[*] We gratefully acknowledge financial support provided by the Australian Research Council (ARC DECRA grant no.: DE120101523) and the ASB Experimental Research Laboratory. We thank Ben Greiner for helpful suggestions.

[†] Send correspondence to the School of Banking and Finance, Australian School of Business, UNSW, Sydney 2052 Email: d.paul@unsw.edu.au All errors are mine.
[‡] Faculty of Business, Bond University, QLD 4229
[§] School of Banking and Finance, Australian School of Business, UNSW, Sydney 2052

Abstract

We investigate whether prices in experimental asset markets behave differently when participants are required to trade over earned wealth compared to unearned wealth. The latter describes the standard practice of endowing participants with cash/assets in experimental asset market studies of bubbles, which may elicit greater-than-normal risk-seeking behaviour, thereby confounding attempts to understand their drivers or mitigators. We take a new methodological approach in the vein of Cherry et al (2002) in seeking to answer this question by requiring participants in one treatment to earn their initial market allocation. We find that bubbles/mispricing occurs with similar frequency, severity, and duration whether trade occurs with earned or unearned wealth. Our results indicate that any confounding effect(s) caused by endowed money in past studies of bubbles is minimal. Consequently, existing methodology in the study of bubbles does not require modification.

1. Introduction

Individual behaviour in economic experiments frequently deviates from the predictions of traditional economic theory. Recent evidence suggests that the prevalence of this phenomenon may be explained by the origin of the assets used in these experiments. In particular, if the claims to assets are not *legitimate* in the sense that they are simply endowed to participants – as is predominantly the case – rather than having been earned through effort, then participants may treat those assets as "other people's money". Hence, they may exhibit unexpectedly high levels of other-regarding (Cherry et al, 2002; Oxoby and Spraggon, 2008) and risk-taking (Thaler and Johnson, 1990; Arkes et al, 1994) behaviour. We examine whether this issue of asset legitimacy explains one of the long-standing puzzles in experimental economics – the severity and frequency with which asset price bubbles occur in experimental asset markets of the type designed by Smith et al (1988).

A 'price bubble' is defined as a sustained period in which the market price of an asset deviates (normally exceeding) from its intrinsic or fundamental value. They pose serious challenges for investors, policymakers, and regulators alike due to their distortionary effects on the price signal, and the chaos they can inflict if they burst. Since the seminal study by Smith et al (1988) that first documented the bubble-and-crash pattern associated with asset prices in continuous double-auction asset markets with inexperienced participants, an extensive experimental literature has emerged that seeks to understand the drivers of bubbles by varying specific participant and/or institutional characteristics of the original experimental design. However, in virtually all such studies participants are initially endowed with an allocation of cash and stock, which they then use to trade in the experimental market. This failure to legitimise the assets through effort, essentially giving participants ‘free money’, has the potential to elicit a “house-money effect”, whereby participants react to their windfall gain by being more risk-taking than they naturally would be if they were trading with their own (earned) money (Thaler and Johnson, 1990). As a result, they may be more willing to overpay for the asset and engage in speculation, leading to the generation (or at least, amplification) of the bubble-and-crash phenomenon typically seen in such studies.

Earlier studies on house-money effects in experimental market settings are sparse and provide conflicting evidence. While Schwarz and Ang (1989, in Porter and Smith, 1995) and Ang et al (2010) do not find a significantly dampened bubble-and-crash pattern to their prices even when participants are required to trade with their own money (which may or may not be earned), Ackert et al (2006) report a tendency for prices to be significantly higher (and remain so) in markets in which participants are given larger endowments. However, the comparability of such studies is complicated by the fact that they use significantly different experimental designs.

This study contributes to the literature on house money effects in experimental asset markets by taking an alternative methodological approach. The specific question we seek to answer is whether asset prices in experimental asset markets behave differently when participants are required to trade over earned wealth compared to unearned wealth. If the associated house-money effects are important in such markets, then bubbles/mispricing should be significantly more common and severe when trade occurs using endowed wealth. By examining a previously untested class of experiments, we also contribute to the on-going debate in the economic literature about the need to legitimise assets with effort in economic experiments in order to conduct valid tests of theory.

A two-treatment experimental design based on Cherry et al (2002) was implemented to answer our question; one treatment called *Earned* involved participants completing a money-earning task (a GMAT-based quiz) that determined their initial allocation of cash and stocks, while in the second, called *Free*, participants were randomly assigned their initial endowment. Participants in both treatments then traded in an experimental asset market based on the standard double-auction asset market design created by Smith et al. (1988).

Our results do not support the claim that a house-money effect elicited by the allocation of 'free money' to traders has a significant impact on price behaviour. Markets in both treatments were characterised by the formation of price bubbles with similar frequency, and the size of the bubbles/mispricing is not significantly different in the *Free* treatment and the *Earned* treatment. The use of house-money also did not significantly change the length/duration of any bubbles/mispricing in *Free* treatment compared to the *Earned* treatment. Hence, issues of asset legitimacy do not appear to be particularly important for Smith et al type asset markets.

The remainder of this paper is organised as follows. In the next section, we canvass the related literature and develop our hypotheses. We describe our methodology and results in sections 3 and 4 respectively, while our conclusions are presented in section 5.

2. Related literature and hypothesis development

2.1 Endowment origin and asset legitimacy

Traditional (normative) economic theory's contention that the origin of wealth is irrelevant to the decision-making process[5] – that the level of total current wealth is what matters, not how it is obtained, and by extension that incremental costs/benefits are relevant to decisions, whilst historical costs/benefits are not – has been challenged in both the economics and psychology literature. Experimental evidence shows that real peoples' decisions are sensitive to sunk costs (Arkes and Blumer 1985; Garland 1990) and that prior gains or windfall gains increase the propensity for individuals to consume and take risk (Thaler and Johnson 1990; Arkes et al 1994). Thaler and Johnson named this latter phenomenon a 'house-money' effect, which conveys the intuition that people appear to be more willing to risk losing what they consider 'other people's money' than their own.

Given that the endowments used to initiate economics experiments can themselves be characterised as windfall gains or 'other people's money' for participants, recent attention has been directed towards determining if participants behave differently when required to earn their initial endowments. The most striking effects of endowment origin are found in dictator games, which involve two players – the 'dictator' and 'responder' – in which the dictator must decide how to split a certain sum of money between himself/herself and the responder (the 'responder' is passive and must accept whatever is offered). Although the game-theoretic equilibrium predicts that the dictator will offer nothing to the receiver, experiments

[5] This assumption is known as the fungibility of money/income.

using house-money have consistently shown that dictators exhibit other-regarding behaviour, offering a significant portion of their endowments to the receiver. However, when Cherry et al (2002) require their dictators to earn their wealth via a money-earning task (a GMAT-based quiz), they find that other-regarding behaviour is virtually eliminated. Oxoby and Spraggon (2008) produce similar results in their dictator game experiments and interpret the process of legitimising claims to the assets of the experiment via the expenditure of effort as akin to the establishment of property rights.

However, asset legitimacy does not have similarly strong effects in all types of economic experiments. For example, the level of free-riding or lack-thereof in public good experiments is not affected by whether participants contribute earned money or house money (Cherry et al 2005; Clark 2002). Hence, the generalizability of endowment origin effects is an open empirical question. In this study, we seek examine whether issues regarding endowment origin are a relevant concern for a different class of economic experiments – asset markets.

2.2 House-money effects in experimental asset markets

Since their seminal study, the experimental asset market designed by Smith et al (1988) has provided the most reliable means to study asset price bubbles; unlike with real-world data, the experimenter can observe the fundamental value of an experimental asset and control the information environment in which investors (i.e. participants) trade. The now standard/baseline experimental market design comprises a continuous double-auction market in which participants trade for a finite number of periods a homogenous hypothetical asset (a ‘stock’) that pays a stochastic dividend at the end of each trading period whose value is drawn from a probability distribution that is known to all participants (dividend draws are i.i.d.). In such an environment, backward induction should rule out the existence of trade at values exceeding the risk-neutral fundamental value. Yet, despite participants possessing common knowledge about the dividend generating process, prices in these markets regularly exhibit marked bubble-and-crash patterns, rising rapidly above the fundamental value in the initial periods, before eventually crashing to intrinsic value towards the end.

Research following Smith et al (1998) focused on replicating this general experimental design while modifying specific aspects, for example, by introducing elements such as short-selling, margin buying, brokerage fees, or futures markets, amongst others[6], to discern which factors help moderate or eliminate bubbles. The results of these studies indicate that bubbles in experimental markets are robust to altering numerous participant and institutional features. Only common group experience with the experimental market design, at least on the part of a portion of market participants (Porter and Smith, 1994; Dufwenberg, Lindqvist, and Moore 2005) is sufficient to reliably ensure trade at fundamental value. More recent research suggests that the inducement of common expectations through training in the fundamental value process (Cheung et al 2012), or the reduction of apparent participant confusion (Huber and Kirchler 2012; Kirchler et al 2012) may also have a similar effect.

A common characteristic of virtually all these bubble experiments is that participants are endowed with a combination of cash and/or stock before the commencement of trade. This act of giving participants 'free money' to trade with

[6] See Palan (2013) for a comprehensive review of the experimental bubbles literature.

may contribute to the generation of bubbles by inadvertently influencing participants' risk appetites via a house-money effect.

House money effects have previously been studied in an experimental asset market setting by Schwarz and Aug (1989), Ackert et al (2006), and Ang et al (2010). The experiments conducted by Schwarz and Aug and Ang et al required participants to use their own money to trade in some sessions. Prices in their markets however are still prone to bubble and crash, suggesting that any house money effect is negligible. However, a potential complication with this approach is that the origin of the money is not controlled for – that is, the money brought in by participants is earned by presumption only. Corgnet et al (2013) also point out that asking participants to bring their own money may induce a selection bias, whereby predominantly risk-seeking types who are happy to lose their money self-select into the subject pool. In addition, the results of Ang et al (2010) are based on a very small sample size (2 sessions), owing to the fact that their examination of house-money effects is a robustness test, rather than the focus of their study. Instead of requiring participants to use their own money, Ackert et al. (2006) vary the size of the endowment given to participants, and detect a significant house-money effect on asset prices in their experimental market. They find that participants who are given a larger endowment are willing to bid larger amounts to acquire the asset. As a consequence, market prices are also significantly higher, and remain so for the duration of their market. These seemingly conflicting results are not directly comparable however, since Ackert et al. (2006) use a markedly different experimental design, namely a Vickery auction in which participants are only able to place bids to purchase new (but identical) assets in each trading period, as opposed to the double auction market used in a typical bubble experiment that allows traders to buy and sell a fixed number of assets. The duration of their market is also significantly shorter, consisting of only 3 trading period instead of the typical 15. In addition, Ackert et al do not explicitly examine the issue of price bubbles, making it difficult it to draw conclusions regarding the issue.

Our study seeks to reconcile the results and rectify the shortcomings of the preceding research by taking an alternative approach to examining the house money effect. Specifically, we incorporate an element of the Cherry et al (2002) methodology – a money-earning stage – into a Smith et al. (1988) type market which allows for a clearer differentiation between 'house/unearned money' and 'earned money', and hence a more robust test of the of the effect of house-money/endowment origin on prices in experimental asset markets.

We note that a concurrent study by Corgnet et al (2013) exists which also seeks to examine the impact of earned and unearned wealth on price bubbles using a money-earning task. The key difference between their study and ours is that they employ a "real effort task" as their money-earning task, while we use a GMAT-based quiz (as in Cherry et al 2002). The task in Corgnet et al involves participants contributing to the development of a research database by downloading academic research papers in return for a fixed payment, which is then converted into a portfolio of cash and shares for the market. The fixed payment is the same for all participants and is paid out regardless of how much effort they actually expend on the task. In contrast, we explicitly map effort to earnings in our task by allocating participants to one of two markets on the basis of their relative performance in the quiz, where one market (for the better performers) is characterised by higher (expected) earnings than the other. Given the university student sample, the completion of a quiz should still feel like ‘work’.[7] A comparison of our result to that of Corgnet et al is useful in the sense that it reveals the extent to which earned/unearned money effects are sensitive to task-type.

If trading with endowed money does not result in significantly more risk-seeking behaviour on the part of (inexperienced) participants, then one would expect prices in markets where trade occurs with house-money to behave similarly to prices in markets where participants are trading with earned money. Consequently, we test the following two null hypotheses using numerous measures of the magnitude and duration of bubbles that exist in the experimental asset market literature (defined in section 4).

H1: *Mispricing/Overvaluation/Bubbles in markets where participants’ initial allocation is endowed is not significantly different in magnitude to markets where participants’ initial allocation is earned.*

H2: *Mispricing/Overvaluation/Bubbles in markets where participants’ initial allocation is endowed is not significantly longer in duration than in markets where participants’ initial allocation is earned.*

[7] Another difference between our designs is that Corgnet et al employ a certain dividend in their market, whereas our dividend is stochastic. Given that dividend certainty does not produce significantly different price behaviour to uncertain dividends (Porter and Smith 1995), we do not expect this to explain any observed differences between the studies.

