Bubbling with Excitement: An Experiment

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Abstract

In an experimental setting, we study the role of emotions in markets. Our experimental market is modeled on those of Smith, Suchanek, and Williams (1988) and Caginalp, Porter, and Smith (2001). Participants take part in a laboratory market in which they trade a risky asset over a computer network. Prior to trading, they watch short videos that are exciting and upbeat—chase scenes; neutral—segments from a historical documentary; fearful—scenes from a horror movie; or sad—scenes from a drama. Our results show that (a) excitement inflates asset-pricing bubbles in magnitude and amplitude relative to all other treatments, (b) arousal per se is not a sufficient condition, (c) fear does not significantly suppress asset-pricing bubbles compared to the other two controls. In short, excitement is more prone to inflate a bubble than fear is to bust it. A follow-up study indicates that the phenomenon is at least in part explained by excited people's greater inclination to extrapolate past positive market trends into future asset prices.

From "tulipmania" of 1637 to the "irrational exuberance" of the late 1990s, popular accounts of investment bubbles emphasize the role of emotions, and, particularly, excitement. In these accounts, aroused emotional states distort better judgment. Sheeran and Spain (2004) write of "the hysteria to buy in the first place, which inflates the bubble so greatly, and the panic selling which bursts the bubble." However, a few gaps in the literature must be highlighted. First, most experimental studies of asset-pricing bubbles, have focused on non-emotional factors such as liquidity, experience, transparency, novelty of environment, and speculation (Caginalp, Porter, and Smith, 2001; Dufwenberg, Lindqvist, and Moore, 2005, Hussam, Porter, and Smith, 2008; Lei, Noussair, and Plott, 2001). Second, although excitement—here defined as a pleasant and arousing feelings driven by the uncertainty in the environment—is commonly experienced in financial markets (Lo and Repin 2002, Lo, Repin and Steenbarger 2005), the causal link between current excitement and risk-taking has been tangential, either focusing on anticipatory excitement (Knutson et al 2005, Kuhnen and Knutson 2005) or general positive affect (Isen and Patrick 1983). Third, these findings have so far relied on individual decisions not on market level consequences. As a result, it is virtually unknown whether or not these emotions are able to dynamically "contaminate a market" in a controlled setting (i.e., to actually change asset prices in the market)—see Lahav and Meer 2010. Finally, it is open to debate how exactly excitement may impact financial decisions—that is, what psychological mechanism may explain the role of excitement in asset-pricing markets. [1]

This paper reports results from 54 financial market laboratory experiments designed to study the role of excitement in asset-pricing bubbles.

In the first 48 experimental markets, we manipulate participants' incidental emotional state with short videos, a commonly used procedure (Rottenberg, Ray, and Gross 2007) and known to impact financial and economic decision-making (Andrade and Ariely 2009). Precisely, a pleasant, arousing, and high-uncertainty treatment (excitement) is compared to three control treatments which vary relatively on either the pleasantness, arousal and/or certainty dimensions (Smith and Ellsworth 1985): one unpleasant, high-arousal, high-uncertainty treatment (fear), one unpleasant, high-arousal, low-uncertainty

[1] See Ackert, Church, and Deaves (2003) for discussion of emotions and financial markets.

treatment (sadness), and one pleasant, low-arousal, low-uncertainty treatment (neutral). After the incidental emotion induction, participants take part in a financial market simulation. Bubbles are measured and compared across the four conditions.

Within this paradigm, we test first and foremost the extent to which excitement impacts asset-pricing bubbles relative to the control treatments. In doing so, two corollary questions are also addressed. On the one hand, we assess if the arousal dimension is a sufficient condition (Zuckerman 1979)—or if a pleasantly arousing experience is needed to produce the effect. Further, the inclusion of a fear treatment allows us to also assess whether an *un*pleasant, high-arousal, and high-uncertainty emotion also uniquely impact asset-pricing bubbles. For instance, if excitement boosts the bubble, wouldn't fear bust it?

Our results show first and foremost that excitement clearly inflates asset-pricing bubbles in magnitude and amplitude relative to all other treatments. Further, arousal per se is not a sufficient condition. Treatments with different arousal levels showed similar bubbles whereas treatments of same arousal levels showed different bubbles. Finally, fear does not significantly reduce asset-pricing bubbles compared to controls. In short, excitement is more prone to inflate a bubble than fear is to bust it.

As important, we also explore the psychological mechanism that may lead excited investors to inflate bubbles. We conduct 6 additional markets in which "excited" and "non-excited" participants within the same markets are asked to predict future asset prices. Participants exposed to the excitement (vs. neutral) treatment prior to trading display a stronger tendency to extrapolate from previous positive price trends when predicting future prices.

The rest of this paper is organized as follows. In the next section we discuss related research. We describe our experimental design in Section II. We present results in Section III, followed by concluding remarks.

I. Related Research

Bubbles in experimental asset markets were first documented by Smith, Suchanek, and Williams (1988). Subsequent studies have documented that bubbles are greater when participants are endowed with more cash relative to risky assets and when

dividends are paid after each round of trading rather than at the end of trading and when participants can buy on margin (Caginalp, Porter, and Smith, 2001). Bubbles may be dampened or eliminated when short sell is allowed though this is not the case for all experimental designs (King, Smith, Williams, and Van Boening, 1993; Haruvy and Noussair, 2004; Ackert, Charupat, and Deaves, 2006). Bubbles are greater when the distribution of dividends is more lottery-like (Ackert, Charupat, and Deaves, 2006), but can arise even when dividends are non-stochastic (Porter and Smith, 1995). Bubbles are dampened or eliminated when some or all participants are experienced (Dufwenberg, Lindqvist, and Moore, 2005). However, even experienced participants may generate bubbles when market parameters change (Hussam, Porter, and Smith, 2008). Bubbles in one experimental asset may engender bubbles of similar magnitude in simultaneously traded assets (Fisher and Kelly, 2000).

One explanation as to why participants in experimental markets buy at above fundamental value is that they expect to be able to sell the asset at a yet higher price. However, Lei, Noussair, and Plott (2001), find that bubbles can arise in markets in which buyers cannot resell and, thus, speculation is not feasible. Schoenberg and Haruvy (2010) find greater bubbles when participants are given periodic performance information about the best performing participant.

Kirchler, Huber, and Stöckl (2010) argue that bubbles arise in markets where the asset has a declining fundamental value because participants do not fully understand the process. Noussair and Ruffieux (2001) generate bubbles in markets with constant fundamental values.

Little, however, has been done to assess and understand the role of emotions on these markets.

Excitement and Bubbles

Pleasant and unpleasant feelings driven by the uncertainty in the environment (i.e., excitement and fear) are commonly experienced in the market place (Lo and Repin 2002, Lo, Repin and Steenbarger 2005). Further, anecdotal evidence often suggests that excitement may help trigger or inflate bubbles. However, empirical evidence for the

causal impact of excitement on bubbles, or risk-taking in general, has been more nuanced, focused either on anticipatory, rather than current, excitement (Knutson et al 2005, Kuhnen and Knutson 2005) or on general positive affect, rather than excitement per se (Isen and Patrick 1983, Lahav and Meer 2010). Knutson and colleagues (2005) showed that the positive arousing feelings associated with the uncertainty generated by the anticipation of a gain ("excitement")—identified by the activation of the nucleus accumbens of the ventral striatum—correlated with risk-seeking behavior. Isen and Patrick (1983) showed that participants who received an unexpected gift certificate prior to a low-stake gambling task bet more chips to controls (i.e., no certificate). The authors argue that the positive affect generated by the gift certificate produced the observed effect. More aligned with our paradigm, Lahav and Meer (2010) induced positive and neutral mood prior to experimental markets through video exposure. They found greater bubbles after inducing positive feelings. In contrast to us, they run only 4 market simulations manipulating the valence of affect from neutral to positive; we run 54 market simulations, manipulating valence from negative to neutral to positive and arousal and uncertainty from low to high. We also directly assess the underlying mechanism through which excitement may impact asset-pricing markets.

