Relative Wealth Concerns in Asset Markets:

An Experimental Approach

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Eric J. Schoenberg
Columbia Business School

Ernan Haruvy
University of Texas, Dallas

ABSTRACT

An important issue in the study of asset market bubbles is the extent to which traders are influenced by the perceived performance of other traders. Extant research on laboratory asset market bubbles has kept performance information private, effectively excluding such relative wealth motives from experimental control. In the present study, we study laboratory asset market bubbles in the setting of Smith et al. (1988), with a 15-period finitely lived asset. We provide subjects with periodic relative performance information for one other subject—either the best performer or the worst performer—and examine whether this information has an effect on trading behavior, satisfaction and market prices in the session. We find a strong effect for all three outcomes and discuss possible reasons for the effect of this relative performance information.
“Knowing that our own individual judgment is worthless, we endeavour to fall back on the judgment of the rest of the world which is perhaps better informed. That is, we endeavour to conform with the behavior of the majority on average. The psychology of a society of individuals each of whom is endeavouring to copy the others leads to what we may strictly term a conventional judgment.”

John Maynard Keynes, 1937

1. Introduction

The recent dramatic economic downturn, widely believed to have resulted from a broad mispricing of financial assets (especially, but not exclusively, mortgage backed securities) has increased interest by economists and public policy makers in asset market bubbles\(^1\). Of particular note are the large losses suffered by experienced financial professionals, apparently due their sustaining rather than correcting these mispricings, leading Alan Greenspan to express a “shocked disbelief” at bankers’ failure to protect their own institutions. Camerer and Fehr (2006) attribute this failure to “institutional constraints such as performance pressure,” that is, to the perceived (and possibly real) pressure to match the current, perhaps illusory, performance of peers. Research suggests that this is a particularly important motivation for professional investors since relative performance has a large impact on the ability to increase funds under management (Sirri and Tufano 1998).

The question motivating the research reported here is whether traders might in general be prone to such peer-reference considerations, or relative wealth concerns, even outside an institutional or agency context. In other words, we ask whether traders might have preferences with regards to relative, as well as absolute, payoffs which affect their behavior and thus the evolution of market prices. There is copious experimental and

\(^1\) Bubbles are generally considered to occur when the market price of an asset exceeds the expected value of its discounted future cash flows, at high volumes and for extended periods.
correlational evidence that individual utility functions are indeed affected by social comparisons (Fehr And Schmidt 1999, Dufwenberg and Gneezy 2000, Charness and Rabin 2002, Diener and Biswas-Diener 2002, Luttmer 2005, Firebaugh and Tach 2005). DeMarzo, Kaniel, and Kremer (2008) provide a theoretical link between relative wealth concerns and asset bubbles using a finite horizon, overlapping generations general equilibrium asset pricing model in which rational agents are concerned about the affordability of future “scarce goods.” Since the price of the scarce goods will be determined by the overall wealth of their age cohort, agents rationally choose to herd in order to avoid the risk of poor relative performance, driving the price of a risky asset well above expected value.

Our research utilizes a methodology for studying bubbles in the laboratory in which individuals trade a risky asset with an easily calculated, common knowledge expected value (Smith, Suchanek and Williams 1988). Prices in experimental markets with inexperienced traders rarely track expected value, but instead typically display a bubble-like pattern; market prices begin below expected value and then exceed expected value for much of the experiment before collapsing near the end, a pattern that research has shown to be robust to a wide variety of manipulations (Porter and Smith 2003). James and Isaac (2000) applied the idea of relative wealth concerns to experimental asset markets by providing direct monetary incentives for superior relative performance. They argue that when traders are paid only if they achieve an above-average outcome, those

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2 There is a large literature on such markets focused primarily on the impact of different institutional features, e.g. futures and spot markets (Porter and Smith 1995, Noussair and Tucker 2006), margin buying and short selling (King, Smith, Williams and Van Boening 1993, Haruvy and Noussair 2006), call markets (Van Boening, Williams, and LaMaster 1993), liquidity (Caginalp, Porter and Smith 1998, Caginalp, Porter and Smith 2001), capital gains taxes (Lei, Noussair, and Plott 2002?), and the opportunity for speculation (Lei, Noussair, and Plott 2001), or on characteristics of the traded asset, such as the skewness of its dividends (Ackert, Charupat, Deaves, and Kluger 2006) and its terminal value (Hirota and Sunder 2007).
who are below average in the final period of the game have an incentive to pay above expected value for the asset in the hope that a high dividend payment will move them above average, fracturing the backward induction argument that equates fundamental value with expected value (Tirole 1982). As predicted, whereas in “absolute” payoff markets even a minority of thrice-experienced traders diminishes the size of bubbles (Dufwenberg, Lindqvist, and Moore 2005), bubbles are not eliminated by experience in tournament payoff markets.

Our methodological innovation was to make social comparison information explicitly available to participants without having it affect monetary payoffs. That is, after each period of the market, we provided participants with information about either the current highest or lowest Account Value among all the participants in that market, where Account Value is defined as the sum of one’s cash and the current market value of one’s shares. We demonstrate that the type of information provided has a significant effect on market prices: average trading prices are higher, the peak deviation of trading price from fundamental value is higher, and there are more periods when trading prices are higher than fundamental value in markets where more participants observe the highest potential monetary payoff as compared to those where more participants observe the lowest potential monetary payoff.

2. Theory and hypothesis development

While the vast majority of asset pricing models assume that investors are solely motivated to maximize absolute expected returns subject to some degree of risk aversion, a number of models have also been proposed based on the assumption that economic
actors also care about relative returns (Abel 1990; Gali 1994; Bakshi and Chen 1996). Despite the growing body of economic research demonstrating that this latter assumption is certainly true in experimental settings, the literature on laboratory asset markets is silent on the role relative wealth concerns might play in price evolution even in absolute payoff markets (though the methodology of James and Isaac 2000 is inspired by the importance of relative outcomes, it is noteworthy that they instantiate such concerns by changing the absolute payoff function).