3 Experimental Design

The experiment consisted of 16 sessions conducted at the ASB Experimental Research Laboratory at the University of New South Wales in August and October 2012, using a student sample recruited through ORSEE (Greiner 2004). A total of 459 students, predominantly undergraduate, participated in the study, none of whom had any prior experience with market experiments. The experiment was computerised using zTree (Fischbacher 2007), with the exception of an end-of-experiment questionnaire, which was completed on paper. All trading was conducted in 'francs' (experimental currency), with earnings converted and paid out in Australian dollars at the end of the experiment at an exchange rate that varied depending on the treatment and the session.

3.1 Treatments

A between-subjects design was implemented, consisting of two treatments – *Earned* and *Free* – which differ only in the way in which the initial allocation of assets and cash in the market is assigned to traders. Prior to their involvement in the market, participants in the *Earned* treatment were required to complete a task that determined their initial allocation. As in Cherry et al (2002), the task was a timed quiz consisting of questions from the Graduate Management Admissions Test (GMAT). However unlike their study, in which participants had to answer 17 questions in 40 minutes, participants in our study were given the task of answering 10 multiple-choice questions (5 numerical reasoning, 5 verbal reasoning) in 20 minutes[8].

[8] In addition to multiple-choice numerical and verbal reasoning questions, the GMAT-based quiz used by Cherry et al (2002) also contained a number of extended response questions. We chose to exclude extended response questions from our quiz due to considerations regarding the length of the experiment, and also to computerise the implementation and grading of the quiz. The

To create an incentive for participants to expend effort on the task, the size of the earnings from the task (the initial market allocation) was linked to participants' relative performance. Performance was measured by the number of questions answered correctly. In the event of a tie, the amount of time taken to complete the quiz was considered; the participant who took less time was deemed to have performed better.

The top 50% of performers were allocated to *'high-stakes'* (*HS*) markets, where the initial allocations consisted of twice the amount of cash and assets received by those in *'low stakes' (LS)* markets, to which the bottom 50% were allocated. In effect, participants *earned* their initial allocations in the market. All experiment sessions were designed to consist of two *HS* and two *LS* markets. Once participants were assigned to either the *HS* or *LS* category of markets on the basis of their performance in the task, they were then randomly allocated to one of the two independent *HS*/*LS* markets[9]. That is, their performance in the task played no role in determining which specific *HS*/*LS* market they were allocated to. To the extent that GMAT performance correlates with intelligence (and intelligence correlates with trading ability), this was done in order to mitigate the possibility that prices in one *HS*/*LS* market varied systemically from the other because it contained more intelligent participants.

In contrast, participants in the *Free* treatment did not complete a task. Instead, they were randomly assigned to a *HS* or *LS* market. Hence, their initial portfolios were simply endowed.

---

20 minutes given to participants to complete the quiz was selected to give participants more than enough time to attempt all questions, and in fact, 90% of subjects completed the quiz before time ran out.

[9] Note, *HS* (*LS*) traders only traded with other *HS* (*LS*) traders allocated to the same market.

3.2 Market Structure

Each experiment session held in August (October) was designed to run 4 separate markets – 2 *HS* and 2 *LS* – of 8 (6) traders each. The market, which was computerised, involved subjects trading units of a risky asset called 'X'[10]. The market ran for 10 periods, each lasting 3 minutes in the August sessions, and 2 minutes in the October sessions[11]. Trade occurred according to continuous double auction trading rules (Smith 1962), with an open order book[12]. In each trading period, traders were able to post bids and asks, and/or accept any posted bid or ask, subject to the constraints posed by their holdings of cash and the risky asset. All trades were for single units of the asset. Short selling and buying on margin were not allowed.

At the end of each period, the asset paid a dividend of 0 or 20 francs with equal probability; all units of the asset paid the same dividend at the end of a given period. Dividends were drawn independently each period by the computer, and the probability distribution governing them was known to all participants. Any non-zero dividends paid were added to the trader's cash balance and their end-of-period portfolio carried over to the next period. Since the average dividend in each period is 10 francs, the risk-neutral fundamental value of the asset is equal to the expected total future dividend stream, or 10 multiplied by the number of remaining trading periods (including the current one). Hence, the fundamental value of the asset in our market declined in steps of 10 from 100 francs in period 1 to 10 francs in period 10, before

[10] The parameters of the market were adapted from Dufwenberg et al (2005), whose design consists of minor variations from the baseline market design of Smith et al (1988) in relation to market length, trading period length, the number of traders, and the distribution of the dividend. Dufwenberg et al markets produce price and trading features that qualitatively mirror those of Smith et al (1988). Our market parameters in the October sessions are identical in all respects to that of Dufwenberg et al. Our August sessions differed from this design in terms of the number of traders (we have 8 vs. 6), and the length of a trading period (3 min. vs. 2 min.).

[11] Trading periods in October are shorter because the conditions of the funding for the October sessions necessitated a shorter experiment length.

[12] This represents another deviation from the Smith et al (1988) design. The depth of the order book does not significantly affect price behaviour in these markets.

expiring worthless after the final dividend draw.

Traders commenced the market with an initial allocation of cash and assets that depended on whether they were (a) assigned to a *HS* or *LS* market and (b) assigned trader type 1 or 2.[13] Subjects knew their own initial allocations, but did not know the initial allocations of others in their market. In each *LS* market, half the traders were randomly assigned type 1, and began the market with 6 units of the asset and 200 francs, while the remainder, type 2, were allocated 2 units of the asset and 600 francs[14]. Since the fundamental value of the asset is 100 at the start of the market, all traders in the *LS* market began with a portfolio initially worth (in expectation) 800 francs. Since Type 1 and 2 traders in the *HS* markets were allocated twice the amounts of cash and assets as their analogues in the *LS* market, the initial expected value of the portfolios of all *HS* market traders was twice as much as the *LS* portfolios, or 1600 francs.

The allocations described above determine the initial liquidity of our markets, which is measured by the cash-to-assets ratio – the ratio of total cash to total fundamental value of all assets at the beginning of the market. Increasing the initial liquidity in an experimental market has been observed to increase the magnitude of bubbles (Caginalp et al 1998, 2000). Hence, to control for this factor, all our markets were designed to have an initial cash-to-assets ratio of 1, provided that markets contained an even number of participants. However, as some sessions ran with fewer than the full complement of participants, the actual number of markets in a session, the number of traders in a market, and consequently the initial cash-to-assets ratio occasionally varied from the intended design. Summary information on all

[13] Subjects in both treatments did not know which trader type they were. Subjects in the *Free* treatment also did not know if they had been allocated to a high-stakes or low-stakes market.
[14] Markets with an odd number of traders had an extra Type 1/Type 2 trader.

experimental sessions, including the number of traders and the initial cash-to-assets ratio in each market is provided in Table 1.

< Insert Table 1 about here>

3.3 Procedures

Earned treatment sessions consisted of three stages – *Task*, *Market*, and *Questionnaire* – while *Free* treatment sessions consisted only of the latter two. The duration of an *Earned* treatment session was approximately 2 hours (1.5 hours in the October sessions), while the *Free* sessions ran for about 1.5 hours (1 hour in the October sessions)[15]. Written instructions were given to participants in all stages, which were also communicated verbally by the experiment administrator[16]. To mitigate potential interaction effects, participants were not allowed to communicate with each other for the duration of the experiment, while the anonymity of their data was ensured by randomly allocating ID numbers to participants before the start of the experiment.

In the *Task* stage, subjects in the *Earned* treatment were given 20 minutes to complete the earnings task on the computer. They were informed that their relative performance in the task would determine their initial allocation of cash and assets in the market, with the top 50% of performers being assigned to markets where the initial portfolios would be twice the size of the initial portfolios in the markets to

---

[15] All experimental sessions (for both treatments) were advertised as lasting 2 hours (1.5 hours for the October sessions) to ensure that (self-)selection biases induced by the relative attractiveness of the length of a treatment's session did not render one treatment's subject pool systematically different to the other.

[16] The written protocol for the market stage, which can be found in the Appendix, was adapted from those used by Dufwenberg et al (2005), Noussair et al (2001), Noussair and Powell (2010) and Lugovskyy et al (2009). The experiment administrator read from a script to ensure consistency in the delivery of verbal instructions between sessions and to help mitigate the possibility of experimenter-induced biases. Participants were also given time to read the instructions on their own, and to ask any clarifying questions privately (these were also answered privately).

which the bottom 50% would be allocated. Once all subjects had completed the task, each subject was shown an on-screen summary of their performance including their rank, their allocated market type[17], and the exact allocation of cash and assets that they would begin the Market stage with.

The *Market* stage began with participants receiving instructions on how to use the market's trading screen to make and accept bids and offers (5 minutes), followed by 10 minutes where subjects practiced trading using the interface. After the end of the practice period, participants were instructed on the other features of the asset market, following which the market proper began. At the end of each trading period, traders were shown a summary screen of their dividend earnings for that period and their end-of-period cash balance and asset inventory.

Following the end of the market, the final stage involved participants completing an end-of-market questionnaire, which gathered general demographic information about the subject pool, and their experience(s) and thought-processes during the market[18]. Participants were then called up one-by-one, paid their earnings (in envelopes) and dismissed. Participants' earnings from the experiment consisted of their (converted) market earnings plus a $5 show-up fee. As each unit of the risky asset expired worthless at the end of the market, participants' market earnings were equal to the Australian dollar equivalent of their cash balance at the end of the market[19]. Average earnings from the experiment was $30.

[17] Participants were told that they were assigned to market type "A" or "B", rather than "high-stakes" or "low-stakes" markets. The more neutral language of the former is less likely to have an unexpected impact on behaviour.

[18] The questionnaire, which can be found at the end of this document, is a modified version of the one used by Ackert et al (2001).

[19] Ending cash balance = initial cash balance + dividend earnings + sales revenue – expenditure on purchases

4. Results

We test our hypotheses by separately comparing *HS*/*LS* markets in the two treatments. Given the aforementioned positive association between bubble behaviour and the initial cash-to-assets ratio of the market, we control for its effects by restricting our analysis to markets with an initial cash-to-assets ratio of 1. This results in the loss of 6 *Free* treatment markets (3 *HS* and 3 *LS*), and 3 *Earned* treatment markets (all *LS)* from the data, leaving 16 *HS* and 12 *LS* markets in the *Earned* treatment, and 12 *HS* and *LS* markets each in the *Free* treatment.

4.1 Descriptive summary of the data

Figure 1 charts the evolution of the median transaction price in the *HS* markets of each treatment when transactions across all markets are pooled. Median prices in both treatments appear to 'track' fundamental value (FV) in the sense that prices generally decline over the course of the market, and no obvious/large bubble-and-crash phenomenon is present. As is typical in bubble studies with inexperienced participants, prices in both treatments begin below fundamental value and remain there for roughly the first third of the market before going above fundamental value (see Porter and Smith, 1995; Palan, 2013). The degree of underpricing in this initial stage of the market appears greater in the *Free* treatment, especially in the first trading period[20], which potentially indicates better price discovery in the *Earned* treatment. However, greater underpricing could also be a result of more risk-averse trading behaviour in the initial stages in the *Free* treatment, which is inconsistent with the assertion that house-money necessarily encourages greater risk-seeking behaviour.

[20] Testing the significance of the difference in Period 1 median prices in the HS markets of *Free* vs. *Earned* treatments using a Wilcoxon-Mann-Whitney (WMW) U test returns a marginally significant result ($n_E = 16$, $n_F = 12$, $U = 96$, p-value (two-sided) = 0.08). Period 2 and 3 median prices are not significantly different.

For the remainder of the market, median prices in both treatments appear to move in tandem, although prices in the *Earned* treatment seem to converge more rapidly to fundamental value[21].

The absence of a clear bubble-and-crash pattern in both treatments is also evident in the pooled *LS* markets, shown in Figure 2. Compared to the *HS* markets, median prices in the *LS* markets of both treatments appear to exhibit more prolonged underpricing in the early stages of the market. In fact, the median price stays below fundamental value in both treatments for the first six periods, compared to only 3 in the case of *HS* markets. Median prices in the *LS* markets of the *Free* and *Earned* treatments also seem to share a stronger association with each other than in the *HS* markets, especially in the second half of the market. However, although they generally track FV, median prices in both treatments fail to fully converge to FV, with period 10 median prices exceeding 200% of FV. This lack of convergence is borne out in the data by in the number of overpriced trades, which are defined as transactions that occur at prices exceeding the maximum possible dividend earnings from the asset. These trades occurred more commonly, and their effects felt more strongly, in the latter periods of a market, when trading volumes were relatively low. While also present in *HS* markets, they were puzzlingly far more prevalent in the *LS* markets of both treatments. Hence these trades, possibly driven by irrationality (Lei et al, 2001) or speculative interest (or both), appear to be a significant factor behind the lack of convergence to FV late in the *LS* markets.