How Excitement May Impact Bubbles

Asset-pricing bubbles may arise when naïve investors believe that the recent past is indicative of the future and buy an asset that has recently rapidly risen because they expect it to continue rising. This creates a feedback loop in which investors buy assets because prices are rising and prices rise because investors are buying. Even sophisticated investors may hold assets they think to be overvalued because they believe less sophisticated investors will drive prices yet higher. For example, Stanley Druckenmiller, the lead manager of Soros's Quantum Fund, believed in December 1999 that the explosion in technology stock prices had gone too far, but he continued to hold technology stocks because he thought they would rise further before declining. As he later explained, "We thought it was the eighth inning, and it was the ninth" (Norris, 2000).

Positive feelings has shown (a) to change information processing by exacerbating decision biases and reliance on heuristics (Bless, Bohner, Schwarz, and Stack, 1990; Schwarz, 1990; Ruder and Bless, 2003) and (b) to vary beliefs by making people form more optimistic risk assessments (Hogarth et al 2011; Johnson and Tversky 1983). Thus, it is possible that excitement may exacerbate the feedback loop in asset bubbles by leading investors to rely more on the recency heuristic when forecasting future prices; furthermore increased optimism may induce investors who already own an asset to forecast yet higher prices. If beliefs in higher prices lead investors to buy, their forecasts can become—in the short run—self-fulfilling. To assess this possibility, we directly test the extent to which excited (vs. non-excited) participants display a stronger tendency to rely on past trends to forecast subsequent prices.

Our multiple control treatments in the main experiment (fear, sadness, and neutral) allow us to also address two corollary questions. First, we assess if the arousal dimension is a sufficient condition (Zuckerman 1979)—or if a pleasantly arousing experience is needed to inflate bubbles. The inclusion of a fear treatment allows us to also test whether an *un*pleasant, arousing, and high-uncertainty emotion also impacts asset-pricing bubbles. Many studies have documented that uncertainty-driven unpleasant emotions, such as fear and anxiety, promote risk-aversion (Lee and Andrade 2011, Lerner and Keltner 2001, Raghunathan and Pham 1999, Tiedens & Linton, 2001). However, most rely on individual decisions rather than market level consequences. Further, it is possible that the impact of emotions is constrained by market trends (Cohn, Fehr and Maréchal 2012). This is particularly important in a market setting where bubbles are prone to emerge in the first place. For instance, if a bubble *facilitates* the spontaneous risk-taking tendencies of an excited investor, through a self-reinforcing feedback loop, the same bubble may also *suppress* the spontaneous risk-averse tendencies of a scared investor. Thus, it is yet to be determined if fear is as likely to burst an asset-pricing bubble as excitement is to inflate a bubble.

II. Experimental Design

Participants were recruited from UC Berkeley's Xlab student subject pool. No

participant took part in more than one experiment session. Participants were paid a show-up fee of $5 and an additional performance based fee averaging $22.

Our experimental market is modeled on those of Smith, Suchanek, and Williams (1988) and Caginalp, Porter, and Smith (2001). A security with a finite life of 15 rounds is traded in a market where transactions are cleared under a continuous double auction (CDA) mechanism. After each round of trading the asset pays a random dividend drawn from a uniform distribution with four potential outcomes of 0, 8, 28, and 60 cents.[2] Thus the expected dividend in each period is 24 cents and the fundamental value of the asset—i.e., the expected value of remaining dividends--is $3.60 prior to the first round of trading and declines by 24 cents each period. At the end of 15 rounds of trading the asset expires worthless. Dividends payments are added to each participant's cash balance at the end of each round, and holdings of cash and shares carry over to the next round. The distribution of dividends is known to all participants and the current fundamental value of the asset is displayed on each participant's computer screen. Participants also see all currently posted offers to buy and to sell. Our initial endowments match those studied by Caginalp, Porter, and Smith (2001) in their Cash Rich (CR) treatment and found to induce large bubbles.

Nine participants trade in each market; no participant traded in more than one market. Three participants receive an initial endowment of $18.00 plus 1 share of the risky asset; three participants receive $14.40 plus 2 shares; three participants receive $10.80 plus 3 shares. After completing three practice rounds of trading, participants are asked to watch a video lasting approximately 5 minutes while the experimenter prepares for the actual experiment. Participants are told, "Because the waiting is a bit long, we will play a video clip. Since we intend to use video clips in another experiment, we've selected a few different video clips. After you've finished watching the clip, please answer a few questions about it. Note that the video is not related to your earnings today. So thank you in advance for helping out." After watching the video clip, participants

[2] To facilitate comparisons across experimental markets, one random dividend sequence (8, 60, 28, 8, 60, 8, 0, 28, 0, 60, 28, 60, 0, 8, 8) was drawn for the first market and then used for all subsequent markets.

answer two short questions about their emotional state and then begin the trading sessions.[3]

The Effect

To test whether excitement inflates bubbles, we ran series of 48 experimental markets (9 participants per market; n=432). In our first series of 16 experimental markets, participants in 8 markets watched an exciting and upbeat video clip involving a chase scene (excitement treatment), while participants in the other 8 markets watched a clip from a slow paced historical documentary (neutral treatment). In the second series of 16 markets, participants in 8 markets watched an exciting and upbeat video clip from a different movie also involving a chase scene (excitement treatment), while participants in the other 8 markets watched a frightening scene from a horror movie (fear treatment). In the third series of 16 markets, participants in 8 markets watched one of the two exciting video clips used in the first two series (excitement treatment), while participants in the other 8 markets watched one of two video clips of sad scenes from dramas (sad treatment).

After watching the video, participants completed a short questionnaire. For the exciting/neutral treatment the questionnaire asked participants to report their level of excitement. For the exciting/fear and exciting/sad treatments, the questionnaire asked about the emotion type (either positive or negative) and intensity of emotional arousal (See Appendix B).

The Mechanism

To test whether excited participants forecasted higher subsequent prices, we ran 6 additional markets with 18 participants per market. For one market, only 16 participants showed up at the lab. In the other markets a total of eight participants either misunderstood the forecasting instructions or had technical difficulties; they were excluded from the forecasting analyses. Thus we had a total of 98 participant level

[3] In a post-experiment survey, 11 of 432 participants correctly guessed the intended purpose of the experiment.

observations. Within each market participants were randomly assigned to watch the documentary (neutral treatment) or the upbeat chasing scene (excitement treatment). After the completion of the third round, participants were provided with a piece of paper and asked to estimate the asset prices at the end of the 4th and 5th rounds (See Appendix D). The simulation was then continued till its completion. Note that excited and non-excited participants were participating in the same markets and, thus, observing the same price sequences in each market. For these experiments, our analyses were conducted at the individual rather than market level. This procedure allowed us to assess whether those in the excitement versus neutral treatments were more likely to extrapolate the positive trends they observed in the first three rounds of the market.[4]

III. Results

The results sections go as follows: First, we present the manipulation checks on the incidental emotion induction. We then present the results on the main experiment where we assess whether (a) excitement impacts bubbles, (b) arousal is a sufficient condition, and (c) fear produces unique effects. Finally, we present the findings on the 6 additional markets where we test a mechanism through which excitement may inflate asset-pricing bubbles.