The literature on social utility functions has focused primarily on direct, paired interactions, making it difficult to know how this research applies to markets consisting of indirect interactions among many participants, but there is also a literature in psychology on social comparison processes which offers a key distinction that inspires the research reported here: the difference between the motivations for and consequences of upward vs. downward comparisons (Buunk and Gibbons 2007). According to Blanton, Buunk, Gibbons and Kuyper (1999), people who compare themselves to superior, as opposed to inferior, performers are more interested in improving performance and also more likely to succeed in doing so, both because upward comparisons may reveal useful information about how to improve and because they may increase the motivation to improve. In contrast, those who compare themselves to inferior performers will be more satisfied with their performance.

We investigate an experimental asset market in which participants are exposed to either upward or downward social comparison information. After each period, participants are informed of their own Account Value, defined as the sum of their cash and the current market value of their shares. Participants are also informed of the current
Account Value of either the trader with the highest Account Value in the market (the “Leader”) or the trader with the lowest Account Value in the market (the “Laggard”) (i.e., in the Upward condition, participants see the Account Value of the market Leader while in the Downward condition, they see the Account Value of the market Laggard, respectively). Immediately after reviewing this information, participants are asked to report how they feel about their current Account Value using a 7-point Likert scale whose values ranged from “very negatively” to “very positively” (the Satisfaction Rating).

Hypothesis 1 relates to expressed Satisfaction Ratings in the different conditions. Individuals’ preference for engaging in downward social comparison when they want to feel better about their circumstances is a natural consequence of a more general principle whereby relative material payoffs affect subjective well-being. For example, Clark and Oswald (1996) show that comparison incomes have a significant impact on overall job satisfaction, while Loewenstein, Thompson and Bazerman (1987) demonstrate that subjective utility is mediated by the difference between one’s own outcome and the outcome received by others.

Hypothesis 1a: Satisfaction Ratings will be higher for traders in the Downward condition.

Hypothesis 1b: Market participants’ Satisfaction Ratings will be increasing in the distance from the Laggard and decreasing in the distance from the Leader.

\[ Satisfaction\ Rating' \ (own\ Account\ Value - Laggard\ Account\ Value) > 0 \]

\[ Satisfaction\ Rating' \ (Leader\ Account\ Value - own\ Account\ Value) < 0 \]
The general insight described so far is that downward comparisons make people happier, but upward comparisons increase the motivation and/or ability to improve performance. The difficulty in applying this insight to predict behavior in experimental markets lies in the inherent theoretical problem posed by bubbles: from an economic perspective, the rational strategy for a risk neutral trader facing a population of other rational risk neutral traders is a “fundamental value strategy” which is a rule of buying the asset at prices lower than fundamental value and selling at prices higher than fundamental value. In a market consisting of all rational risk neutral traders, trade will not take place except for trade due to spurious noisy behavior (Milgrom and Stokey 1982). Traders will thus reap the market returns. Outperforming market returns requires a trader to extract profits from traders who are not rational in the above sense. The market is a zero-sum game so any gains to trade by one party translate to a loss to trade to another party.

Nevertheless, Lei, Noussair and Plott (2001) and Caginalp, Porter and Smith (2001) both argue that even participants who understand the logic of the fundamental value strategy choose to use a speculative strategy, which Caginalp et. al. model as being momentum-based, i.e. traders place orders with the expectation of a continued rise in prices. This belief that participants initially “learn” to use speculative strategies finds further support in the fact that bubbles recur in markets with once–experienced traders (Hussam, Porter and Smith 2008).

In the absence of any explanation as to why traders learn to speculate, or whether this learning succeeds in improving speculators’ outcomes, it is difficult to predict the
impact of a greater motivation to improve performance. We note, however, that in the early periods of the game, when prices typically begin below fundamental value and then trend upwards, traders using either fundamental or momentum-based strategies will want to buy shares. We therefore expect that traders exposed to upward comparisons will be more motivated to buy at prices below expected value.

Hypothesis 2: Traders receiving Upward comparison information will demand more of the asset at prices below expected value

Caginalp, Porter and Smith (2000) provide evidence that larger positive price movements cause an enhanced momentum effect, which leads to bigger bubbles. Thus, if traders given Upward comparison information increase the overall demand for the asset in the early periods of the market, driving price upwards, this process ought to result in bigger bubbles. A number of measures have been suggested in the literature to test for the magnitude of bubbles, but we note that our approach, like Caginalp et. al., treats as exogenous the causes of the initial undervaluations that lead traders to initiate the positive price movements towards expected value. Thus, we rely on two measures which focus on the extent of overvaluation: One measure is Maximum deviation from fundamental value. This is the measure identified as most relevant by Caginalp, Porter and Smith (2001) and is defined by $\max_t \{(P_t-f_t)\}$, where $P_t$ denotes price and $f_t$ denotes fundamental value at time $t$. The second measure is Boom duration, the maximum number of consecutive market periods when the median market price is above expected value ($P_t>f_t$), a metric utilized by King et al. (1993) and Haruvy and Noussair (2006).
Hypothesis 3a: Markets with a larger number of traders receiving Upward comparison information will manifest greater bubbles as exhibited by higher Maximum deviations from fundamental value.

Hypothesis 3b: Markets with a larger number of traders receiving Upward comparison information will manifest greater bubbles as exhibited by longer Boom Durations.