< Insert Figure 1 about here >

[21] However, differences in median prices between HS markets of the two treatments in periods 7-10 are not statistically significant (WMW test).

<Insert Figure 2 about here >

While the figures described above do not provide any striking evidence that endowed money induces a house-money effect in experimental asset markets, the pooled data masks considerable heterogeneity in price behaviour at the individual market level. Figures A1 and A2 (A3 and A4) in the Appendix show the time series of median transaction prices in each *HS* (*LS*) market of the *Earned* and *Free* treatment respectively. While it is difficult to detect any strong difference between treatments by examining these figures, note that many individual *HS* and *LS* markets in both treatments are in fact characterised by sustained periods of underpricing ("negative bubbles") rather than overpricing.[22] Earning your initial allocation also clearly does not prevent the bubble-and-crash phenomenon – of all the *HS* markets in both treatments, it is the *Earned* treatment that contains the most obvious example of that phenomenon (E_HS8). Bubble-and-crash patterns also do not appear to occur significantly more often in *Free* treatment *HS* markets, with arguably only F_HS2 and F_HS3 being candidates. The case for a house-money effect finds a little more encouragement in the *LS* markets, where it is the *Free* treatment with market F_LS3 that has the clearest bubble-and-crash pattern. Markets F_LS8 and F_LS15 also exhibit severe overpricing but without the associated crash. For *Earned*, only market E_LS4 has an obvious bubble-and-crash pattern.

[22] Markets E_HS6, E_HS10, E_HS12, E_LS3, E_LS6, E_LS9, and E_LS11 in *Earned*, and markets F_HS6, F_HS15, F_LS1, F_LS2, F_LS12, and F_LS14 in *Free*.

4.2 Statistical Analysis

4.2.1 Bubble Measures

To conduct a more rigorous analysis of the individual markets and formally test our hypotheses, we calculate a number of variables commonly used in the literature to detect mispricing/bubbles. These measures can broadly be categorised into two groups. "Bubble magnitude" measures, such as *Price Amplitude, Total Dispersion, Normalised Deviation, Haessel-R^2,* or *Average Bias,* assess the degree and/or direction of mispricing in a market. "Bubble-length" measures on the other hand, such *Duration, Boom Duration,* or *Bust Duration,* examine the how long mispricing lasts in a market.

Price Amplitude measures the extent to which average price in a market changes relative to FV. Haruvy and Noussair (2006) measure it as $\max_t\{(\bar{P}_t - F_t)/F_t\} - min_t\{(\bar{P}_t - F_t)/F_t\}$, where the largest and smallest deviations of average price $\bar{P}_t$ from the fundamental value F_t are normalised by the fundamental value in the respective period. Large values of this measure indicate big swings in price relative to fundamental value and hence the possible existence of a bubble.

Total Dispersion (Haruvy and Noussair, 2006) measures the aggregate absolute deviation of median price from fundamental value across all trading periods, and is defined as $\sum_t |MedianP_t - F_t|$. Since it treats both positive and negative deviations from FV identically, it is a measure of mispricing rather than over or undervaluation, with smaller values indicating a closer correspondence between price and fundamental value. A related measure, *Normalised Deviation*, accounts for both the size of the price deviation and the level of trading activity in a market. We calculate it as $\sum_t V_t |MedianP_t - F_t| / (p \times TSU)$, where V_t is the volume of trade in period *t*, *TSU* is the total number of units of the asset in the market, and p is the length of a trading period in minutes (3 for August sessions, 2 for October). This is a modified version of the measure used by Haruvy et al (2007) in which we normalise the original measure by the length of a trading period, since longer trading periods should expect to see more trade. Large values of this measure may be caused by large absolute deviations of price from fundamental value and/or a high volume of trade, which may suggest heightened speculative or irrational trading behaviour. We can also assess how closely prices tend to track changes in fundamental value in a market by determining its *Haessel-*R^2 (Dufwenberg et al 2005), which is simply the R-squared calculated by regressing average prices on fundamental values. A goodness of fit measure, it tells you how much of the variation in the average price across periods is explained by changes in fundamental value; values closer to 0 (1) suggest the potential existence (absence) of price bubbles[23].

Note that none of the above measures tell you if the asset is generally overvalued or undervalued. To gauge the degree of overpricing/underpricing in a market, we calculate *Average Bias* (Haruvy and Noussair 2006), which measures how far median prices deviate from fundamental value on average, and is calculated as $\frac{1}{N}\sum_{t=1}^{N}(MedianP_t - F_t)$. Large positive (negative) values suggest that prices tend to stay above (below) FV. Values close to zero however may suggest that prices stay close to fundamental value or that the asset experiences equal degrees of over and underpricing in the market; assessing the *Average Bias* in conjunction with *Total Dispersion* helps to shed light in this regard, since observing a small (large) *Total*

[23] Stockl et al (2010) however point out that using Haessel-R^2 as a measure of price bubbles is problematic since markets in which prices increase (monotonically) over the life of the asset may also have high R-squared values even though there's no real fit between FV and price. Indeed, this is evident in two of our markets, F_LS8 and F_LS12. Excluding these markets from our comparison of Haessel R^2 between treatments does not change our qualitative result.

Dispersion at the same time as a near-zero *Average Bias* would imply the former (latter).

The first of the bubble-length measures, *Duration* (Porter and Smith 1995), calculates the maximum number of consecutive periods where average price increases relative to fundamental value, or $max\{m: \bar{P}_t - F_t < \bar{P}_{t+1} - F_{t+1} < \cdots < \bar{P}_{t+m} - F_{t+m}\}$. Larger values of *Duration* point to sustained periods where changes in (average) transaction price across trading periods do not 'adequately' track changes in the FV, potentially indicating the presence of a bubble. *Boom (Bust) Duration* (Haruvy and Noussair 2006) is defined as the maximum number of consecutive periods where median prices stay above (stay below) FV; large values indicate long periods of overvaluation (undervaluation), potentially signalling the presence of a bubble ("negative bubble").

We now re-state our hypotheses in relation to the above measures as follows. Hypothesis 1, which contends that bubbles/mispricing is equal in magnitude when participants have to trade over earned wealth compared to unearned wealth becomes:

> ***H1a:*** The *Price Amplitude, Total Dispersion, Normalised Deviation, Average Bias* and *Haessel-R^2* measures do not differ significantly that between the *Free and Earned* treatments.

We test this against a two-sided alternative hypothesis which contends that these measures differ significantly between treatments due to the presence of a house-money effect when participants trade with unearned wealth. Since a house-money effect predicts greater risk-seeking, speculation, and hence mispricing, we also examine the one-sided alternative hypothesis that the above measures are significantly larger in the *Free* treatment than in the *Earned*. The sole exception to this is *Haessel-R^2*, where the direction of the one-sided alternative is reversed.

Hypothesis 2, which states that trading over earned wealth makes no difference to the length of bubbles/ mispricing, becomes:

> ***H2a:*** *Duration, Boom Duration,* and *Bust Duration* do not differ significantly between the *Free* treatment and the *Earned* treatment.

Here, the two-sided alternative once again is that these measures differ significantly between the two treatments. The one-sided alternative for *Duration* and *Boom Duration* is that they are significantly larger in the *Free* treatment than in *Earned*. If house-money effects lead to higher prices and potentially more prolonged overpricing, then periods of sustained underpricing should be shorter in the *Free* markets. Hence, the one-sided alternative for *Bust Duration* is that it is significantly larger in the *Earned* treatment.

4.2.2 HS Markets

Panels A and B of Table 2 contain the values of the bubble measures from each of the *HS* markets in the *Earned* and *Free* treatments respectively. The average value of each measure across all HS markets of the respective treatments is shown at the bottom of each panel. Due to the limited number of observations (each market is a single observation), we examine the statistical significance of the difference between treatments using a Wilcoxon-Mann-Whitney U (WMW) test, which is the non-parametric equivalent of the independent samples t-test.[24] The p-values associated with the one-sided and two-sided tests are shown in Panel C.

A cursory glance at the relative mean values of the bubble-magnitude variables in our *HS* markets would appear to suggest the presence of house-money effects. The average values of *Amplitude*, *Total Dispersion*, and *Normalised Deviation* are all higher in the *Free* treatment, while *Haessel-*R^2 has a higher average value in the *Earned* treatment. The only exception is *Average Bias,* for which the *Earned* treatment actually has a higher average value. However, the results of the two-sided WMW tests reveal that these differences are in fact not statistically significant. Nonetheless, we find some support for a house-money effect in the one-sided WMW tests, where *Amplitude, Haessel-*R^2 *and Normalised deviation* are significant, albeit only at the 10% level (*Amplitude* p-value = 0.072; *Haessel-*R^2 p-value = 0.055; *Normalised deviation* p-value = 0.055). Given that differences in *Total Dispersion* between treatments is not significant when examined using a one-sided test (p-value = 0.148), it appears that the marginal significance of *Normalised deviation* is being driven more by trading volume than mispricing.

That *Average Bias* is not significantly larger in *Free* treatment than in the *Earned* (one-sided p-value = 0.58) is especially problematic for the case of a house-money effect, since it predicts heightened risk-taking/speculative behaviour when trading with unearned wealth and consequently higher prices. Note also that the mean *Average Bias* in both treatments is close to zero while *Total Dispersion* averages considerably greater than zero. This suggests that the 'average' *HS* market in both treatments is characterised by periods of overvaluation *and* undervaluation that tend

[24] The WMW test compares the rank-sums of the observations from two independent samples under the null hypothesis that both samples come from the same underlying distribution. The null is rejected if the observed rank-sum for one of the samples is unusually large/small relative to that expected under the null.

to (mostly) cancel each other out. This is consistent with our earlier observations on the evolution of median prices in the pooled data, as well as the fact that many individual markets are characterised by prolonged under-pricing rather than overpricing.

Turning to the bubble-length measures, the *HS* markets provide no support to the notion that trading with unearned money prolongs bubbles/mispricing. Differences between the *Free* and *Earned* treatments on all three measures are not significant in all tests.

< Insert Table 2 about here >

4.2.3 LS Markets

The values of the bubble measures from each of the *LS* markets in the *Earned* and *Free* treatments are shown in Panels A and B of Table 3 respectively. The results of the corresponding WMW tests are shown in Panel C.

The experience of the *LS* markets in regards to the bubble-magnitude measures is very similar to what is seen in the *HS* markets. Like the *HS* markets, the relative mean values of all bar one of the measures correspond to what would be expected if house-money had an effect on prices. Here, the mean value of *Amplitude, Total Dispersion, Average Bias,* and *Normalised Deviation* in the *Free* treatment exceeds that of the *Earned* treatment, while the one exception is *Haessel-*R^2 (Free: 0.63 vs. Earned: 0.6). However once again, these differences between the treatments are not statistically significant (two-sided test). Even with the one-sided WMW test, only *Total Dispersion* returns a significant result, but that too only marginally (p-value = 0.07). The story is the same for the bubble-length measures in the *LS* markets, where no significant difference is detected between treatments for *Duration, Boom Duration*, or *Bust Duration*. As in the *HS* markets, the 'average' *LS* market in both treatments exhibits periods of overvaluation nullified by periods of undervaluation of similar magnitude (or vice versa), as suggested by the small mean *Average Bias* values and the relatively large *Total Dispersion* averages.

< Insert Table 3 here >

The weight of the statistical evidence from both *HS* and *LS* markets points to a failure to reject hypothesis H1a. Bubble/Mispricing magnitude measures are not significantly different between the two treatments when examined with a two-sided WMW test. Although some measures are deemed significantly larger in the *Free* treatment when applying a one-sided test, they are only marginally so. In addition, these variables are not significant in both *HS* and *LS* markets. In regards to hypothesis H2a, the lack of significance associated with any of the tests involving measures of bubble-length makes the failure to reject it a considerably more straightforward issue.

Even though we use a different earnings task to Corgnet et al (2013), our results qualitatively mirror theirs. An implication of this is that our main result – that endowed wealth does not distort experimental asset markets – is robust to alternative earnings task types (at least the types tested so far).

4.2.3 Earnings dispersion

One area where our results do not fully coincide with Corgnet et al (2013) is in their finding that the dispersion of earnings is significantly lower in the earned money treatment. Earnings dispersion – measured by the standard deviation of final earnings (in francs) – in our experiments is summarised in Panels A and B of Table 4 for the HS and *LS* markets respectively. Looking at the *HS* markets, we observe that earnings dispersion is only significantly different (and larger) in the *Free* treatment at the 10% level (two-sided p-value = 0.082). In the *LS* markets, the average earnings dispersion in *Earned* markets is in fact higher, but the difference between treatments is not significant.

Corgnet et al (2013) point to significantly larger trading volumes in their house-money markets as an important factor behind their finding of greater earnings dispersion. We believe this is indeed a likely reason for the weaker results on earnings dispersion in our study. Whereas their experiment is characterised by a significant difference in turnover[25] between treatments, turnover does not different significantly in ours (*HS* markets p-value (two-sided) = 0.219, *LS* markets p-value (two-sided) = 0.16).