Emotion Manipulation

The emotion manipulation produced the expected results. In the first set of 16 experiments, after watching video participants were asked to indicate their level of excitement on a 9-point scale (1=very calm/relaxed; 9=very active/excited). As expected, they reported higher average excitement levels after watching the exciting video clip, 6.3, than after watching the neutral video, 3.5 ($p<0.0001$ rank sum test). In the second set of 16 experiments, since we also wanted to control for arousal levels, participants were asked (a) the emotional state that best represented what they were feeling and (b) to

[4] These 6 markets are in addition to the 48 markets discussed above. Because of the differences in procedures, the pricing results from these markets are not reported with those in the other 48 markets.

indicate the intensity of the experienced emotional state. As expected, after watching the exciting video 94% of participants report feeling Excitement/Pleasure/Enthusiasm and 6% report feeling Anxiety/Fear/Nervousness, while after watching the scary video 30% of participants report feeling Excitement/Pleasure/Enthusiasm and 70% report feeling Anxiety/Fear/Nervousness. The reported level of arousal remained the same across treatments. After watching the exciting (scary) video participants report average emotional intensity of 5.8 (5.4). We cannot reject the null hypothesis that the underlying distribution emotional intensity is the same in the two treatments. The same logic was used in the third set of 16 experiments and the results confirmed the expectations. After watching the exciting video 89% of participants report feeling Excitement/Pleasure/Enthusiasm and 11% report feeling Sadness/Distress/Unhappiness, whereas after watching the sad video only 19% of participants report feeling Excitement/Pleasure/Enthusiasm and 81% report feeling Sadness/Distress/Unhappiness. Again, arousal remained the same. After watching the exciting (sad) video participants report average emotional intensity of 5.7 (5.9). We cannot reject the null hypothesis that the underlying distribution emotional intensity is the same in the two treatments. If we compare the intensity reported by participants who watched the neutral videos—3.5, those who watched the scary videos—5.4, and those who watched the sad videos—5.9, we can reject the hypothesis that the intensity in the neutral treatments is the same as those in the fear and sadness treatments ($p<0.0001$ in both cases) but not the hypothesis that the intensity in the fear and sadness treatments are the same.

The Impact of Excitement on Bubbles

Figure 1 plots the average price in each round averaged over each of the four treatments: excitement, neutral, fear, and sadness. In all but the last round of trading, the cross-sectional average prices are higher for the excitement treatment.

We analyze two metrics of asset-pricing bubbles, magnitude and amplitude:

1. *Magnitude* measures the average difference in the price of the risky asset and its fundamental value across the fifteen rounds of trading. Magnitude is calculated as $Magnitude = \frac{1}{15}\sum_{r=1}^{15}\left(\bar{P}_r - f_r\right)$ where $\bar{P}_r$ is the average volume

weighted transaction price in trading round r and f_r is the fundamental value (i.e., the expected value of remaining dividends) in trading round r.[5]

2. *Amplitude* measures the maximum difference in the price of the risky asset and its fundamental value across the fifteen rounds of trading. Amplitude is calculated as $Amplitude = \max_{r\in(1,15)}\left(\overline{P}_r - f_r\right)$ where $\overline{P}_r$ is the average volume weighted transaction price in trading round r and f_r is the fundamental value (i.e., the expected value of remaining dividends) in trading round r.

Table I, Panel A reports the average magnitude of bubbles across markets for each treatment. First, we observe bubbles in the neutral treatment, which is consistent with Caginalp, Porter, and Smith (2001) results when they used the same endowments, dividend distribution policy, and order-book transparency that we use. In other words, the presence of a video clip prior to the experimental market is not per se producing any unexpected effect.

Excitement clearly inflates the bubble. The average magnitude of bubbles after participants watch the exciting videos (285), is much greater than the average magnitudes of bubbles following the neutral (166), fear (186), and sadness (198). We formally test for differences in magnitude and amplitude of bubbles under our treatments, with a two-sample t test with equal variances and with a two-sample Wilcoxon rank-sum (Mann-Whitney) test. For both tests, the magnitude of bubbles under the excitement treatment is great than that under the neutral, fear, and sadness treatments. We reject the null hypothesis magnitude(excitement) = magnitude(neutral) with $t = 3.70$, $p < 0.001$ (t test) and $z = 3.15$, $p < 0.002$ (rank sum test). We reject the null hypothesis magnitude(excitement) = magnitude(fear) with $t = 3.11$, $p < 0.01$ (t test) and $z = 2.87$, $p < 0.01$ (rank sum test). We reject the null hypothesis magnitude (excitement) = magnitude(sadness) with $t = 2.61$, $p < 0.01$ (t test) and $z = 2.50$, $p < 0.02$ (rank sum test).

Table I, Panel B reports the average amplitude of bubbles across markets for each treatment. The average amplitude of bubbles after participants watch the exciting videos (512) is much greater than the average amplitude of bubbles following the neutral (314), fear (382), and sadness (357). We formally test for differences in magnitude and

[5] Since the average fundamental value in each experiment is the same, regardless of treatment, our magnitude measure is equivalent to the Relative Deviation (RD) measure of bubbles in experimental markets proposed by Stöckl, Huber, and Kirchler (2010).

amplitude of bubbles under our treatments, with a two-sample t test with equal variances and with a two-sample Wilcoxon rank-sum (Mann-Whitney) test. For both tests, the amplitude of bubbles under the excitement treatment is greater than that under the neutral, fear, and sadness treatments. We reject the null hypothesis amplitude (excitement) = amplitude(neutral) with $t = 3.39$, $p < 0.01$(t test) and $z = 3.16$, $p < 0.01$(rank sum test). We reject the null hypothesis amplitude(excitement) = amplitude(fear) with $t = 2.34$, $p < 0.02$ (t test) and $z = 2.35$, $p < 0.02$ (rank sum test). We reject the null hypothesis amplitude(excitement) = amplitude(sadness) with $t = 2.76$, $p < 0.01$ (t test) and $z = 3.03$, $p < 0.01$ (rank sum test).

Finally, we calculate "duration", that is, the maximum number of consecutive periods in a market in which the spread of the average transaction price minus fundamental price ($\bar{P}_r - f_r$) increases over the previous period and we calculate the number of trades in each market. Mean duration is greater in the excitement treatments (9.7) than in the neutral treatments (6.7) ($p<0.02$, t-test and rank sum test); however, mean duration is not significantly different between the excitement treatment, the fear treatment (10.9), and the sadness treatment (8.0). There are no robust differences between treatments in the mean number of trades executed in each market.

Arousal and Fear

Arousal per se cannot account for the impact of excitement on asset-pricing markets. There are no statistically significant differences in mean magnitude and amplitude when the neutral treatment (low arousal) is compared to the fear and sadness treatments (both highly arousing).

Also, whereas excitement clearly inflates the bubble, fear is not able to repress it. There are two possibilities for this null finding, one methodological and one conceptual. As noted above, 30% of the participants who viewed video clips from horror movies reported that the emotional state they experienced was Excitement/Pleasure/Enthusiasm rather than the expected Anxiety/Fear/Nervousness. Although a minority, these 30% might have mitigated the impact of fear.

A conceptual account is also possible. As theoretically argued above, it is possible that excitement may exacerbate the feedback loop in asset bubbles by leading investors to rely more on the recency heuristic when forecasting future prices. By the same logic, if the experimental market setting fosters bubbles, a recency heuristic might cue to higher prices, counteracting any scared participants' tendency to be risk-averse. Indeed, a closer look at the graphs shows that fear was the only condition in which, on average, first round prices were below fundamental value.[6] Thus before the recency heuristic had an opportunity to play a role, fear may have produced risk-aversion. As the past became clearer and more salient (i.e., a bubbling asset-pricing market) mostly due to the properties of the experiment, the impact of fear may have been mitigated.

The Mechanism

We ran 6 additional markets with 18 participants per market to test whether excited participants were more prone to extrapolate past prices. Participants within the same market were randomly assigned to watch either the documentary (neutral condition) or the upbeat chasing scene (excitement condition) and after the completion of the third round, they were asked to estimate the asset prices at the end of the 4^{th} and 5^{th} rounds (See Appendix D). Note that excited and non-excited participants were participating in the same markets and, thus, observing the same price sequences in each market.