We also consider a third relevant measure used in the literature on experimental markets, the overall Average Price paid for the asset\(^3\), which is obviously influenced by both overvaluations and undervaluations. We observe that while past researchers have attributed prices above expected value to speculative motives arising from momentum beliefs, an alternative parsimonious explanation is that prices above expected value are due to risk-seeking behavior.

Hypothesis 3c: Markets with a larger number of traders receiving Upward comparison information will manifest greater bubbles as exhibited by higher Average Price.

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\(^3\) Some research, like Haruvy and Noussair (2006), uses a measure called Average Bias, which is directly comparable to the Average Price. The two differ by a constant, which is equal to the average fundamental value.
3. Experimental Design

The data reported below are based on two protocols different in a number of respects. All analyses were conducted by comparing only markets within a particular protocol. We begin by describing the features common to both protocols.

Participants in groups of 8 to 10 traders traded a stock-like asset with a declining, public knowledge expected value (Smith, Suchanek, and Williams 1988). Participants were recruited from the student population at two large research universities via a combination of posters and e-mails. Participants sat at computer terminals in separate individual cubicles and were given instructions (Appendix A) on the structure of the market, which had 15 trading periods during which participants could buy and/or sell shares of the stock. They were informed that at the end of each period, each share would pay a dividend in cash, determined by a computerized random draw from four equally probable values (0, 8, 28 or 60 experimental units; payoff conversion rates to dollars varied by protocol and are shown in Appendix E), with an expected value of 24 units. Participants were initially endowed with one, two or three shares of the asset plus a cash account of 945, 585 or 225 units, respectively, so that all participants began with the same expected value payoff of 1305 units. At the end of the experiment, participants were paid their show-up fee plus an amount of money equal to the payoff conversion rate multiplied by the sum of their starting cash account, the total value of the dividends they received, and any amounts received from sales of shares, less any amount paid for purchases of shares.

Participants were next instructed in the use of a multiple unit double auction market process (Plott and Gray 1990) programmed and conducted with the software Ztree
Participants were given a reference sheet that showed the expected value of each share at the beginning of each trading period, along with an explanation of how it was calculated (Appendix B). Participants were given unlimited time to ask questions and then played a two-round practice game to experience the trading process (see Appendix C for an example of the trading screen). Finally, their accounts were reset to their initial values and the actual market commenced.

After each period of the session, participants viewed an “Account Status” screen (Appendix D) which included the following information about the current state of their account: (1) Total Cash, (2) Total Shares, (3) Share Price, and (4) Account Total (defined in the instructions and on screen as cash plus market value of shares).

On their “Account Status” screen, participants also received one of two types of social comparison information; they either saw the largest account total of any trader in the session (the “Upward” condition) or they saw the smallest account total of any trader in the session (the “Downward” condition). After reviewing their Account Status screen, participants were asked to report how they felt about their current account total using a 7-point Likert scale ranging from “very negatively” to “very positively.”

In Appendix E, we enumerate differences between our two protocols. A primary distinction which we use to distinguish them in the analyses below is that in one protocol, participants knew only the type of social comparison that they themselves were receiving (“Private Markets”), while in the other, they also knew that everyone else was receiving the same type of social comparison information (“Public Markets”).

Table 1 provides summary details for the 37 total sessions run in six treatments. Public Markets consisted of 14 groups varying from 8 to 10 traders (N=131) in two
treatments. In the AllUp treatment (7 sessions, N=66) all participants saw upward comparisons. In the AllDown treatment (7 sessions, N=65) all participants saw downward comparisons. Approximately half of participants were undergraduates and half were from an assortment of graduate and professional schools. Ages ranged from 18 to 59, with an average of 23.1 and a median of 21. 48.0% of participants were male.

Private Markets consisted of 23 groups of 9 traders (N=207). Private Markets were conducted in four treatments which varied in the number of traders receiving upward information: either 0, 3, 6, or 9 traders, with the remainder of the traders seeing downward information. There were 5, 6, 7, and 5 sessions in the 0U, 3U, 6U and 9U treatments, respectively. Ages ranged from 18 to 46, with an average age of 24.0 and a median age of 23. 68.1% of participants were male.

Final payments in the Public Markets (including the $5 show-up fee) ranged from a high of $73.55 to a low of $5.00. The average payoff was $18.54, and the median payoff was $14.20. Final payments in the Private Markets (including the $5 show-up fee) ranged from a high of $58 to a low of $5. The average payoff was $21.91, and the median payoff was $21.00.

Table 1: Summary information for each experimental treatment

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Protocol</th>
<th>Number of Sessions</th>
<th># Upward Traders per Session (N)</th>
<th># Downward Traders per Session (N)</th>
<th>Upward average earnings</th>
<th>Downward average earnings</th>
</tr>
</thead>
<tbody>
<tr>
<td>9U</td>
<td>Private</td>
<td>5</td>
<td>9 (45)</td>
<td>0 (-)</td>
<td>1095.4</td>
<td>-</td>
</tr>
<tr>
<td>6U</td>
<td>Private</td>
<td>7</td>
<td>6 (42)</td>
<td>3 (21)</td>
<td>1142.5</td>
<td>1287.1</td>
</tr>
<tr>
<td>3U</td>
<td>Private</td>
<td>6</td>
<td>3 (18)</td>
<td>6 (36)</td>
<td>1211.7</td>
<td>1345.7</td>
</tr>
<tr>
<td>0U</td>
<td>Private</td>
<td>5</td>
<td>0 (-)</td>
<td>9 (45)</td>
<td>-</td>
<td>1266.6</td>
</tr>
<tr>
<td>AllUp</td>
<td>Public</td>
<td>7</td>
<td>8-10 (66)</td>
<td>-</td>
<td>1286.0</td>
<td>-</td>
</tr>
<tr>
<td>AllDown</td>
<td>Public</td>
<td>7</td>
<td>-</td>
<td>8-10 (65)</td>
<td>-</td>
<td>1422.2</td>
</tr>
</tbody>
</table>
4. Results

Table 2 summarizes the results of the hypothesis tests, to be discussed below.