< Insert Table 4 about here >

4.2.4 The impact of endowment size

Our *Free* treatment markets, which are free of the selection issues[26] associated with our *Earned* markets, provide an opportunity to test whether the finding of Ackert et al (2006) that larger (cash) endowments result in higher prices also applies to Smith et al (1988) type double auction markets. Recall that participants in our *HS* markets were provided with twice the level of cash and assets as those in *LS* markets. Table 5 compares the bubble measures in the *HS* (Panel A) and *LS* (Panel B) markets of the

[25] Turnover is defined as the aggregate volume of trade across all trading periods normalised by the total number of units of the asset available in the market.

[26] That is, participants in the *Free* treatment were randomly assigned to *HS* and *LS* markets (and were not informed on the type of market in which they were trading), whereas those in the *Earned* treatment were selected into one or other based on their task performance. If task performance is correlated with intelligence (or some other factor), then *HS* and *LS* markets in the *Earned* treatment will systematically differ in a factor other than just the endowment level.

Free treatment. We compare our null hypothesis of no difference between these two market types against a two-sided alternative that contends that there is a difference, and the one-sided alternative that mispricing/bubbles is more severe in the *HS* markets. The p-values of the respective WMW tests are shown in Panel C.

We find that mispricing is not greater in the *HS* markets. If anything, it is the bubble-magnitude measures in the *LS* markets that are larger, significantly so in the case of *Normalised Deviation* (two-sided p-value = 0.023). Some of this is driven by mispricing, as *Total Dispersion* is (marginally) significant at the 10% level (two-sided p-value = 0.061), but mostly by larger trading volumes in the LS markets (two-sided p-value of Turnover = 0.04). *HS* markets also do not experience a greater degree of overvaluation, as *Average Bias* in both *HS* and *LS* markets is close to zero and not significantly different from each other. None of the bubble-length measures differ significantly between the two types of markets either.

This apparent contradiction of Ackert et al (2006) probably has its roots in differences in the initial cash-to-assets ratios of their study and ours. The market design of Ackert et al (2006) involves participants bidding to buy single units of a fixed supply of new stock in each period using an endowment of only cash. As the supply of stock is the same in both treatments, the initial cash-to-assets ratio in their high endowment treatment is necessarily larger than in their low endowment treatment. In contrast, our *HS* and *LS* markets both have the same initial cash-to-assets ratio of 1, since larger cash endowments are accompanied by an equivalent increase in the asset supply. Hence, the higher prices associated with larger cash endowments observed by Ackert et al (2006) appear to be driven by the liquidity of their markets (the cash-to-assets ratio) rather than the size of the of the (cash) endowment per se, which is consistent with Caginalp et al (1998; 2000).

< Insert Table 5 about here >

5. Conclusion

Recent evidence has drawn attention to the potentially distortionary effects that endowing experiment participants with assets without requiring them to earn them has on individual behaviour. Individuals who experience windfall gains are likely to consume more, take more risk, and display greater other-regarding behaviour than they normally would with their own (earned) money. Of particular relevance to experimental asset markets of the type designed by Smith et al (1988) is the enhanced tendency for risk-taking, or house-money effect, which could amplify the bubble-and-crash patterns observed in such experiments. We examine whether this is indeed the case using a two-treatment design where participants in one treatment are required to earn their initial wealth while participants in the other are simply endowed it. Our results show no significant difference in price behaviour between the two treatments, suggesting that issues regarding asset legitimacy in experimental asset markets are not particularly important and do not confound the results of existing studies. Legitimising assets with effort does not appear to be necessary for this class of experiment.

References:

Ackert, L., Charupat, N., Church, B., & Deaves, R. (2006). An experimental examination of the house money effect in a multi-period setting. *Experimental Economics, 9*(1), 5-16. doi: 10.1007/s10683-006-1467-1

Ang, J., Diavatopoulos, D., & Schwarz, T. (2010). The Creation and Control of Speculative Bubbles in a Laboratory Setting. In C.-F. Lee, A. Lee & J. Lee (Eds.), *Handbook of Quantitative Finance and Risk Management* (pp. 137-164): Springer US.

Arkes, H. R., & Blumer, C. (1985). The psychology of sunk cost. *Organizational Behavior and Human Decision Processes, 35*(1), 124-140. doi: http://dx.doi.org/10.1016/0749-5978(85)90049-4

Arkes, H. R., Joyner, C. A., Pezzo, M. V., Nash, J. G., Siegel-Jacobs, K., & Stone, E. (1994). The Psychology of Windfall Gains. *Organizational Behavior and Human Decision Processes, 59*(3), 331-347. doi: http://dx.doi.org/10.1006/obhd.1994.1063

Caginalp, G., Porter, D., & Smith, V. (1998). Initial cash/asset ratio and asset prices: An experimental study. *Proceedings of the National Academy of Sciences of the United States of America, 95*(2), 756-761.

Caginalp, G., Porter, D., & Smith, V. L. (2000). Overreactions, Momentum, Liquidity, and Price Bubbles in Laboratory and Field Asset Markets. [Article]. *Journal of Psychology & Financial Markets, 1*(1), 24-48.

Charles, N. N., & Owen, P. (2010). Peaks and valleys: Price discovery in experimental asset markets with non-monotonic fundamentals. *Journal of Economic Studies, 37*(2), 152-180.

Cherry, T. L., Frykblom, P., & Shogren, J. F. (2002). Hardnose the Dictator. *The American Economic Review, 92*(4), 1218-1221.

Cherry, T. L., Kroll, S., & Shogren, J. F. (2005). The impact of endowment heterogeneity and origin on public good contributions: evidence from the lab. *Journal of Economic Behavior & Organization, 57*(3), 357-365. doi: DOI: 10.1016/j.jebo.2003.11.010

Cheung, S. L., Hedegaard, M., & Palan, S. (2012). To See Is To Believe: Common Expectations in Experimental Asset Markets: Institute for the Study of Labor (IZA).

Clark, J. (2002). House Money Effects in Public Good Experiments. *Experimental Economics, 5*(3), 223-231. doi: 10.1023/a:1020832203804

Corgnet, B., Hernán, R., Kujal, P., & Porter, D. (2013). The effect of earned vs. house money on price bubble formation in experimental asset markets.

Dufwenberg, M., Lindqvist, T., & Moore, E. (2005). Bubbles and Experience: An Experiment. *The American Economic Review, 95*(5), 1731-1737.

Fischbacher, U. (2007). z-Tree: Zurich toolbox for ready-made economic experiments. *Experimental Economics, 10*(2), 171-178. doi: 10.1007/s10683-006-9159-4

Garland, H. (1990). Throwing good money after bad: The effect of sunk costs on the decision to escalate commitment to an ongoing project. *Journal of Applied Psychology, 75*(6), 728-731.

Haruvy, E., & Noussair, C. N. (2006). The Effect of Short Selling on Bubbles and Crashes in Experimental Spot Asset Markets. *The Journal of Finance, 61*(3), 1119-1157.

Haruvy, E., Yaron, L., & Noussair, C. N. (2007). Traders' Expectations in Asset Markets: Experimental Evidence. *The American Economic Review, 97*(5), 1901-1920.
Huber, J., & Kirchler, M. (2012). The impact of instructions and procedure on reducing confusion and bubbles in experimental asset markets. *Experimental Economics, 15*(1), 89-105. doi: 10.1007/s10683-011-9290-8
Kirchler, M., Huber, J. r., & St˘ckl, T. (2012). Thar She Bursts: Reducing Confusion Reduces Bubbles. *American Economic Review, 102*(2), 865-883. doi: doi: 10.1257/aer.102.2.865
Lei, V., Noussair, C. N., & Plott, C. R. (2001). Nonspeculative Bubbles in Experimental Asset Markets: Lack of Common Knowledge of Rationality vs. Actual Irrationality. *Econometrica, 69*(4), 831-859.
Lugovskyy, V., Puzzello, D., & Tucker, S. (2009). An Experimental Study of Bubble Formation in Asset Markets Using the Tâtonnement Pricing Mechanism: University of Canterbury, Department of Economics and Finance.
Noussair, C., Robin, S., & Ruffieux, B. (2001). Price Bubbles in Laboratory Asset Markets with Constant Fundamental Values. *Experimental Economics, 4*(1), 87-105. doi: 10.1023/a:1011445522861
Oxoby, R. J., & Spraggon, J. (2008). Mine and yours: Property rights in dictator games. *Journal of Economic Behavior & Organization, 65*(3–4), 703-713. doi: http://dx.doi.org/10.1016/j.jebo.2005.12.006
Palan, S. (2013). A REVIEW OF BUBBLES AND CRASHES IN EXPERIMENTAL ASSET MARKETS. *Journal of Economic Surveys*, n/a-n/a. doi: 10.1111/joes.12023
Porter, D. P., & Smith, V. L. (1994). Stock market bubbles in the laboratory. *Applied Mathematical Finance, 1*(2), 111-128. doi: 10.1080/13504869400000008
Porter, D. P., & Smith, V. L. (1995). Futures contracting and dividend uncertainty in experimental asset markets. [Article]. *Journal of Business, 68*(4), 509.
Smith, V. L. (1962). An Experimental Study of Competitive Market Behavior. *Journal of Political Economy, 70*(2), 111-137.
Smith, V. L., Suchanek, G. L., & Williams, A. W. (1988). Bubbles, Crashes, and Endogenous Expectations in Experimental Spot Asset Markets. *Econometrica, 56*(5), 1119-1151.
Thaler, R. H., & Johnson, E. J. (1990). Gambling with the House Money and Trying to Break Even: The Effects of Prior Outcomes on Risky Choice. *Management Science, 36*(6), 643-660. doi: 10.1287/mnsc.36.6.643

Table 1: Experimental Sessions

Panels A and B of this table provide summary information on the experimental sessions of the *Earned* and *Free* treatments respectively. Eight sessions of each treatment were conducted at the University of New South Wales in August (sessions 1-6) and October (sessions 7-8) of 2012. Each session was designed to run 4 separate markets: two 'High-Stakes' (HS) and two 'Low-Stakes' (LS) markets. Participants in HS markets began the market with twice the amount of cash and assets as those in LS markets. Each market in the August (October) sessions was designed for 8 (6) participants/traders. The allocation of assets and cash within a market was designed so that the beginning ratio of total cash to total asset value (Cash-to-Assets ratio) in a market was equal to 1. The actual number of markets in a session, the number of traders in a market, and the initial Cash-to-Assets ratio occasionally varied from this design due to an insufficient number of participants attending a session.

Panel A: Earned Treatment

High Stakes Markets				**Low-Stakes Markets**			
Session	*Market Name*	*No.Traders*	*Initial Cash-to-Asset Ratio*	*Session*	*Market Name*	*No.Traders*	*Initial Cash-to-Asset Ratio*
E1	E_HS1	8	1	**E1**	E_LS1	8	1
	E_HS2	8	1		E_LS2	6	1
E2	E_HS3	8	1	**E2**	E_LS3	8	1
	E_HS4	8	1		E_LS4	8	1
E3	E_HS5	8	1	**E3**	E_LS5	7	0.87
	E_HS6	8	1		E_LS6	8	1
E4	E_HS7	8	1	**E4**	E_LS7	7	0.87
	E_HS8	8	1		E_LS8	7	1.15
E5	E_HS9	8	1	**E5**	E_LS9	8	1
	E_HS10	8	1		E_LS10	8	1
E6	E_HS11	8	1	**E6**	E_LS11	8	1
	E_HS12	8	1		E_LS12	8	1
E7	E_HS13	6	1	**E7**	E_LS13	6	1
	E_HS14	6	1		E_LS14	6	1
E8	E_HS15	6	1	**E8**	E_LS15	8	1
	E_HS16	6	1				

Panel B: Free Treatment

High Stakes Markets				**Low-Stakes Markets**			
Session	*Market Name*	*No.Traders*	*Initial Cash-to-Asset Ratio*	*Session*	*Market Name*	*No.Traders*	*Initial Cash-to-Asset Ratio*
F1	F_HS1	8	1	**F1**	F_LS1	8	1
	F_HS2	8	1		F_LS2	8	1
F2	F_HS3	8	1	**F2**	F_LS3	8	1
	F_HS4	7	0.87		F_LS4	7	0.87
F3	F_HS5	8	1	**F3**	F_LS5	8	1
	F_HS6	8	1		F_LS6	8	1
F4	F_HS7	8	1	**F4**	F_LS7	7	0.87
	F_HS8	7	0.87		F_LS8	8	1
F5	F_HS9	8	1	**F5**	F_LS9	8	1
	F_HS10	8	1		F_LS10	8	1
F6	F_HS11	7	0.87	**F6**	F_LS11	8	1
	F_HS12	8	1		F_LS12	8	1
F7	F_HS13	8	1	**F7**	F_LS13	9	0.89
F8	F_HS14	6	1	**F8**	F_LS14	6	1
	F_HS15	6	1		F_LS15	6	1

Table 2: Bubble Measures in High-Stakes Markets

Panels A and B of the table below show the values of the bubble measures in each high-stakes market of the *Earned* and *Free* treatments respectively. Only markets with an initial cash-to-asset-value ratio of 1 are shown and included in the analysis. *Amplitude* measures the trough-to-peak change in average price relative to fundamental value (FV), standardised by the fundamental value in each period (HN 2006). *Total Dispersion* is the aggregate absolute deviation of median price from FV across all trading periods, while *Average Bias* measures how far median prices deviate from FV on average. *Haessel* R^2 is a goodness-of-fit measure between average price and FV that shows how much of the variation in average price across periods is explained by changes in fundamental value. *Normalised deviation* is a measure of aggregate mispricing which takes into account both the absolute deviation of median prices from FV and the volume of trade across all trading periods. *Duration* is calculated as the maximum number of consecutive trading periods where average price increases relative to fundamental value. *Boom* (*Bust*) *Duration* is the maximum number of consecutive periods where median price exceeds (stays below) FV. We test if these bubble measures differ significantly between the *Earned* and *Free* treatments using the non-parametric Wilcoxon-Mann-Whitney (WMW) U test under the null hypothesis is that values in both groups come from the same distribution (i.e. no significant difference). The two-sided alternative hypothesis is that values in both groups come from different distributions. The one-sided alternative hypothesis that we test is that bubble measure values are significantly larger in the *Free* treatment than in the *Earned* treatment, except in the case of *Haessel R2* and *Bust Duration*, where it is the opposite. The p-values associated with these tests, shown in Panel C, are calculated using a continuity-corrected normal approximation that is adjusted for ties.