Figure 2 plots the average price observed by all participants till round 3 and their predicted prices for rounds 4 and 5. Two metrics were generated and used to compare across the neutral and excitement treatments: (a) the change from actual price in round 3 (AP3) to predicted price in round 4 (PP4); (b) the change from actual price in round 3 (AP3) to predicted price in round 5 (PP5).

Both metrics suggest that participants in the excitement treatment were more prone likely to extrapolate the previous positive market trends into their estimations of future asset prices. Participants in the excitement conditions predicted round 4 to have a much higher price than the actual round 3 price (PP4 - AP3 = 19.45) when compared to

[6] First round prices in the fear treatment were, on average, below fundamental value, but the difference is not statistically significant. However, the difference in average first round prices in the fear treatment versus the neutral and sad treatments is statistically significant ($p < 0.05$, 2 tailed t-test).

participants in the neutral treatment (PP4 – AP3 = -4.31), with $t(96) = 2.80$, $p < 0.01$ (independent samples t test with equal variance assumed) and $z = 2.06$, $p < 0.05$ (rank sum test). Participants in the excitement conditions also predicted round 5 to have a much higher price than round 3 (PP5 – AP3 = 37.3) when compared to participants in the neutral treatment (PP5 – AP3 = 1.25), with $t(96) = 2.88$, $p < .01$ (independent samples t test with equal variance assumed) and $z = 2.29$, $p < 0.05$ (rank sum test).

IV. Discussion

An advantage of the Smith, Suchanek, and Williams (1988) experimental setting is that it has been well studied. It is well known, for example, that bubbles are more likely when participants are endowed with more cash relative to risky assets and when dividends are paid after each round of trading rather than at the end of trading, when the order book is transparent, and when participants can buy on margin (Caginalp, Porter, and Smith, 2001). While we do not permit buying on margin, our allocations are cash rich—matching the cash rich (CR) endowments employed by Caginalp, Porter, and Smith (2001), dividends are paid after every round, and the order book is viewed by all participants; this is likely why we get bubbles in most experiments regardless of treatment.

As noted above, several features of the Smith, Suchanek, and Williams (1988) experimental setting have been criticized. In our experiments, criticized features of the experimental setting such as declining fundamental value, short sale constraints, and inexperienced participants, are held constant across treatments. Thus, while these features may, in part, explain why bubbles arise in this setting, they do not explain our main finding that bubbles are significantly larger when participants are excited as the trading begins.

Although not the primary interest of our research, it is worth assessing the relationship between emotional intensity and performance by regressing each participant's earnings on his or her emotional intensity rating. We do this separately for the 24 experiments with exciting videos and for the 24 experiments with neutral, scary, or sad videos. For experiments with exciting videos, the coefficient on intensity is negative

and significant ($t = -2.3$, $p < 0.021$). Thus, greater reported emotional intensity is associated with lower earnings. For experiments with neutral, scary, or sad videos, the coefficient on intensity is marginally negative and statistically insignificant ($t=-0.05$, $p < 0.958$) thus greater reported emotional intensity is not associated with higher or lower earnings.

Conclusion

Historical accounts suggest that rapid, unexpected increased in wealth during the appreciation phase of asset-pricing bubbles can lead investors to experience intense, positive emotions. We document, in an experimental setting, that magnitude and amplitude of bubbles are greater when, prior to trading, participants experience high intensity, positive emotions than when they experience low intensity, neutral emotions, or high intensity, negative emotions. Thus, in real world markets, rapidly rising prices may trigger investor excitement leading to larger asset-pricing bubbles.

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Table I: Magnitude and Amplitude of Bubbles

Panel A reports the average magnitude of bubbles across market experiments by treatment. Magnitude is calculated as $Magnitude = \frac{1}{15}\sum_{r=1}^{15}\left(\bar{P}_r - f_r\right)$, where $\bar{P}_r$ is the average transaction price in trading round r and f_r is the fundamental value (i.e., the expected value of remaining dividends) in trading round r. Panel B reports the average amplitude of bubbles across market experiments by treatment. Amplitude is calculated as $Amplitude = \max_{r\in(1,15)}\left(\bar{P}_r - f_r\right)$.

Panel A: Average Magnitude across Markets

Treatment	N	Mean	Standard Error
Excitement	24	285.4	17.3
Neutral	8	166.1	19.9
Fear	8	186.0	18.0
Sadness	8	197.8	26.0

Panel B: Average Amplitude across Markets

Treatment	N	Mean	Standard Error
Excitement	24	512.3	30.2
Neutral	8	314.7	43.9
Fear	8	382.0	30.1
Sadness	8	357.1	34.5

Figure 1: **Average Prices by Round for Each Treatment**

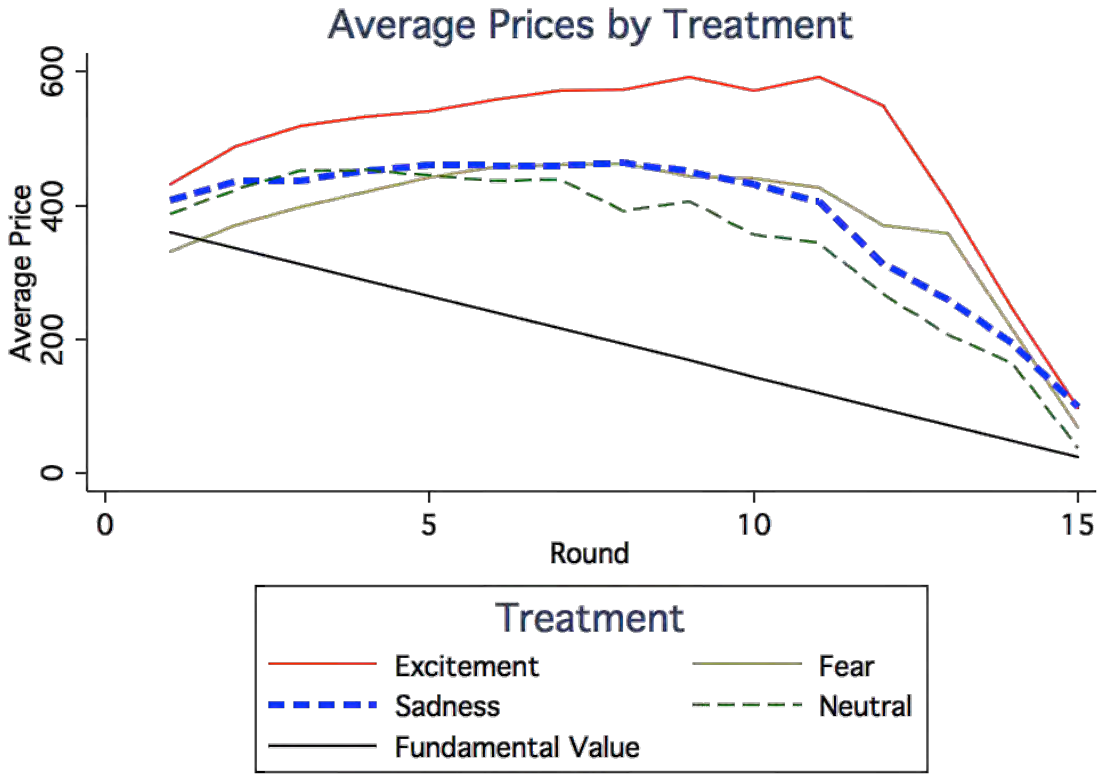
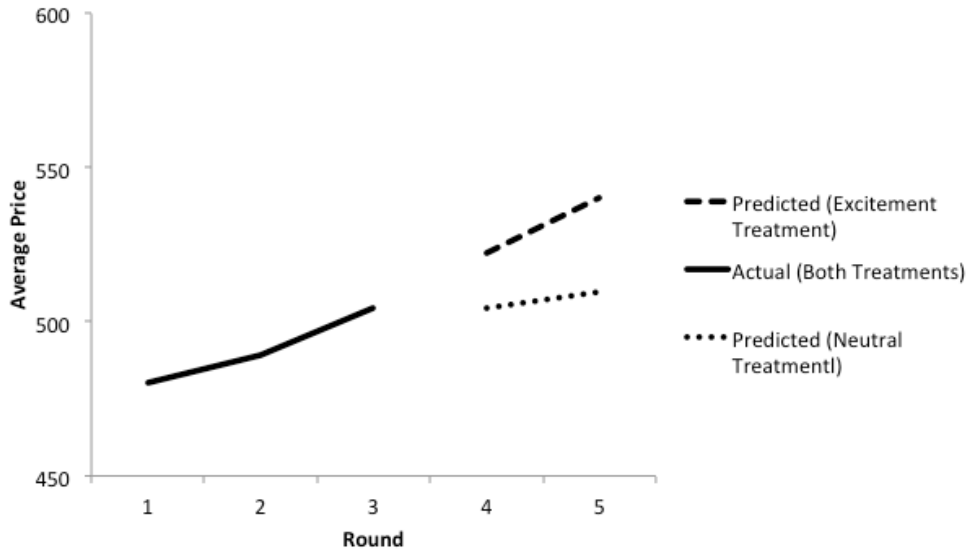