Table 2: Summary of Results

<table>
<thead>
<tr>
<th>H</th>
<th>Description</th>
<th>Statistical test</th>
<th>T[d.f.], p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1a</td>
<td>Satisfaction (Downward)&gt;Satisfaction (Upward)</td>
<td>Two-sided t-test for Upward vs. Downward traders</td>
<td>Private: 2.27[206], p=0.02 Public: 1.99[130], p=0.05</td>
</tr>
<tr>
<td>H1b</td>
<td>Satisfaction Ratings increase in Account Value vis-a-vis reference</td>
<td>T-statistics from linear regression model</td>
<td>Private: 2.33[206], p=0.03 Public: 2.29[130], p=0.02</td>
</tr>
<tr>
<td>H2</td>
<td>Rational demand is higher with upward comparisons</td>
<td>Two-sided paired t-test of Average Purchase Price and Average Purchase Volume for Upward vs. Downward traders in 3U and 6U treatments</td>
<td>Price: 1.54[12], p=0.15 Volume: 1.50[12], p=0.16</td>
</tr>
<tr>
<td>H3a</td>
<td>Max Dev increases in # of Upward traders</td>
<td>Two-sided t-test for 0U vs. 9U and AllUp vs. AllDown treatments</td>
<td>Private: 2.25[8], p=0.05 Public: 2.19[12], p=0.05</td>
</tr>
<tr>
<td>H3b</td>
<td>Boom Duration increases in # of Upward traders</td>
<td>Two-sided t-test for 0U vs. 9U and AllUp vs. AllDown treatments</td>
<td>Private: 3.15[8], p=0.01 Public: 2.91[12], p=0.01</td>
</tr>
<tr>
<td>H3c</td>
<td>Average Price increases in # of Upward traders</td>
<td>Two-sided t-test for 0U vs. 9U and AllUp vs. AllDown treatments</td>
<td>Private: 3.66[8], p=0.01 Public: 3.45[12], p=0.005</td>
</tr>
</tbody>
</table>

To test Hypothesis 1, we perform a t-test on the post-Period 15 Satisfaction Ratings (the “Final Satisfaction Rating”) of participants in the Upward vs. Downward conditions. Across all Private Markets, participants in the Upward Condition reported an average Final Satisfaction Rating of 2.3 (on a 7-point scale with a midpoint of 3) vs. 2.9 for those in the Downward Condition (t= 2.27[206], p=0.02). Across all Public Markets, participants in the Upward Condition reported an average Final Satisfaction Rating of 1.9 vs. 2.2 for those in the Downward Condition (t= 1.99[130], p=0.05).
We note, however, that there is a noticeable (though not statistically significant) difference in final payments to Upward vs. Downward participants: in Private Markets, Upward participants had an average Final Account Value of 1134.2 vs. 1298.7 for Downward participants, while in Public Markets, Upward participants had an average Final Account Value of 1285.0 vs. 1422.2 for Downward participants. In the Discussion section, we offer a possible explanation for this discrepancy, but in this context it raises the possibility that the differences in Final Satisfaction Ratings are driven by the actual amount of money received rather than by Condition.

In Table 3, we present regression results for two linear models predicting Final Satisfaction Ratings using as independent variables a combination of a traders’ Own Final Account Value and either Condition (Model 1) or the difference between one’s own Final Account Value and the Social Comparison Final Account Value (Model 2). For both Private Market and Public Markets, Condition remains a marginally significant predictor of Final Satisfaction Ratings even when controlling for Final Account Value (p=0.05 for Private and p=0.08 for Public Markets, and p=0.01 across both Private and Public Markets (result not shown in Table 3).

Table 3. Linear models predicting Final Satisfaction Ratings

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>1.4 (0.26)***</td>
<td>1.3 (0.26)***</td>
<td>1.4 (0.28) ***</td>
<td>1.4 (0.27) ***</td>
</tr>
<tr>
<td>Own Final Account Value (E$)</td>
<td>0.13 (0.02)***</td>
<td>0.10 (0.02)***</td>
<td>0.08 (0.01)***</td>
<td>0.68 (0.014)***</td>
</tr>
<tr>
<td>Upward Condition</td>
<td>-0.43 (0.24)*</td>
<td>-0.62 (0.32)*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Own Final - Social Comparison Final Account Value (E$)</td>
<td></td>
<td>0.21 (0.09)**</td>
<td></td>
<td>0.16 (0.07)*</td>
</tr>
</tbody>
</table>

* p<0.10 ** p<0.05 *** p<0.001
Table 3 also provides support for Hypothesis 1b: a linear model shows that Final Satisfaction Ratings are increasing in the difference between one’s own Final Account Value and the Social Comparison Final Account Value.

Testing Hypothesis 2 is complicated by the fact that research has demonstrated that demand for the experimental asset is heavily influenced by endogenous market factors. That is to say, traders base demand not only on exogenous factors such as the asset’s dividend structure and their own risk preferences, but on predictions of future prices which are formed by observing trading patterns within the market itself. Thus, since we demonstrate below that our manipulation of Social Comparison information affects market prices, we would like to distinguish between demand arising from the manipulation itself and demand arising from the effect of the manipulation on market prices. In short, the “gold standard” for testing for differences in demand between participants in different Social Comparison conditions is to compare Upward and Downward traders who are exposed to the same market prices (i.e., within session tests of the social comparison effect).