Panel A: Earned treatment

Market Name	*Amplitude*	*Total Dispersion*	*Average Bias*	*Haessel* R^2	*Normalised Deviation*	*Duration*	*Boom Duration*	*Bust Duration*
E_HS1	0.96	127.50	0.65	0.69	25.24	6	5	3
E_HS2	0.17	8.50	-0.75	1.00	0.85	1	1	6
E_HS3	0.76	91.50	3.95	0.85	10.30	6	7	2
E_HS4	0.74	64.50	-0.25	0.89	5.54	4	5	3
E_HS5	2.03	122.00	6.00	0.53	6.86	7	6	3
E_HS6	0.82	203.00	-19.70	0.68	15.27	6	1	9
E_HS7	1.17	154.00	-2.40	0.55	35.60	7	4	4
E_HS8	3.59	393.50	32.95	0.09	44.58	6	7	2
E_HS9	0.31	64.00	-6.40	0.95	4.59	3	0	5
E_HS10	0.65	232.50	-22.65	0.77	15.06	7	2	7
E_HS11	1.10	181.00	10.60	0.94	15.00	2	6	4
E_HS12	0.89	270.00	-25.80	0.20	28.72	8	2	7
E_HS13	0.47	67.00	2.70	0.98	4.76	1	5	2
E_HS14	1.01	94.50	-7.05	0.87	11.18	4	2	5
E_HS15	1.42	147.00	14.00	0.84	9.76	2	7	1
E_HS16	0.98	96.50	5.65	0.94	6.34	1	5	2
Average:	**1.07**	**144.81**	**-0.53**	**0.74**	**14.98**	**4.44**	**4.06**	**4.06**

Panel B: Free treatment

Market Name	*Amplitude*	*Total Dispersion*	*Average Bias*	*Haessel* R^2	*Normalised Deviation*	*Duration*	*Boom Duration*	*Bust Duration*
F_HS1	0.42	48.00	4.00	0.95	1.67	1	5	2
F_HS2	2.39	194.00	13.60	0.55	32.77	6	6	3
F_HS3	1.65	165.00	8.30	0.51	20.72	7	6	3
F_HS5	1.34	117.00	11.50	0.90	9.72	3	8	1
F_HS6	0.68	191.00	-18.50	0.72	19.13	4	1	6
F_HS7	1.36	192.50	-9.95	0.50	14.99	8	4	5
F_HS9	2.27	264.00	-13.80	0.01	42.21	8	5	5
F_HS10	1.01	227.00	-4.70	0.60	28.23	6	4	3
F_HS12	0.44	34.00	-2.70	0.92	5.68	1	1	1
F_HS13	1.08	187.00	-16.70	0.49	57.18	6	2	5
F_HS14	1.55	136.50	-0.75	0.64	30.54	7	6	3
F_HS15	1.55	362.50	-34.75	0.41	43.25	9	1	9
Average:	**1.31**	**176.54**	**-5.37**	**0.60**	**25.51**	**5.50**	**4.08**	**3.83**

Panel C: WMW U Test

	Amplitude	*Total Dispersion*	*Average Bias*	*Haessel* R^2	*Normalised Deviation*	*Duration*	*Boom Duration*	*Bust Duration*
p-value (1-sided)	0.072	0.148	0.771	0.055	0.055	0.139	0.556	0.416
p-value (2-sided)	0.144	0.296	0.486	0.109	0.109	0.279	0.925	0.832

Table 3: Bubble Measures in Low-Stakes Markets

Panels A and B of the table below show the values of the bubble measures in each low-stakes market of the *Earned* and *Free* treatments respectively. Only markets with an initial cash-to-asset-value ratio of 1 are shown and included in the analysis. *Amplitude* measures the trough-to-peak change in average price relative to fundamental value (FV), standardised by the fundamental value in each period (HN 2006). *Total Dispersion* is the aggregate absolute deviation of median price from FV across all trading periods, while *Average Bias* measures how far median prices deviate from FV on average. *Haessel* R^2 is a goodness-of-fit measure between average price and FV that shows how much of the variation in average price across periods is explained by changes in fundamental value. *Normalised deviation* is a measure of aggregate mispricing which takes into account both the absolute deviation of median prices from FV and the volume of trade across all trading periods. *Duration* is calculated as the maximum number of consecutive trading periods where average price increases relative to fundamental value. *Boom* (*Bust*) *Duration* is the maximum number of consecutive periods where median price exceeds (stays below) FV. We test if these bubble measures differ significantly between the *Earned* and *Free* treatments using the non-parametric Wilcoxon-Mann-Whitney (WMW) U test under the null hypothesis is that values in both groups come from the same distribution (i.e. no significant difference). The two-sided alternative hypothesis is that values in both groups come from different distributions. The one-sided alternative hypothesis that we test is that bubble measure values are significantly larger in the *Free* treatment than in the *Earned* treatment, except in the case of *Haessel R2* and *Bust Duration*, where it is the opposite. The p-values associated with these tests, shown in Panel C, are calculated using a continuity-corrected normal approximation that is adjusted for ties.

Panel A: Earned treatment

Market Name	*Amplitude*	*Total Dispersion*	*Average Bias*	*Haessel* R^2	*Normalised Deviation*	*Duration*	*Boom Duration*	*Bust Duration*
E_LS1	0.39	67.50	0.45	0.91	12.23	2	5	2
E_LS2	2.79	165.50	12.55	0.91	48.75	5	7	3
E_LS3	1.65	282.00	-25.10	0.63	71.59	9	2	8
E_LS4	2.61	232.50	2.65	0.15	52.68	8	6	4
E_LS6	1.86	328.00	-28.20	0.03	107.52	9	2	8
E_LS9	1.25	210.00	-18.40	0.68	81.44	8	3	7
E_LS10	1.90	213.50	-5.65	0.28	90.07	8	5	5
E_LS11	2.16	216.00	-15.70	0.75	60.96	7	3	7
E_LS12	2.42	193.00	-8.30	0.88	46.35	8	3	6
E_LS13	3.89	257.50	-8.85	0.25	136.46	9	4	6
E_LS14	0.64	97.50	-1.25	0.83	28.40	2	7	2
E_LS15	2.61	173.50	-0.65	0.92	64.56	8	4	4
Average:	**2.01**	**203.04**	**-8.04**	**0.60**	**66.75**	**6.92**	**4.25**	**5.17**

Panel B: Free treatment

Market Name	*Amplitude*	*Total Dispersion*	*Average Bias*	*Haessel* R^2	*Normalised Deviation*	*Duration*	*Boom Duration*	*Bust Duration*
F_LS1	0.56	252.50	-25.25	0.89	53.60	6	0	10
F_LS2	2.17	299.50	-22.25	0.16	96.44	8	3	6
F_LS3	2.49	361.00	4.80	0.01	63.26	5	4	3
F_LS5	0.74	109.50	-0.25	0.76	13.96	5	6	2
F_LS6	1.34	207.00	19.70	0.62	12.99	2	8	1
F_LS8	8.65	372.50	25.25	0.90	101.51	9	7	3
F_LS9	2.84	214.00	-10.40	0.73	63.81	6	4	6
F_LS10	0.83	120.00	-6.50	0.64	28.74	5	6	3
F_LS11	1.54	134.00	11.40	0.89	17.42	2	8	1
F_LS12	4.11	399.50	-24.65	0.88	134.14	9	4	6
F_LS14	1.45	361.00	-34.30	0.20	121.06	9	1	8
F_LS15	3.00	585.00	58.50	0.93	196.25	3	10	0
Average:	**2.48**	**284.63**	**-0.33**	**0.63**	**75.26**	**5.75**	**5.08**	**4.08**

Panel C: WMW U Test

	Amplitude	*Total Dispersion*	*Average Bias*	*Haessel* R^2	*Normalised Deviation*	*Duration*	*Boom Duration*	*Bust Duration*
p-value (1-sided)	0.44	0.07	0.29	0.56	0.42	0.84	0.19	0.13
p-value (2-sided)	0.89	0.14	0.58	0.93	0.84	0.35	0.38	0.27

Table 4: Earnings Dispersion

The standard deviation of participants' earnings in each High-Stakes (Low-Stakes) market is shown in Panel A (B). Markets are categorised according to the treatment in effect - *Earned* or *Free*. Only markets with an initial cash-to-asset-value ratio of 1 are shown and included in the analysis. The statistical significance of the difference between treatments is determined using the Wilcoxon-Mann-Whitney (WMW) U test under the null hypothesis is that values in both treatments come from the same distribution (i.e. no significant difference). The two-sided alternative hypothesis is that values in both groups come from different distributions. The p-value associated with this test is calculated using a continuity-corrected normal approximation that is adjusted for any ties.

Panel A: High-stakes markets

Treatment: Earned		Treatment: Free	
Market Name	*SD Earnings*	*Market Name*	*SD Earnings*
E_HS1	237.75	F_HS1	617.80
E_HS2	178.70	F_HS2	433.59
E_HS3	295.30	F_HS3	587.62
E_HS4	412.53	F_HS5	228.97
E_HS5	132.62	F_HS6	440.29
E_HS6	471.87	F_HS7	220.11
E_HS7	923.67	F_HS9	922.13
E_HS8	992.44	F_HS10	1282.52
E_HS9	136.72	F_HS12	440.86
E_HS10	193.02	F_HS13	661.25
E_HS11	466.71	F_HS14	748.71
E_HS12	604.25	F_HS15	329.28
E_HS13	76.06		
E_HS14	268.62		
E_HS15	571.39		
E_HS16	259.17		
Average Earned:	**388.80**	**Average Free:**	**576.09**

WMW p-value (two-sided) = 0.082

Panel B: Low-Stakes markets

Treatment: Earned		Treatment: Free	
Market Name	*SD Earnings*	*Market Name*	*SD Earnings*
E_LS1	450.16	F_LS1	478.24
E_LS2	226.01	F_LS2	169.76
E_LS3	309.93	F_LS3	537.55
E_LS4	378.70	F_LS5	181.64
E_LS6	250.51	F_LS6	187.10
E_LS9	917.16	F_LS8	280.43
E_LS10	669.88	F_LS9	533.06
E_LS11	582.14	F_LS10	487.00
E_LS12	377.46	F_LS11	321.24
E_LS13	686.34	F_LS12	233.30
E_LS14	455.81	F_LS14	464.06
E_LS15	528.39	F_LS15	834.24
Average Earned:	**486.04**	**Average Free:**	**392.30**

WMW p-value (two-sided) = 0.312

Table 5: Bubble Measures in Free treatment markets

Panels A and B of the table below show, respectively, the values of the bubble measures in each Low-stakes (*LS*) and High-stakes (*HS*) market of the *Free* treatment. Only markets with an initial cash-to-asset-value ratio of 1 are shown and included in the analysis. *Amplitude* measures the trough-to-peak change in average price relative to fundamental value (FV), standardised by the fundamental value in each period (HN 2006). *Total Dispersion* is the aggregate absolute deviation of median price from FV across all trading periods, while *Average Bias* measures how far median prices deviate from FV on average. *Haessel* R^2 is a goodness-of-fit measure between average price and FV that shows how much of the variation in average price across periods is explained by changes in fundamental value. *Normalised deviation* is a measure of aggregate mispricing which takes into account both the absolute deviation of median prices from FV and the volume of trade across all trading periods. *Duration* is calculated as the maximum number of consecutive trading periods where average price increases relative to fundamental value. *Boom* (*Bust*) *Duration* is the maximum number of consecutive periods where median price exceeds (stays below) FV. We test if these bubble measures differ significantly between *HS* and *LS* markets of the *Free* treatment using the non-parametric Wilcoxon-Mann-Whitney (WMW) U test under the null hypothesis is that values in both groups come from the same distribution (i.e. no significant difference). The two-sided alternative hypothesis is that values in both groups come from different distributions. The one-sided alternative hypothesis that we test is that bubble measure values are significantly larger in *HS* markets than in the *LS* markets, except in the case of *Haessel* R^2 and *Bust Duration*, where it is the opposite. The p-values associated with these tests, shown in Panel C, are calculated using a continuity-corrected normal approximation that is adjusted for ties.