Figure 2: **Average Predicted Prices by Round for Each Treatment Compared to Actual Previous Prices**



Appendix

A. Instructions

This is an experiment in market decision making. You will be paid in checks for your participation at the end of the experiment. Different participants may earn different amounts. What you earn depends on your decisions and the decisions of others.

The experiment will take place through computer terminals at which you are seated. If you have any questions during experiment, raise your hand and a monitor will come by to answer your question.

I. The Situation

In this experiment, each participant will be given some **Cash** and **Shares** at the beginning.

When the experiment starts, you will participate in a market where **Shares** can be bought and sold between participants. You pay out of your Cash when you buy a share, and you get Cash when you sell a share.

The experiment is divided into **15** consecutive trading **Rounds**. Within each round, the market is open for trading Shares.

Shares will earn the owners a cash income called **Dividend**. At the end of EACH round, EACH share will pay the owner a dividend. The dividend per round can be **0, 8, 28 or 60 cents**, with equal chances. The dividends will be added to your cash amount immediately.

At the end of **15**th round, a final dividend will be paid to the owner. Once that dividend is paid, the shares will be worth nothing. Your earnings will be based on the amount of cash that you accumulate. You can accumulate cash by buying and selling shares, and/or by holdings shares and collecting dividends.

Since (0 + 8 + 28 + 60) ÷ 4 = 24, the average dividend per round per share is 24 cents. That is, over many rounds, the average dividend per round tends to be 24 cents per share.

If you hold a share from round 1 to round 15, the share will pay you 15 dividends. The total dividend value you receive can be as low as 0 cents (15 × 0 = 0). This would be the result if all 15 of the dividends are 0. The total can be as high as 900 cents (15 × 60 = 900), if all 15 of the dividends are 60. Given that each possible dividend has an equal chance of occurring each round, the average total dividend value tends to be 360 cents (15 × 24 = 360).

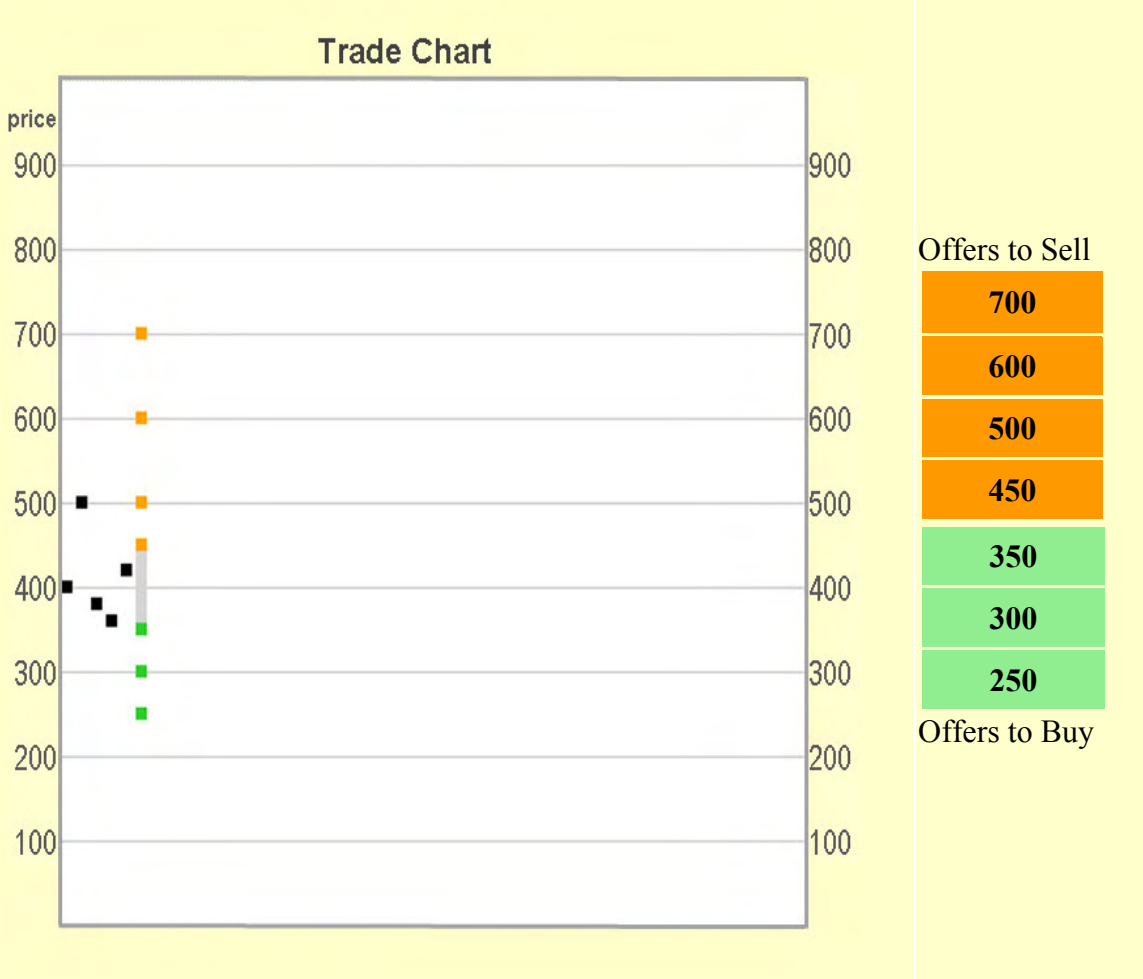
If you purchase a share in the 2nd round and hold it until the end of the 15th round, the average total dividend value will be 336 cents (14 × 24 = 336), and the total dividend could be as low as 0 cents (14 × 0) and as high as 840 cents (14 × 60).

Similarly, if you hold a share for any number of rounds, ***n***, the share may return a dividend of as little as 0 cents or as much as ***n*** × 60 cents. The average dividend total tends to be ***n***× 24 cents.

When a round is over, your Cash and Shares will carry over to the next round.

II. How to Trade Shares?

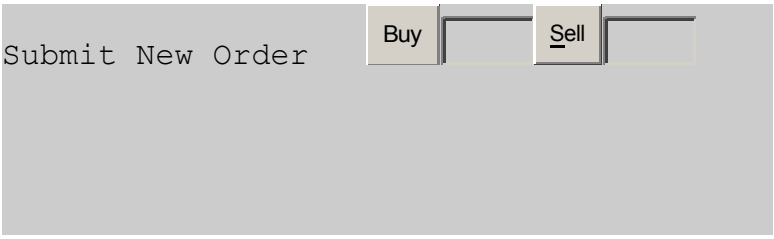
Within each round, participants can buy or sell shares from one another by making offers to buy or to sell. First, let's see how offers are shown in the market.