Table 4 presents data on two key indicators of demand: the average price at which the asset is purchased, and the average volume of purchases. Upward traders manifest a higher average purchase price in 7 out of 13 sessions and a higher volume of purchases in 6 out of 13 sessions (in 2 sessions, trading volume for the two groups is identical). The average difference across all sessions is higher in both cases, but these differences are not significant in two-sided (marginally significant in one-sided) paired t-tests ($t=1.54[12]$, $p=0.15$ for Average Purchase Price and $t=1.50[12]$, $p=0.16$ for Average Purchase Volume).
Table 4: Measures of Rational Demand in Mixed Markets
(Demand at Prices Below Expected Value in treatments 6U and 3U)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Session</th>
<th>Average Purchase Price</th>
<th>Average Purchase Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Downward Traders</td>
<td>Upward Traders</td>
</tr>
<tr>
<td>3U</td>
<td>1</td>
<td>141.0</td>
<td>155.2</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>81.8</td>
<td>127.5</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>126.1</td>
<td>111.5</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>199.0</td>
<td>203.5</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>145.0</td>
<td>156.8</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>140.6</td>
<td>136.9</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>201.2</td>
<td>192.5</td>
</tr>
<tr>
<td>6U</td>
<td>1</td>
<td>127.8</td>
<td>140.6</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>220.2</td>
<td>201.2</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>118.6</td>
<td>117.6</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>196.3</td>
<td>195.8</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>208.1</td>
<td>251.1</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>271.4</td>
<td>300.0</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>167.5</strong></td>
<td><strong>176.2</strong></td>
<td><strong>8.7</strong></td>
</tr>
</tbody>
</table>

Figure 1 shows the median prices for each period of each session in the AllUp, AllDown, 9U, 0U, 6U, and 3U treatments. A visual comparison of the AllUp vs. AllDown sessions and the 9U vs. 0U sessions suggests a difference in prices between these treatments, which is confirmed by Table 5, which presents averages across all sessions in a given treatment for three measures of the magnitude of bubbles that have been used extensively in the research literature on experimental markets and defined in section 2: (1) Maximum Deviation, (2) Boom Duration, and (3) Average Price. For all three measures, there are statistically significant differences between the 9U and 0U treatments ($t = 2.25[8]$, $p=0.05$ for Maximum Deviation; $t = 3.15[8]$, $p=0.01$ for Boom Duration; and $t = 3.66[8]$, $p=0.01$ for Average Price) and also between the AllUp and AllDown treatments ($t = 2.19[12]$, $p=0.05$ for Maximum Deviation; $t = 2.91[12]$, $p=0.01$.
Figure 1.

All Up Sessions

All Down Sessions

9U Sessions

0U Sessions

6U Sessions

3U Sessions
for Boom Duration; and $t = 3.45[12], p=0.005$ for Average Price). In addition, for Maximum Deviation and Average Price, the 6U and 3U treatments have average values which lie between the average values for the 9U and 0U treatments, though none of the intermediate treatment values are significantly different from any of the other treatments.

Table 5: Average Bubble Measures by Treatment

<table>
<thead>
<tr>
<th>Treatment [N]</th>
<th>Maximum Deviation (Experimental $)</th>
<th>Boom Duration (Periods)</th>
<th>Average Price (Experimental $)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0U [5]</td>
<td>107.4</td>
<td>7.2</td>
<td>172.4</td>
</tr>
<tr>
<td>3U [6]</td>
<td>173.7</td>
<td>8.5</td>
<td>220.5</td>
</tr>
<tr>
<td>6U [7]</td>
<td>124.9</td>
<td>7.1</td>
<td>202.1</td>
</tr>
<tr>
<td>9U [5]</td>
<td>182.8</td>
<td>9.8</td>
<td>222.8</td>
</tr>
<tr>
<td>AllDown [7]</td>
<td>129.2</td>
<td>7.3</td>
<td>190.8</td>
</tr>
<tr>
<td>AllUp [7]</td>
<td>299.4</td>
<td>11.4</td>
<td>304.2</td>
</tr>
</tbody>
</table>
5. Discussion

We offered relative performance concerns as a motivation which might explain bubbles. Our data provide compelling evidence that having all traders in a market aware of the best or worst performance in a market does affect prices. Specifically, in comparing markets with different social reference points, upward social reference appears to result in higher prices and exacerbate bubbles relative to downward social reference. Within market evidence appears to support this conclusion. In markets where some traders are given upward social reference and some are given downward social reference points, the traders who view upward social reference end up trading more and paying more for the shares they purchase at prices below fundamental value.

There are two classes of relevant theoretical explanations proposed in the literature. One is risk seeking in response to tournament-like incentives, which social reference points arguably create. A second class of explanations pertains to imitation, which is potentially a rational or boundedly rational strategy when a trader is faced with uncertainty and/or ambiguity which the trader believes might be resolved by information or insight gained from other traders or, alternatively, when traders are competing for a scarce good. A valid concern is that imitation as a strategy might be difficult to distinguish from imitation as an error; that is, traders might simply be confused and utilize ad hoc reference-dependent strategies such as anchoring on observed prices. We review each set of explanations in turn and discuss the possible confounding role played by confusion.
5.1 Risk Seeking with Tournament-like Incentives

It may be appropriate to think about markets with clear social reference points as similar to games with tournament payoff structures, as is the case with the allocation of scarce goods. This view would be consistent with trading patterns that appear risk-seeking, such as buying at prices above fundamental values.