Panel A: High-Stakes markets of Free treatment

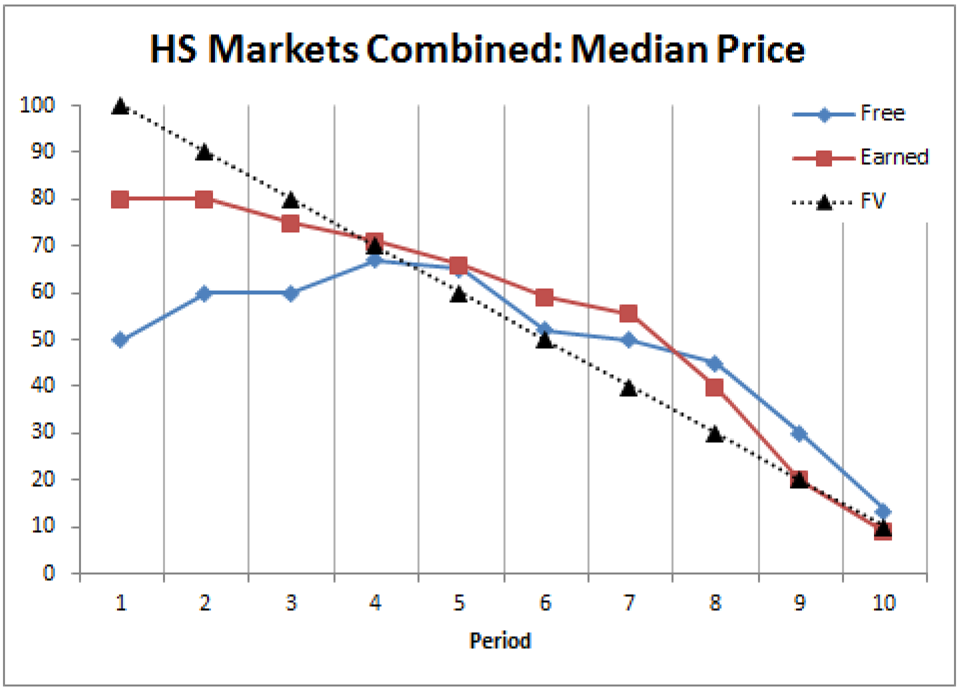
Market Name	*Amplitude*	*Total Dispersion*	*Average Bias*	*Haessel* R^2	*Normalised Deviation*	*Duration*	*Boom Duration*	*Bust Duration*
F_HS1	0.42	48.00	4.00	0.95	1.67	1	5	2
F_HS2	2.39	194.00	13.60	0.55	32.77	6	6	3
F_HS3	1.65	165.00	8.30	0.51	20.72	7	6	3
F_HS5	1.34	117.00	11.50	0.90	9.72	3	8	1
F_HS6	0.68	191.00	-18.50	0.72	19.13	4	1	6
F_HS7	1.36	192.50	-9.95	0.50	14.99	8	4	5
F_HS9	2.27	264.00	-13.80	0.01	42.21	8	5	5
F_HS10	1.01	227.00	-4.70	0.60	28.23	6	4	3
F_HS12	0.44	34.00	-2.70	0.92	5.68	1	1	1
F_HS13	1.08	187.00	-16.70	0.49	57.18	6	2	5
F_HS14	1.55	136.50	-0.75	0.64	30.54	7	6	3
F_HS15	1.55	362.50	-34.75	0.41	43.25	9	1	9
Average:	**1.31**	**176.54**	**-5.37**	**0.60**	**25.51**	**5.50**	**4.08**	**3.83**

Panel B: Low-Stakes markets of Free treatment

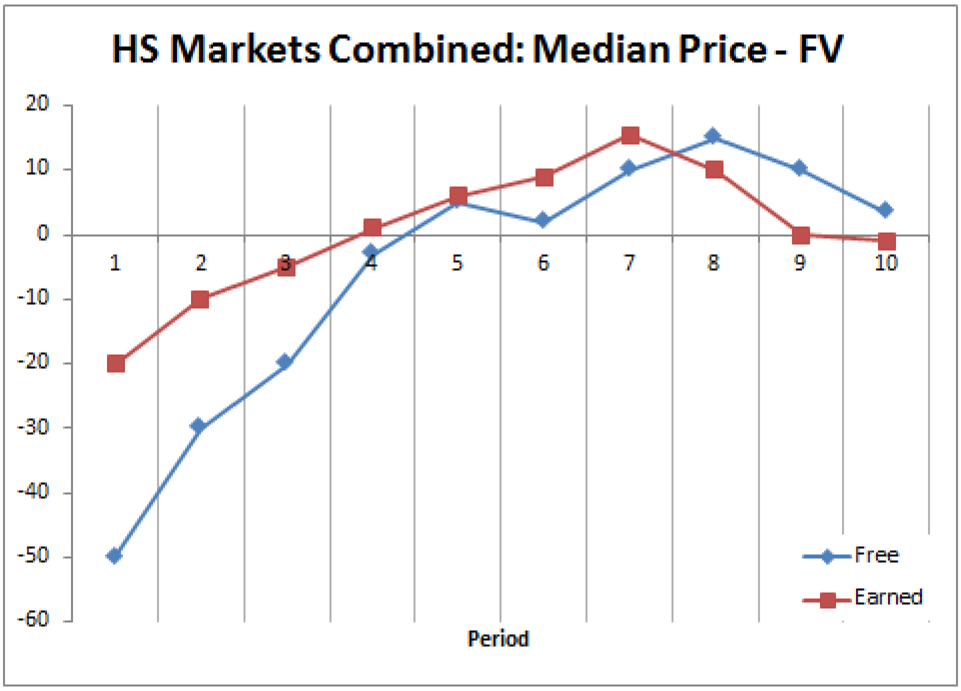
Market Name	*Amplitude*	*Total Dispersion*	*Average Bias*	*Haessel* R^2	*Normalised Deviation*	*Duration*	*Boom Duration*	*Bust Duration*
F_LS1	0.56	252.50	-25.25	0.89	53.60	6	0	10
F_LS2	2.17	299.50	-22.25	0.16	96.44	8	3	6
F_LS3	2.49	361.00	4.80	0.01	63.26	5	4	3
F_LS5	0.74	109.50	-0.25	0.76	13.96	5	6	2
F_LS6	1.34	207.00	19.70	0.62	12.99	2	8	1
F_LS8	8.65	372.50	25.25	0.90	101.51	9	7	3
F_LS9	2.84	214.00	-10.40	0.73	63.81	6	4	6
F_LS10	0.83	120.00	-6.50	0.64	28.74	5	6	3
F_LS11	1.54	134.00	11.40	0.89	17.42	2	8	1
F_LS12	4.11	399.50	-24.65	0.88	134.14	9	4	6
F_LS14	1.45	361.00	-34.30	0.20	121.06	9	1	8
F_LS15	3.00	585.00	58.50	0.93	196.25	3	10	0
Average:	**2.48**	**284.63**	**-0.33**	**0.63**	**75.26**	**5.75**	**5.08**	**4.08**

Panel C: WMW U Test

	Amplitude	*Total Dispersion*	*Average Bias*	*Haessel* R^2	*Normalised Deviation*	*Duration*	*Boom Duration*	*Bust Duration*
p-value (one-sided)	0.937	0.973	0.602	0.728	0.990	0.558	0.793	0.558
p-value (two-sided)	0.141	0.061	0.840	0.583	0.023	0.930	0.447	0.930



(a)



(b)

Figure 1: The evolution of median prices in each treatment using pooled data from all *HS* markets with a cash-to-assets ratio = 1 is shown in (a), while the deviations from fundamental value are shown in (b).

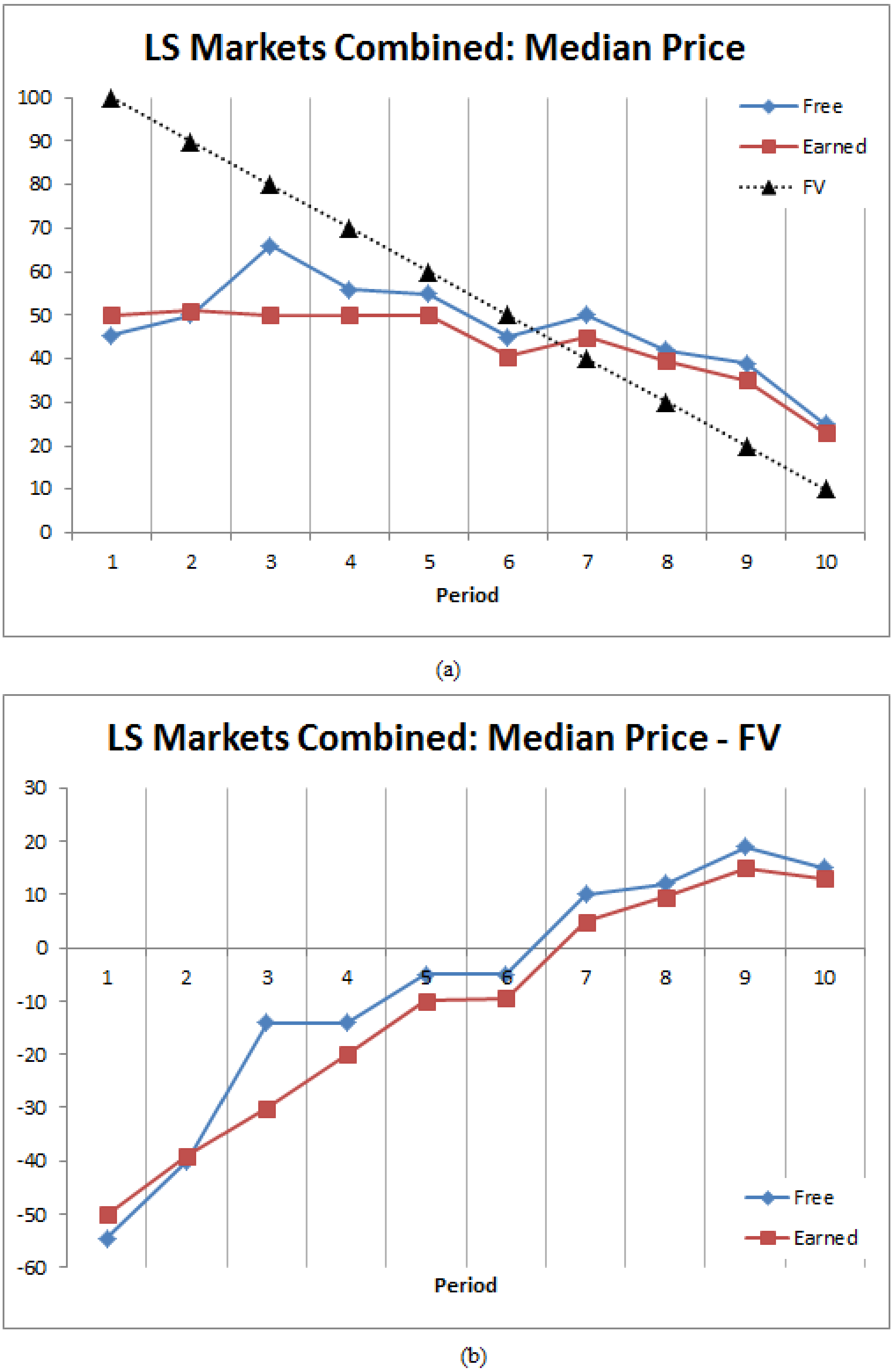


Figure 2: The evolution of median prices in each treatment using pooled data from all *LS* markets with a cash-to-assets ratio = 1 is shown in (a), while the deviations from fundamental value are shown in (b).