Every time someone makes an offer to buy a share at a certain price, a **GREEN** dot will appear on the Trade Chart. Every time someone makes an offer to sell at a certain price, an **ORANGE** dot will appear on the Trade Chart. Once a trade is actually made, the trade will be shown as a **BLACK** dot on the Trade Chart. For example, right now shown on the Trade Chart, five trades that have taken place are: 400, 500, 380, 360 and 420.

Next to the Trade Chart, the **Offers to Buy** will be listed in increasing order, while the **Offers to Sell** will be listed in decreasing order. For example, the Offers to Sell are now 700, 600, 500 and 450; and the Offers to Buy are now 350, 300 and 250.

Orders



Offers are made through "**Orders**" Section. To enter a new offer to buy, type your buying price next to "**Buy**" button on the "Submit New Order" row, and click "**Buy**" button to submit your offer.

To enter a new offer to sell, type your selling price next to "**Sell**" button on the "Submit New Order" row, and click "**Sell**" button to submit your offer.

Orders

In the "**Orders**" section, the second row is "**Immediate Order**", where you can accept existing offers in the market.

The "Buy" box shows you the lowest offer you can buy from at the point of time. For example, the price showing right now is 450. This indicates the best selling offer in the market is now 450. If you click on the "Buy" button next to it, you will immediately buy a share at the price of 450.

The "Sell" box shows you the highest offer you can sell to at the point of time. For example, the price showing right now is 350. This indicates the best buying offer in the market is now 350. If you click on the "Sell" button next to it, you will immediately sell a share at the price of 350.

Cancel Orders

Click on an order to Cancel it

Whenever you enter new offers to buy, or sell, you will have those offers appear as buttons under "**Cancel Orders**" section. By clicking on these buttons, you can take them out of the market. For example, it is showing right now that you have an offer at 500. If you click on the button, you withdraw your offer at the price.

III. Examples

Let's see an example of a trade below. Note that the prices here are arbitrarily chosen and are irrelevant to the actual prices that will happen in the experiment.

Suppose you have 3 shares and 1050 in Cash at the start of a round, and you make one transaction purchasing a share for 420 cents within the round. If the dividend for the round is 60 cents, then:

Your share holdings will increase from 3 to 4 units.

You will pay 420 out of your Cash holdings, and for the round you will receive a total dividend of (60 × 4 shares)=240. Thus your cash will decrease by (420-240)=180 cents. Your new cash holding will be (1050 - 180) = 870 cents.

Another example:

Following the previous example, you now have 870 cash and 4 shares. Suppose in the next round you make two transactions. You sell one share for 300 and another share for 350. If the dividend for the round is 8, then:

Your share holdings will, decrease from 4 to 2 units.

You get (300+350) = 650 from your sales of 2 shares, and you will receive a total dividend of (2 shares × 8)=16. Your Cash holdings will increase by (650+16) = 666 cents. Your new cash holding will thus be (870 + 666) = 1536 cents.

IV. Practice Session

This experiment will last for **15 round**s. Each round will last for 3 and half minutes.

Before the actual 15 rounds start, we will give you a **Practice Session**, during which you can practice making offers and making transactions.

When the Practice Session is over, it will take some time to re-initialize and configure the trading program. The preparation could take around 5 to 8 minutes.

[Below, we introduce why we would play video.]

[Same Video within treatment – Experiment Set 1 and Set 2]

Because the waiting is a bit long, we will play a **video** clip. We intend to use the video in another experiment and want to get some feedback from you. After you've finished watching the clip, please answer a few questions about it. Note that the video is not related to your earnings today. So thank you in advance for helping out.

[Two Videos within treatment – Experiment Set 3]

Because the waiting is a bit long, we will play some **video** clips. Since we intend to use the videos in another experiment, we've selected a few **different** video clips. You will be randomly assigned to **one** of them. After you've finished watching the clip, please answer a few questions about it. Note that the video is not related to your earnings today. So thank you in advance for helping out.

V. Summary

1. You will be given an initial amount of Cash and Shares at the very beginning.

2. Each share pays the owner a dividend of either 0, 8, 28 or 60 cents at the end of EACH of the 15 trading rounds. The dividend amounts have the same chance of being drawn at the end of a round. Thus, the average dividend per round per share is 24 cents. Between rounds, you will be given some short time to review your holdings.

3. You can submit offers to BUY shares and offers to SELL shares.

4. You can make immediate trades by buying at the current lowest offer to sell or selling at the current highest offer to buy.

5. The market lasts for 15 rounds. At the end of round 15, there will be one last dividend payment. After that the share expires and is worth nothing to you.

6. We will give you a Practice Session whereby you become familiar with the trading program. After that we will re-initialize the program and get ready for the actual session.

The instructions are over. If you have any question, raise your hand and consult the monitor. Otherwise, click "Start", login with the "Account Name" on the note on your desk, and wait for the Practice Round.

Start

B. Video Survey Questions

The experiments were run in three sets. Each set consisted of 16 experiments. No participants took part in more than one experiment. In the first set, participants watched exciting positive valence, high intensity videos prior to the market in 8 experiments and neutral valence, low videos prior to 8 experiments. Exciting and neutral experiments were run in pairs on the same days. In the second set, participants watched exciting positive valence, high intensity videos prior to the market in 8 experiments and fear inducing negative valence, high intensity videos prior to 8 experiments. Exciting and fear inducing experiments were run in pairs on the same days. In the third set, participants watched exciting positive valence, high intensity videos prior to the market in 8 experiments and sad negative valence, high intensity videos prior to 8 experiments. Exciting and sad experiments were run in pairs on the same days.

After watching the videos, participants answered the following questions.

Experiment Set 1 (Neutral; Excitement)

1. How did this movie clip make you feel (from 1=very calm/relaxed to 9=very active/excited)

2. Do you think this clip is a nice filler task to be used in future experiments?

_No _Yes

Experiment Set 2 (Fear; Exciting)

1. Please indicate (a) the emotional state that BEST describes what you've experienced while watching the video clip--only one option allowed. Then, indicate the intensity of the selected emotional experience.

__Anxiety/Fear/Nervousness ___ (1=very little;9=very much)

__Excitement/Pleasure/Enthusiasm ___ (1=very little;9=very much)

2. Do you think this clip is a nice filler task to be used in future experiments?

_No _Yes

Experiment Set 3 (Sad Mixed; Exciting Mixed)

1. Please indicate the emotional state that BEST describes what you've experienced while watching the video clip--only one option allowed. Then, indicate the intensity of the selected emotional experience.

__Sadness/Distress/Unhappiness ___ (1=very little; 9=very much)

__Excitement/Pleasure/Enthusiasm ___ (1=very little; 9=very much)

2. Do you think this clip is a nice filler task to be used in future experiments?

_No _Yes

C. Post-Experiment Survey

Feedback
(Please provide us some feedback on today's experiment. Thank you in advance!)

Q1: What is the purpose of the study?

Q2: What was your strategy in the experiment?

Q3: Did you ever buy shares at prices above the remaining average dividend value? If so, what is your reason?

Q4: Did you encounter any difficulty in the experiment?

D. Instructions for Prediction Experiment

MAKE A PREDICTION

Before we start the next round, we would like you to make a prediction about the market. Precisely, what we would like you to do is look at the Trade Chart and indicate on the sheet of paper next to you how much you think the Share Price will be at the end of round 4 and at the end of round 5. That is, what do you think the last traded prices will be at the end of rounds 4 and 5? (Note that the last traded price each round is indicated by the last black dot on the chart for that round).