Hvide (2002) demonstrates that rational agents competing for a single tournament prize will choose higher variance strategies and Gilpatric (2004) shows this is true even if there is a cost to increasing variance, but that rational agents will be risk-averse when there is only a single “booby” prize for the tournament loser. Similarly, James and Isaac (2000) offer rational risk-seeking behavior as their theoretical explanation for the failure of prices to stabilize at expected value even after experience in markets where payments are restricted to those with above average performance. While this payoff structure explicitly creates a scarce good, we believe that our design achieves the same effect implicitly, with the scarce good being the utility (disutility) of being the market leader (laggard).

An alternative theoretical explanation for the association between upward social reference and greater risk-seeking is based on prospect theory (Kahneman and Tversky 1979). Prospect theory posits that decision makers are more likely to make risk-seeking choices when trying to avoid outcomes which are encoded as a loss relative to some reference outcome. Though relatively little research has been done on how individuals establish reference outcomes, Tversky and Kahneman (1981) note that social norms are

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4 In the context of real-world markets, it is not uncommon for fund managers or traders to be evaluated on their trading strategies, for the purpose of bonuses or retention, vis-à-vis the leading performers in their group. It is not difficult to see how such reference points can be construed as tournament incentives.
likely to be influential. Thus, if an individual bases his reference outcome on the highest outcome in a market, he may construe his current outcome as a loss, and be more risk-seeking.

If traders who aspire to be the market leader (the scarce good) engage in more risk seeking behavior, this would drive prices away from fundamental values while lowering expected earnings for the risk seekers. We do indeed observe that in the mixed Private Market treatments (i.e., the 3U and 6U sessions), where both Upward Comparison and Downward Comparison traders experience the same dividend stream, Upward Comparison traders (the risk seekers according to this argument) have lower payoffs than Downward Comparison traders (1142.5 vs. 1287.1 for 6U and 1211.7 vs. 1345.7 for 3U, both statistically insignificant differences).

5.2 Imitation

DeMarzo, Kaniel, and Kremer (2008; hereafter DKK) propose a model where rational traders imitate the strategies of other traders when they pursue scarce goods. In DKK’s model, seemingly risk-seeking behavior may be a result of behavior by risk-averse traders with an incentive to imitate other traders’ strategies. This, according to DKK, is because a failure to imitate the crowd increases the risk to one’s relative wealth, and therefore the risk of being outbid for scarce goods. Clark and Oswald (1998) likewise show that rational agents who care about relative outcomes (and are risk-averse with regards to the comparison) will match the strategies of other agents.

Imitation can also be the result of momentum trading behavior. Caginalp, Porter and Smith (2001) argue that at least some experimental market traders utilize a
complementary strategy based on a prediction that the future price trend will be similar to the recent past trend. The use of such a strategy was demonstrated in the laboratory in Haruvy and Noussair (2006). A momentum strategy is consistent with imitation because a trader who observes others buying will wish to buy as well.

Finally, Camerer and Fehr (2006) argue that the presence of incentives for the rational use of imitation distinguishes which social interactions result in aggregate outcomes near to or far from a Nash equilibrium. They suggest that Nash equilibria will only occur in social interactions when rational agents have an incentive to use substitution strategies, i.e. to do the opposite of irrational agents. By contrast, when rational agents have an incentive to use complementary strategies, i.e. to match the strategies of irrational agents, outcomes can be far from a Nash equilibrium, as we observe in our experiments.

A fundamental value strategy is a type of substitution strategy, while a momentum strategy is a type of complementary strategy. While we did not explicitly capture momentum strategies in the present study, we can confirm that not a single one of the 338 traders in our studies consistently used a fundamental value strategy, suggesting that our participants either do not agree or do not understand that substitution strategies are superior in this setting.

**5.3 Anchoring price expectations on current price**

Haruvy, Lahav and Noussair (2007) show that inexperienced traders’ expectations regarding asset prices are often decoupled from (declining) fundamental value and traders often expect flat price trajectories despite declining fundamentals. These expectations are
usually violated, as price almost always declines near the end of experimental sessions (though not infrequently remains above even the maximum possible value of the asset). In seven (18.9%) of our sessions, however, the median price did indeed stabilize at some apparently arbitrary value no later than the 5th period and remained relatively flat until the end of the session (see Figure 1). Across these seven sessions, nearly half of traders bought shares in Period 15 at this arbitrary price.

Figure 2: Seven sessions with flat price trajectories

Given a long line of research in psychology demonstrating that people in ambiguous or uncertain situations will imitate the actions or beliefs of others (Sherif 1936, Deutsch & Gerard 1955, Echterhoff, Higgins and Levine 2009), a plausible explanation for this price stability is that laboratory traders are erroneously using the
market price of the asset as a better indicator of its “worth” than fundamental value. While this phenomenon has occasionally been observed in other studies (see, for example, Sessions 1, 4, 8 and 9 in the supplementary Appendix for Dufwenberg, Lindqvist, and Moore 2005, Session 9 in Becker, Fischbacher and Hens 2002, and Session 1 in Ackert, Churapat, Church and Deaves 2002), we suspect that one particular aspect of our social reference design may account for its frequency in our studies. As part of the calculation of Account Values at the end of each Period of the market, we inform participants of the current market value of the asset, drawing their attention to the market price as a key component in calculating their current wealth and hence possibly reinforcing the belief that the market price represents the proper value of the shares.

We find an intriguing parallel between this laboratory phenomenon and Keynes’ description in our opening quote of how a “conventional judgment” can arise from a process of imitation under uncertainty. We note, however, that since this phenomenon occurs in sessions in five of our six experimental treatments, this form of imitation appears to occur in addition to, rather than instead of, the strategic use of imitation which we have posited as being induced by relative wealth considerations.