Appendices

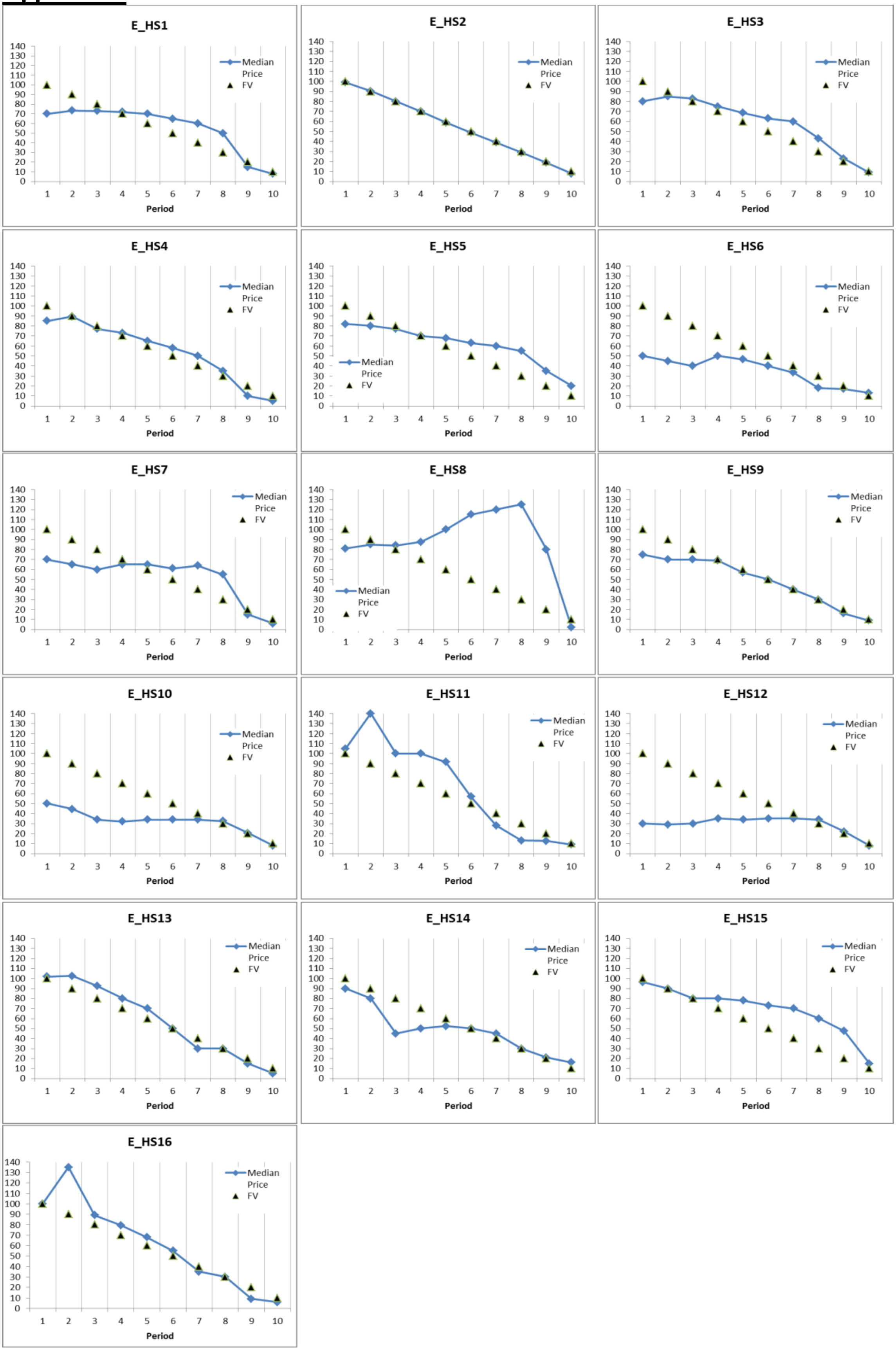


Figure C1: Median transaction prices in all *HS* markets of the *Earned* treatment with initial cash-to-assets = 1.

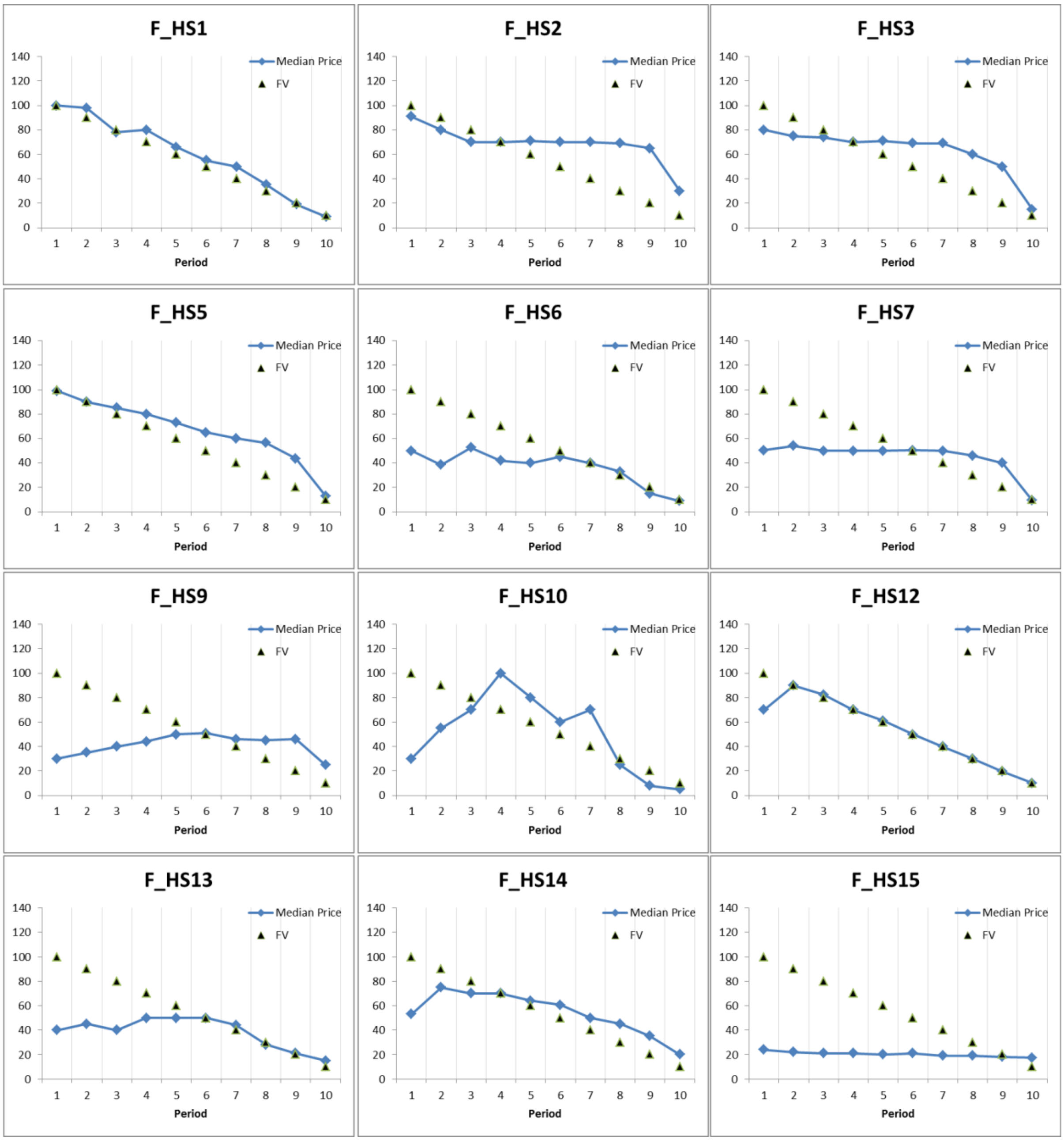


Figure D2: Median transaction prices in all *HS* markets of the *Free* treatment with initial cash-to-assets = 1.

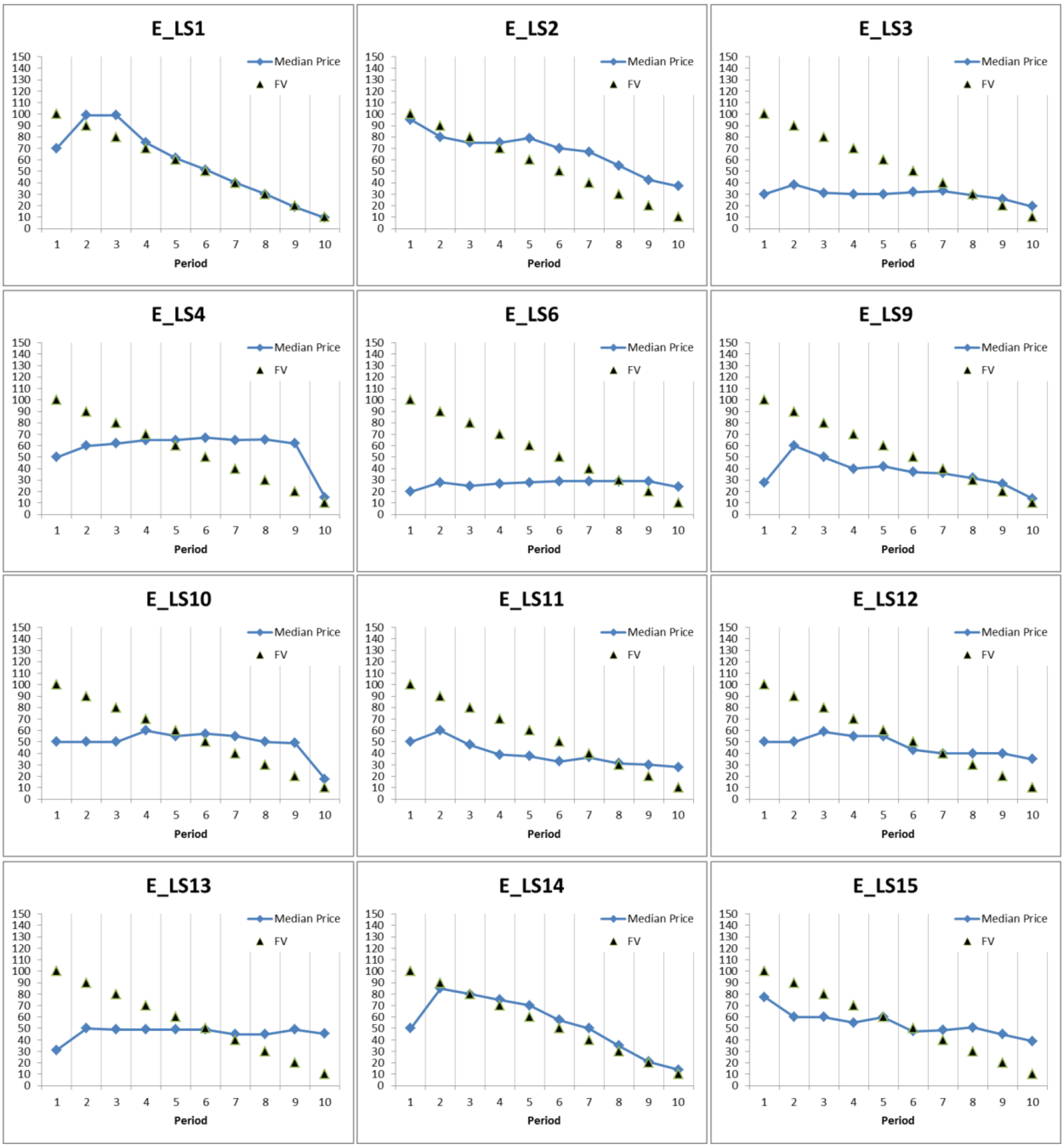


Figure E3: Median transaction prices in all *LS* markets of the *Earned* treatment with initial cash-to-assets = 1.