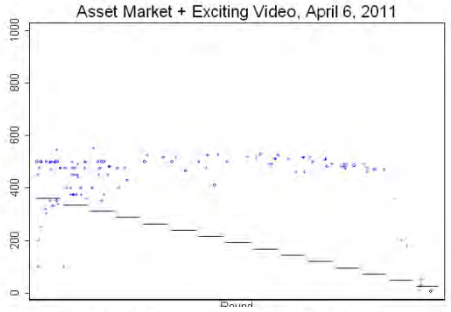
At the end of round 4, the Share Price will be _____

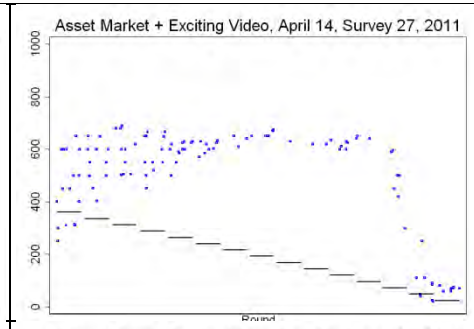
At the end of round 5, the Share Price will be _____

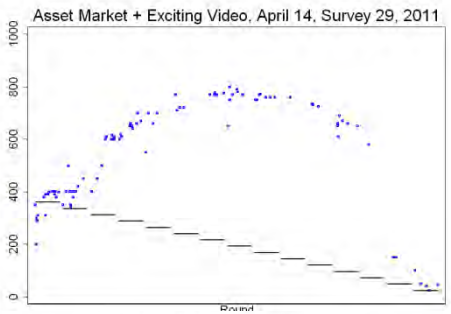
Also, please indicate:

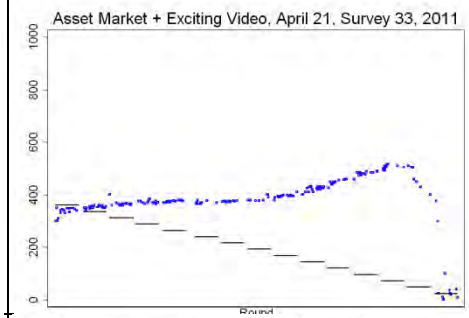
Gender___M __F
Age___
Major_____ (open ended)