In conclusion, we agree with Hussam, Porter and Smith (2008) that experimental market research clearly shows what “traders do not do… they do not think about the problem the way we do as economists.” We suggest that a productive approach to investigating how they do think will be via the application of psychological theories that bear on such fundamental questions as motivation and learning. In both cases, the psychological emphasis on the importance of social factors presents fertile territory for future research.
References


Appendix A: Private Market Instructions

1. General Instructions

This is an experiment on decision making in a market. The experiment consists of a sequence of trading Periods in which you will have the opportunity to buy and sell in a market. The currency used in the market is francs. All trading will be done in terms of francs. The cash payment to you at the end of the experiment will be in dollars. The conversion rate is: 80 francs to $1.

2. How to use the computerized market

In the top right hand corner of the screen you see how much time is left in the current trading Period. The goods that can be bought and sold in the market are called Shares. In the center of your screen you see the number of Shares you currently have and the amount of Money (francs) you have available to buy Shares.

If you would like to offer to sell a share, 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 share, and then select “Submit Offer To Sell”. Please do so now. Type a number in the appropriate space, and then click on the field labeled “Submit Offer To Sell”. You will notice that 9 numbers, one submitted by each participant, now appear in the second column from the left, entitled “Offers To Sell”. Your offer is listed in blue. Submitting a second offer will replace your previous offer.

The lowest offer-to-sell price will always be on the bottom of that list. You can select an 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 share for the currently selected sell price. Please purchase a share now by selecting an offer and clicking the “Buy” button. Since each of you had offered to sell a share and attempted to buy a share, if all were successful, you all have the same number of shares you started out with. This is because you bought one share and sold one share. Please note that if you have an offer selected and the offer gets changed, it will become deselected if the offer became worse for you. If the offer gets better, it will remain selected.

When you buy a share, your Money decreases by the price of the purchase. When you sell a share your Money increases by the price of the sale. 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 labeled “Submit Offer To Buy”. You can replace your offer-to-buy by submitting a new offer. You can accept any of the offers-to-buy by selecting the offer and then clicking on the “Sell” button. Please do so now.

Please note that you if you attempt to “Buy” a share listed in the “Ask” table, you must have enough money to buy the share at the offered price, and if you attempt to “Sell” for an amount listed in the “Bid” table, you must have a share to sell. If you do not have enough money, or enough shares, you will get an error message. You will also get an error message if you attempt to buy or sell a share from yourself.

In the middle column, labeled “Transaction Prices”, you can see the prices at which Shares have been bought and sold in this period.

You will now be asked some questions. Please answer them. Then you will now have about 2 minutes to buy and sell shares, followed by a second round of two minutes. These are two
practice periods. 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.

After each trading period, you will receive a status report for the period just ended. The status report includes the following information:

- The dividend payment for this period
- The number of shares you currently own
- The total amount of dividends you receive (that is, the number of shares you own multiplied by the dividend payment for the period).
- Your cash account at the end of THIS period
- The market price of the shares (the market price is the average of the prices at which the share was traded in the most recent period or in the prior period if no trades took place in the current period)
- Your account total (that is, your cash account plus the market value of your shares)

In addition, you will also see the current account total of one other player in the market.

Finally, you will be asked a question about how you feel about your current account level. Once everyone has answered that question, the next round of the game will begin.

3. Specific Instructions for this experiment

The experiment will consist of 15 trading periods. In each period, there will be a market open for 2 minutes, in which you may buy and sell shares. Shares are assets with a life of 15 periods, and your inventory of shares carries over from one trading period to the next. You may receive dividends for each share in your inventory at the end of each of the 15 trading periods.

At the end of each trading period, including period 15, the computer will randomly determine the dividend value for all shares in that period. Each period, each share you hold at the end of the period:

- earns you a dividend of 0 francs with probability 1/4
- earns you a dividend of 8 francs with probability 1/4
- earns you a dividend of 28 francs with probability 1/4
- earns you a dividend of 60 francs with probability 1/4

Each of the four dividend values is equally likely, thus the average dividend in each period is 24. Dividends are added to your cash balance automatically. After the dividend is paid at the end of period 15, there will be no further earnings possible from shares. In other words, at the end of the experiment, the shares are worth nothing.
4. Average Holding Value Table

We have provided a sheet of paper to help you make decisions. First, it includes a basic reminder that if you want to sell a share for a particular amount, you enter an ask price, and if you want to buy a share for a particular amount, you enter a bid price.

Second, it includes an **AVERAGE HOLDING VALUE TABLE** to help you make decisions. There are 5 columns in the table. The first column, labeled Ending Period, indicates the last trading period of the experiment. The second column, labeled Current Period, indicates the period during which the average holding value is being calculated. The third column gives the number of holding periods from the period in the second column until the end of the experiment. The fourth column, labeled Average Dividend per Period, gives the average amount that the dividend will be in each period for each unit held in your inventory. The fifth column, labeled Average Holding Value Per Unit of Inventory, gives the average value for each unit held in your inventory from now until the end of the experiment. That is, for each share you hold for the remainder of the experiment, you will earn on average the amount listed in column 5.