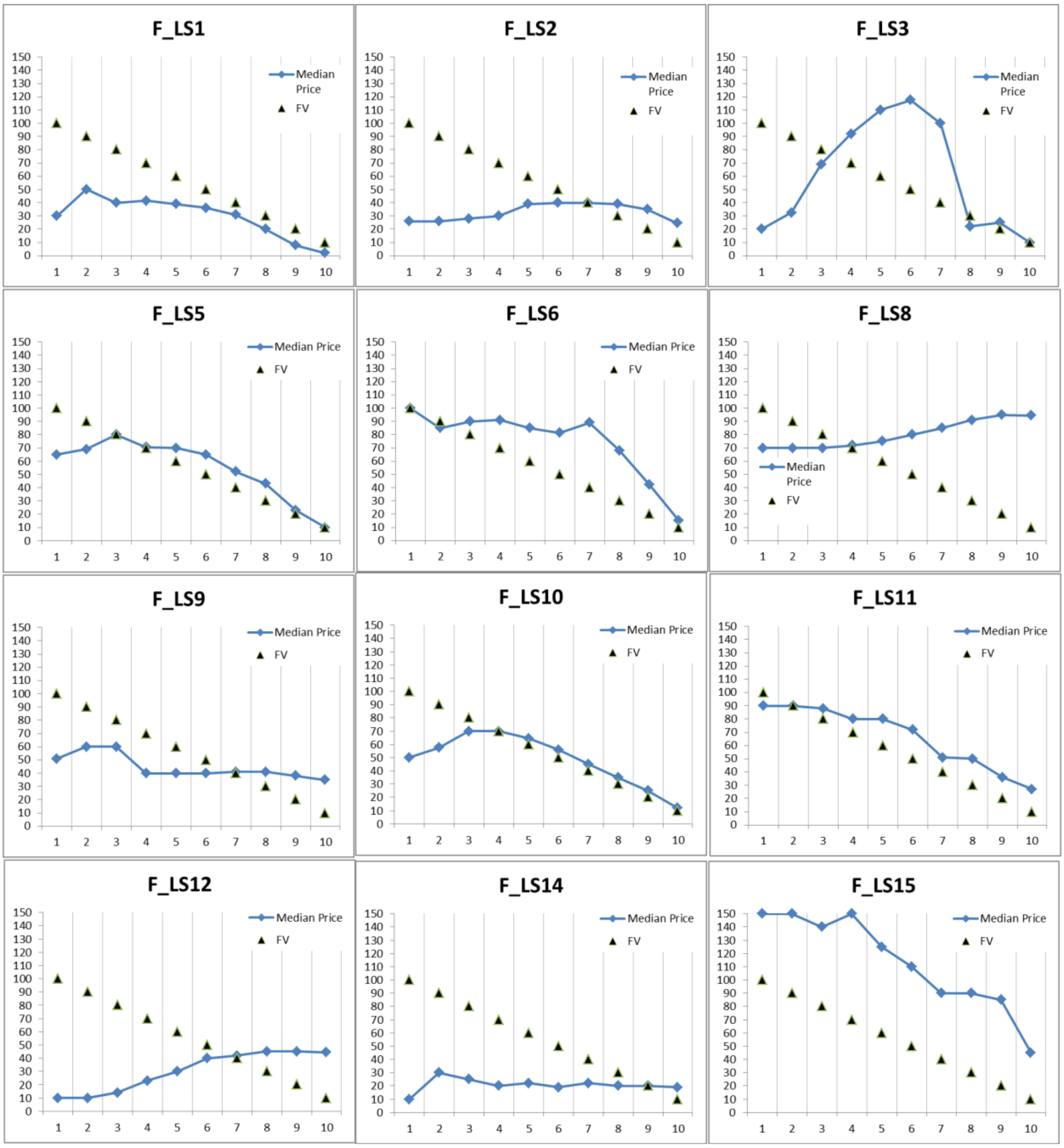


Figure F4: Median transaction prices in all *LS* markets of the *Free* treatment with initial cash-to-assets = 1.

Appendinx - Participant Instructions

*The written instructions provided to experiment participants in the August 2012 sessions is shown below. The parts of the instructions that are unique to the Earned treatment are bolded, italicised and bracketed in red font **[like this]**.The content of the instructions for October session participant is identical, except for a shorter experiment length and trading period length.*

General instructions

This is an experiment in the economics of market decision-making. The instructions are simple and if you follow them carefully and make good decisions, you may earn a considerable amount of money, which will be paid to you, in cash, at the end of the experiment.

The experiment consists ***[of two stages. The first stage involves the completion of a task, through which you will earn the money that you will begin the second stage of the experiment with. The second stage will consist]*** of a sequence of trading periods in which you will have the opportunity to buy and sell in a market. All trading will be in terms of *francs.* The cash payment to you at the end of the experiment will be in Australian dollars, rounded up to the nearest 5 dollars. The conversion rate is ____ francs to 1 dollar.

The experiment will last no more than 1.5/***[2]*** hours, and will include up to 30 minutes of instructions and practice. Please do not speak with any other participants during this experiment. Please also remember to switch off your mobile phone. Failure to comply with these rules will result in your exclusion from the experiment and the forfeiture of all payments.

[Stage One

You will have 20 minutes to complete a quiz on the computer. The quiz consists of 10 multiple-choice questions taken from the numerical and verbal reasoning sections of the Graduate Management Admission Test (GMAT).

How you perform in the quiz relative to other participants determines your quiz earnings – better performers earn more. Performance is measured by the number of questions answered correctly. Where two or more participants are tied for the number of correct answers, the amount of time taken to complete the quiz is taken into consideration; the participant who has taken less time is deemed to have performed better.

Quiz earnings are awarded in the form of a portfolio of cash and goods that you will begin the second (i.e. next) stage of the experiment with. The top 50% of performers will be assigned to market type A, while the bottom 50% will be allocated to market type B. The initial portfolios in type A markets consist of twice the amount of cash and goods as the initial portfolios in Type B. As a result, they are worth twice as much.

An introduction screen will shortly appear on your computer, detailing the instructions for the quiz. Please read them carefully before clicking "Start Quiz" to

begin the quiz. You may use the supplied calculator and working paper to help you answer the questions. Please also note that the usual rules of a test apply.

Once you and all other participants have completed the quiz, the market type (A or B) that you have been assigned to and your quiz earnings will be communicated to you on-screen. This is your private information – do not reveal it to other participants.]

How to use the Computerised Market

Before proceeding ***[to Stage 2]***, we introduce the market interface that you will be using for the remainder of the experiment. Please note that any actions you take during this demonstration period will not count towards your earnings or influence your position later in the experiment.

In the top right hand corner of the screen you see how much time, in seconds, is left in the current trading Period. The good that can be bought and sold in the market is called X. In the centre of your screen you see how many units of X you currently have and the amount of Cash that you have available. Note that the amounts shown on your screen are for demonstration purposes only and have no relation to ***[your performance in the task in Stage 1 (and hence your initial portfolio in Stage 2)]*** what you will begin the actual market with.

When you would like to offer to sell a unit of X, use the text area entitled “Enter offer to sell” in the first column. In that text area you can enter the price at which you are offering to sell a unit of X, and then select “Submit Offer To Sell”. Please do so now. Type in a number in the appropriate space, and then click on the field labelled “Submit Offer To Sell”. You will notice that 8 numbers, one submitted by each participant in your market, now appear in the second column from the left, entitled “Offers To Sell”. Your offer is listed in blue. You can submit multiple offers; new offers will be added to the list, but will not replace your previous offer(s).

The lowest offer-to-sell price will always be on the top of that list and will, by default, be selected. You can select a different offer by clicking on it. It will then be highlighted. If you select “Buy”, the button at the bottom of this column, you will buy one unit of X for the currently selected sell price. Please purchase a unit now by selecting an offer and clicking the “Buy” button. Since each of you had offered to sell a unit of X and attempted to buy a unit of X, if all were successful, you all have the same number of units of X you started out with. This is because you bought one unit of X and sold one unit of X.

When you buy a unit of X, your Cash balance decreases by the price of the purchase, and any existing offers-to-buy submitted by you are cancelled. When you sell a unit of X your Cash balance increases by the price of the sale, and any existing offers-to-sell submitted by you are cancelled. You may make an offer to buy a unit by selecting “Submit offer to buy.” Please do so now. Type a number in the text area “Enter offer to buy”, then press the red button labelled “Submit Offer To Buy”. The highest offer-to-buy price will always be on top of that list and will, by default, be selected. You can accept any of the offers-to-buy by selecting the offer and then clicking on the “Sell” button. Please do so now. In the middle column, labelled “Transaction Prices”, you can see the prices at which X has been bought and sold in this period. The most recent transaction will be listed at the top.

You will now have about 10 minutes to buy and sell X. This is a practice period. Your actions in the practice period do not count toward your earnings and do not influence your position later in the experiment. The only goal of the practice period is to master the use of the interface. Please be sure that you have successfully submitted offers to buy and offers to sell. Also be sure that you have accepted buy and sell offers. If you have any questions, please raise your hand and the experimenter will come by and assist you.

[Stage 2 -] **Specific Instructions for the Market**

The market consists of you and 7 other traders ***[who were assigned to the same market type as you (i.e. A's only trade with other A's, B's only trade with other B's)]***. At the beginning of the market, you will be endowed with/***[have been allocated]*** a portfolio of goods (called 'X') and Cash ***[earned by participants of your market-type in Stage 1]***. Other traders in your market may have a different distribution of cash and goods in their initial portfolio to you.

The market has 10 periods, each lasting 3 minutes. In each period, you may buy and/or sell units of the good called X. X can be considered an asset with a life of 10 periods, and your inventory of X carries over from one trading period to the next. Note that your cash balance and asset inventory cannot fall below zero.

At the end of each trading period, each unit of X pays a dividend, which is randomly determined by the computer. The possible dividend values and the associated likelihoods are shown below:

Dividend	→	0	20
Likelihood	→	½	½

Since each dividend is equally likely, the average dividend per period is 10 francs. The dividend draws in each period are independent. This means that the likelihood of a particular dividend in a period is not affected by the dividend in previous periods. After the final dividend is paid at the end of period 10, each unit of X expires worthless.

Average Holding Value Table

You can use the table at the end of this document to help you make decisions. It calculates the average amount of dividends you will receive if you hold a unit of X in your inventory for the rest of the market, or equivalently, how much in dividends you give up, on average, when you sell a unit of X at any time. Each of the 5 columns of the table is described below:

1. *Ending Period*: indicates the last trading period of the market, period 10.
2. *Current Period*: indicates the period during which the average holding value is being calculated.
3. *Number of holding periods:* This is equivalent to the number of times a dividend can be received if a unit of X is held in your inventory from the current period to the end of the market.
4. *Average Dividend Per Period*: gives the average amount that the dividend will be in each period for each unit of X held in your inventory.
5. *Average Holding Value Per Unit of Inventory*: gives the expected total dividend for the remainder of the experiment for each unit of X that is held in your inventory for the rest of the market. That is, for each unit you hold in your inventory for the remainder of the market, you will receive on average the amount listed in column 5 in dividends. Equivalently, it tells you how much in future dividends you give up on average when you sell a unit in the current period. The number in column 5 is calculated by multiplying the numbers in columns 3 and 4.

Example: Suppose that there are 4 periods remaining. Since the dividend paid on a unit of X has a 50% chance of being 0 and a 50% chance of being 20, the dividend is in expectation 10 per period for each unit of X. If you hold a unit of X for 4 periods, the total dividend paid on the unit over the 4 periods is in expectation 4×10 = 40.

Calculating Your Earnings

Your dividend earnings in each period depends on the number of units of X in your inventory at the **end** of the period, and is calculated as follows:

PERIOD DIVIDEND EARNINGS = END-OF-PERIOD INVENTORY UNITS x DIVIDEND PER UNIT FOR THAT PERIOD

Dividend earnings are added to your cash balance at the end of each period.

When you spend money to buy unit(s) of X, the total amount of cash that you have is reduced by the amount of the purchase. If you sell unit(s) of X, the total amount of cash you have increases by the amount of the sale. Your end-of-period cash balance is calculated as follows:

END OF PERIOD CASH = BEGINNING OF PERIOD CASH + PERIOD DIVIDEND EARNINGS

+ (SALES REVENUE – EXPENDITURES ON PURCHASES)

Since each unit of X expires worthless after the final dividend payment, your earnings from the experiment will equal the balance of your cash account at the end of the market/experiment. Note that you do not have to calculate your earnings by yourself. The computer does all the work.

There will also be a show up fee of $5 (non-tradable) to all participants.

An earnings report will appear on-screen at the end of each period. After seeing your earnings, press the “Continue” button to go to the next period. The next period will begin once all of you press the “Continue” button.

Average Value Holding Table

Ending Period	Current Period	Number of Holding Periods	×	Average Dividend Per Period	=	Average Holding Value Per Unit in Inventory
10	1	10		10		100
10	2	9		10		90
10	3	8		10		80
10	4	7		10		70
10	5	6		10		60
10	6	5		10		50
10	7	4		10		40
10	8	3		10		30
10	9	2		10		20
10	10	1		10		10

Appendix – End of experiment questionnaire

The following questionnaire, a modified version of the one used by Ackert et al (2001), was completed by participants at the end of the experiment.

Post-Market Questionnaire

1. What year are you in university? ________

2. What department/school are you in at university (e.g., finance, economics)?

____

3. What is your sex (tick one) **male ______ female ______**

4. What is your age? _______ years

5. How interesting did you find this experiment? (circle the appropriate number)

Not Very Interesting 1- - - - -2- - - - -3- - - - -4- - - - -5- - - - -6- - - - -7 **Very Interesting**

6. Have you ever traded securities for yourself or others? (tick one) **yes _______ no _______**

7. Have you ever participated in the management of an investment portfolio? (tick one)
yes ________ no ________

8. Compared to the amount of money available to you from alternative sources, how would you characterize the amount of money earned for participating in this experiment? (circle the appropriate number)

Nominal Amount 1- - - - -2- - - - -3- - - - -4- - - - -5- - - - -6- - - - -7 **Considerable Amount**

9. How would you characterize your attitude toward risk while participating in the market? (circle the appropriate number)

Very Risk Averse 1- - - - - 2- - - - -3- - - - -4- - - - -5- - - - - 6- - - - -7 **Very Risk-Taking**

10. Describe as best you can the trading/investment strategy you followed in the market, including any changes in strategy as the market evolved.

11. If you wish to leave any feedback for the experimenters regarding this experiment (e.g. the instructions), please do so below.