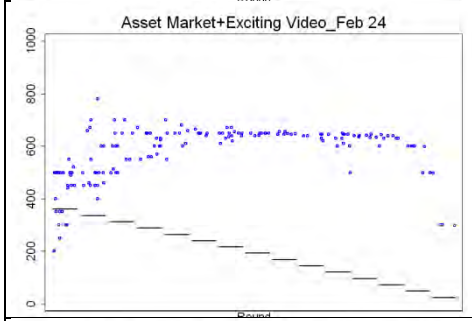
Exciting Video

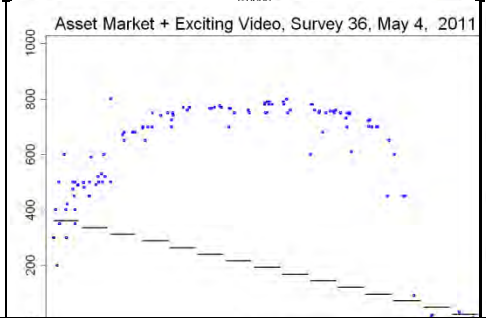


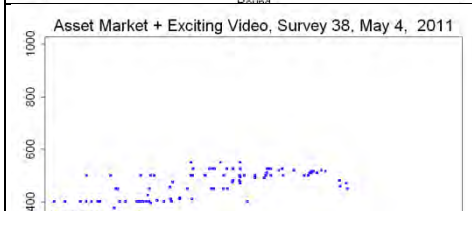


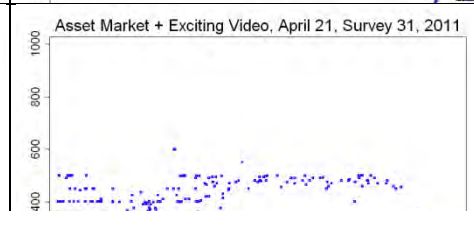




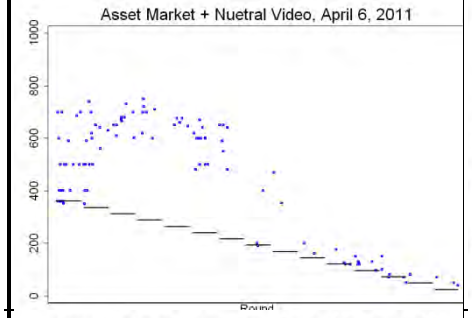


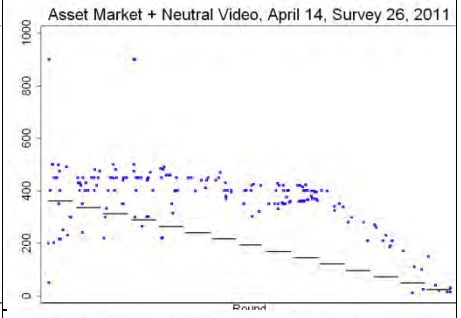


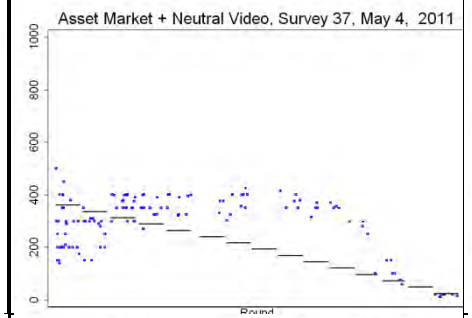


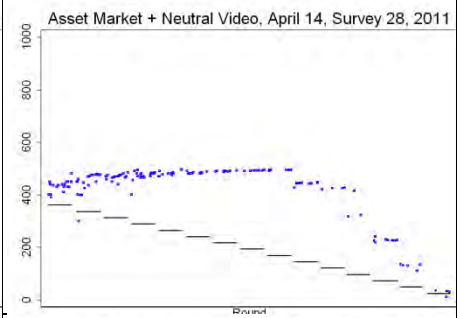


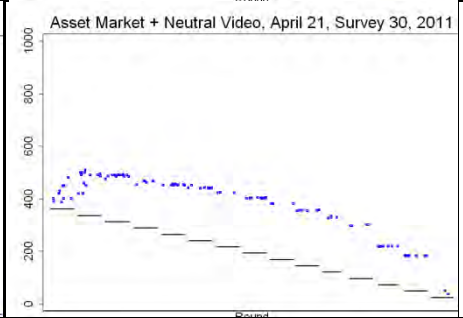
Neutral Video

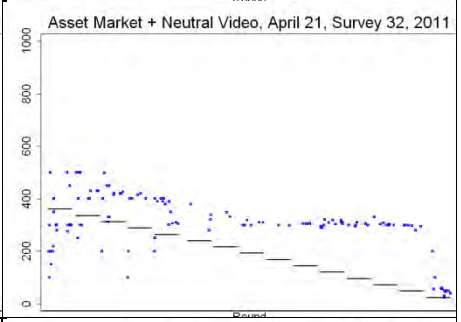


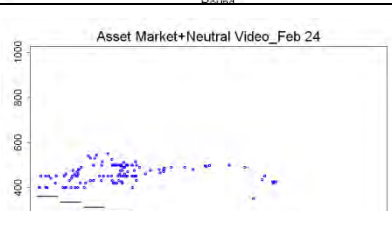


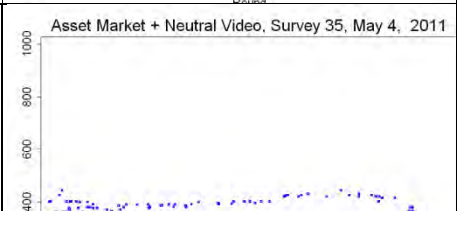






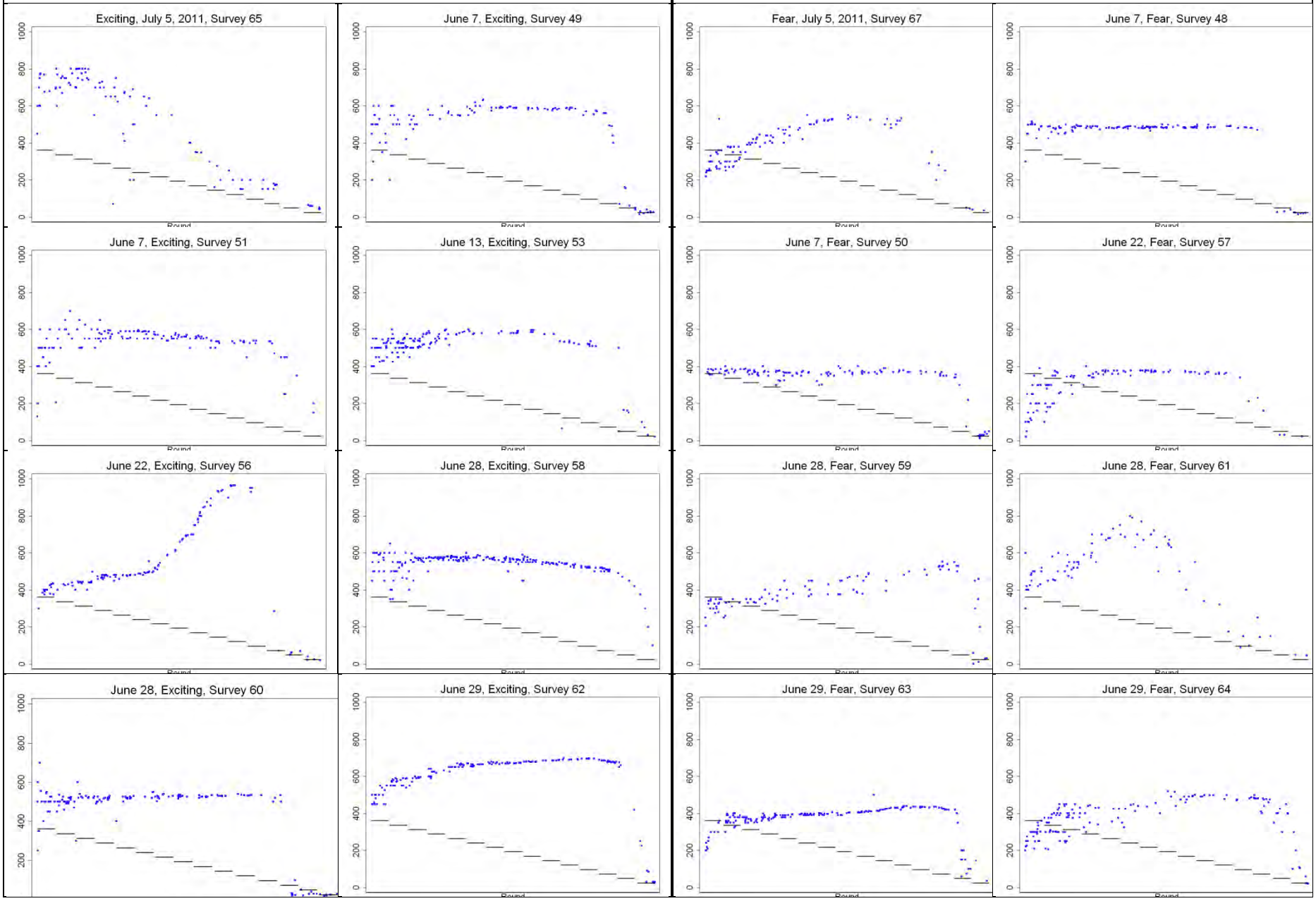




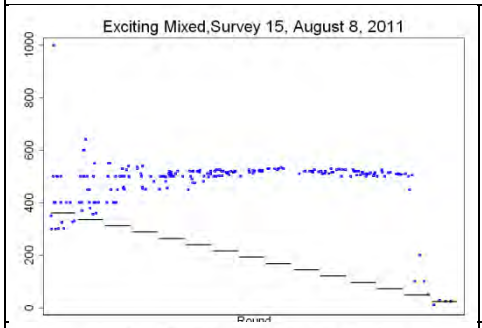


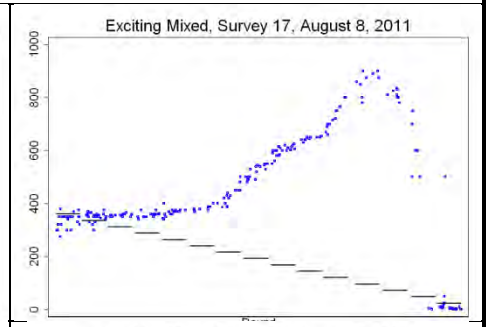
Exciting Video

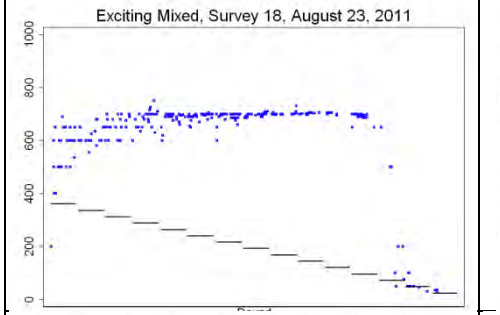
Fear Video

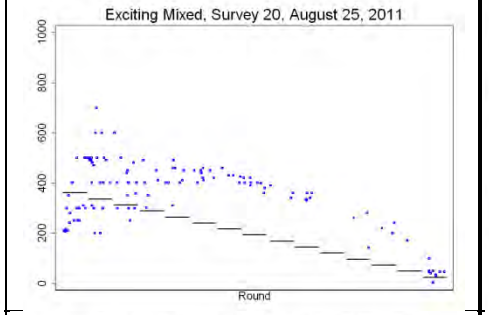


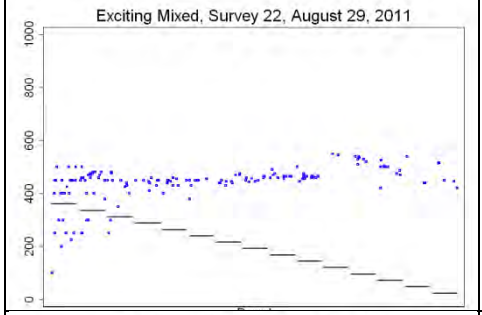
Exciting Video

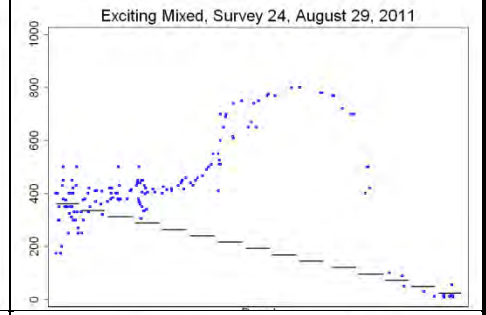


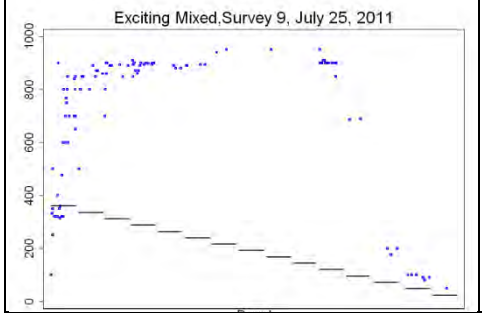


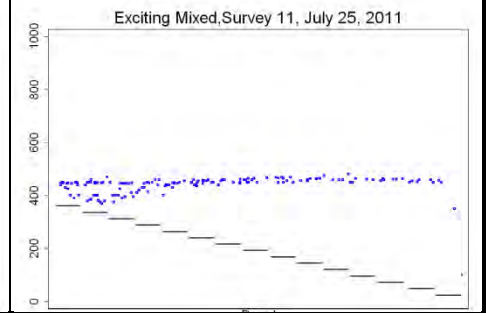












Sad Video