Suppose for example that there are 7 periods remaining. Since the dividend on a Share has a 25% chance of being 0, a 25% chance of being 8, a 25% chance of being 28 and a 25% chance of being 60 in any period, the dividend is on average 24 per period for each Share. If you hold a Share for the remaining 7 periods, the total dividend for the Share over the 7 periods is on average 7*24 = 168. Therefore, the total value of holding a Share over the 7 periods is on average 168.
Appendix B: Private Markets Experiment Help Sheet

“Enter Ask Price” = “Enter Bid Price” =
I want to sell a share for $X I want to buy a share for $Y
BUY = I will buy a share
SELL = I will sell a share
for the price highlighted above for the price highlighted above

AVERAGE HOLDING VALUE TABLE

<table>
<thead>
<tr>
<th>Ending Period</th>
<th>Current Period</th>
<th>Number of Holding Periods</th>
<th>x</th>
<th>Average Dividend Per Period</th>
<th>Average Holding Value Per Share in Inventory</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>1</td>
<td>15</td>
<td>24</td>
<td></td>
<td>360</td>
</tr>
<tr>
<td>15</td>
<td>2</td>
<td>14</td>
<td>24</td>
<td></td>
<td>336</td>
</tr>
<tr>
<td>15</td>
<td>3</td>
<td>13</td>
<td>24</td>
<td></td>
<td>312</td>
</tr>
<tr>
<td>15</td>
<td>4</td>
<td>12</td>
<td>24</td>
<td></td>
<td>288</td>
</tr>
<tr>
<td>15</td>
<td>5</td>
<td>11</td>
<td>24</td>
<td></td>
<td>264</td>
</tr>
<tr>
<td>15</td>
<td>6</td>
<td>10</td>
<td>24</td>
<td></td>
<td>240</td>
</tr>
<tr>
<td>15</td>
<td>7</td>
<td>9</td>
<td>24</td>
<td></td>
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<td>15</td>
<td>8</td>
<td>8</td>
<td>24</td>
<td></td>
<td>192</td>
</tr>
<tr>
<td>15</td>
<td>9</td>
<td>7</td>
<td>24</td>
<td></td>
<td>168</td>
</tr>
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<td>15</td>
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<td>5</td>
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<td></td>
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</tr>
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<td>15</td>
<td>12</td>
<td>4</td>
<td>24</td>
<td></td>
<td>96</td>
</tr>
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<td>15</td>
<td>14</td>
<td>2</td>
<td>24</td>
<td></td>
<td>48</td>
</tr>
<tr>
<td>15</td>
<td>15</td>
<td>1</td>
<td>24</td>
<td></td>
<td>24</td>
</tr>
</tbody>
</table>

5. Your Earnings

Your earnings for the entire experiment will equal the amount of cash that you have at the end of period 15, after the last dividend has been paid. The amount of cash you will have is equal to:

The cash (called “Money” on your screen) you have at the beginning of the experiment

+ dividends you receive

+ money received from sales of shares

- money spent on purchases of shares
# Appendix C: All Markets Trading Screen

![Trading Screen](image)

## Table: Period and Market

<table>
<thead>
<tr>
<th>Period</th>
<th>1 of 15</th>
<th>Remaining Time [sec]: 30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market</td>
<td>2/5</td>
<td></td>
</tr>
</tbody>
</table>

## Table: Ask Price, Purchase Price, and Bid Price

<table>
<thead>
<tr>
<th>Shares</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ask Price</td>
<td>300</td>
</tr>
<tr>
<td>Purchase Price</td>
<td>200 206</td>
</tr>
<tr>
<td>Bid Price</td>
<td>150</td>
</tr>
</tbody>
</table>

## Buttons

- **Submit Ask Price**
- **Buy**
- **Sell**
- **Submit Bid Price**
# Appendix D: Private Markets Account Status Screen

<table>
<thead>
<tr>
<th>Period</th>
<th>Trial of 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Your cash balance (before distribution)</th>
<th>$830</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current price/share</td>
<td>$0</td>
</tr>
<tr>
<td>Your shares</td>
<td>4</td>
</tr>
<tr>
<td>Total Dividends</td>
<td>$240</td>
</tr>
<tr>
<td>Total cash</td>
<td>$830</td>
</tr>
<tr>
<td>Total shares</td>
<td>4</td>
</tr>
<tr>
<td>Average Market Price Per Share</td>
<td>$195</td>
</tr>
<tr>
<td>Your account balance (cost plus market value of shares)</td>
<td>$100</td>
</tr>
<tr>
<td>The person with the HIGHEST account value has</td>
<td>$100</td>
</tr>
</tbody>
</table>

How do you feel about your current account? (circle one):

- **Very negatively**
- **Neutrally negatively**
- **Slightly negatively**
- **Neither significantly negatively nor positively**
- **Slightly positively**
- **Neutrally positively**
- **Very positively**
Appendix E  
Additional Notes on Methods

The Public and Private Markets differed in the following ways:

- Traders in Public Markets only received oral instructions, while traders in Private Markets were given both written and oral instructions.

- In Public Markets, the “Stock Price” displayed on the Account Status screen was defined in the instructions as the highest “bid” made for a share in the preceding period. In Private Markets, it was defined as the average price of all trades in the preceding period (or the average price in the last period when there were trades).

- Trading periods lasted either 3 or 2 minutes in Public Markets vs. 2 minutes in all Private Markets.

- The conversion payout rate in Public Markets was 100 E$:1 US$ while it was 80 E$:1 US$ in Private Markets.

- Traders in Public Markets were offered the chance to buy a lottery ticket at the end of each trading Period. The ticket cost E$6 and offered a 1 in 20 chance of winning E$120.

- Traders in Public Markets were able to post multiple bids and offers while traders in Private Markets could only have one bid or offer outstanding at a time (older ones were cancelled after a new one was posted).

- Traders in Private Markets were presented with specific labels for each possible Satisfaction Rating, while those in Public Markets only saw labels for the extreme and middle values.
The fourteen Public Markets reported in this research were conducted over a roughly thirty month period as part of a larger set of studies. A small number of participants participated in more than one session, but in only one session was there more than one experienced participant. There were two minor changes in market procedure within Public Markets.

- After the first three markets, the instructions were modified by adding an additional reminder, verbally stressed by the experimenter, that the shares were worthless at the end of the experiment
- After the first 10 markets, the length of each period of the game was shortened from 3 to 2 minutes.

Neither of these changes within the Public Market treatments had a statistically significant effect on any of the measures reported.