Emotions and market activity: Cause or consequence?

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Abstract

Many observers have asserted that there is a correlation between traders' moods and asset market behavior, with Joviality associated with high prices and Fear with low prices. In this paper, we conduct a laboratory experiment to examine the direction of causality in this relationship. The results show that moods, induced by videos, shown in virtual reality, do not influence market prices. However, there is a strong relationship between market activity and subsequent emotional states, suggesting that the correlation between emotional states and market activity is driven by the influence of market activity on emotional states, not the other way around.

1 Introduction

The connection between asset market behavior and emotional states is intuitive to many observers. Market commentators frequently make this link, associating excitement or exuberance with high prices and fear with low prices. Following the 1929 stock market crash, Irving Fisher (1930) attributed the crash to an unjustified *panic* on the part of investors. In 1996, the Chairman of the Federal Reserve Bank, Alan Greenspan, after a strong market runup that year, remarked "But how do we know when *irrational exuberance* has unduly escalated asset values, which then become subject to unexpected and prolonged contractions…" (Greenspan, 1996). Warren Buffett, one of the world's most prominent investors, in a

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widely read New York Times editorial, stated that his motto is "be greedy when others are *fearful* and fearful when others are greedy" (Buffett, 2008), apparently associating fear in the market with the opportunity to buy at low prices. On January 22, 2024, the New York Post asserted "Steel yourself — the stock market is *irrationally exuberant* again" (Lachman, 2024) during a bull market. There are several "*Fear* Indices", published regularly, which are taken as measures of downside risk in the stock market. In all these cases, positive emotions are associated with higher prices and the negative emotion of fear with low prices.

Such statements are not confined to journalists, investors, and policymakers. Distinguished academic observers have made remarks along the same lines. For example, Galbraith (1984) describes stock market price bubbles as "speculative *euphoria*". Shiller (2000), when describing the phenomenon of asset price bubbles, writes "... I define a speculative bubble as a situation in which news of price increases spurs investor *enthusiasm*... bringing in a larger and larger class of investors who, despite doubts about the real value of an investment, are drawn to it partly by *envy* of others' successes and partly through a gamblers' *excitement*". During an appearance on CNBC, Krugman (2020) commented "When you look at the way that people have piled into the stocks of bankrupt companies like Hertz, there's clearly something, a bit of *mania* going on. It's very hard to escape the sense that there's mania now..."

These observers are not precise on whether they believe that the relationship between emotional states and market behavior is correlational or causal, though most seem to suggest that the causality runs from emotions to market behavior. There does seem to exist a sound intuition for why higher market prices would lead to more positive emotions, since the average paper wealth of investors typically increases when prices increase. Lower prices would presumably lead to negative emotional states as investors incur losses in paper wealth. One of these emotional states might be fear, as individuals may worry that the decrease in wealth might affect their future consumption. However, the underlying mechanism for the reverse causal relationship, whereby emotional state would cause asset price movements, as the commentators seem to suggest, is not obvious to us.

In our view, determining the direction of the relationship between emotional state and asset prices is important for policymakers, firms and traders. If emotional states affect financial markets, government policy must take into account the effects of aggregate mood on the market even when it does not originate from market activity. The fallout from tragic events or the outcomes of national

competitions could affect asset prices, or economic news might impact the market beyond its real effect on the economy. Similarly, firms would have to consider when emotionally charged events that are unrelated to their businesses affect their share prices. On the other hand, if the causality goes from market behavior to emotional states, government policymakers and corporate decision makers would not have to account for emotionally charged announcements or events having knock-on effects on financial markets. Trading strategies would also be informed with a better understanding of how emotional states and markets are related.

In this paper, we investigate the direction of the causality between emotional states[1] and market activity using a laboratory experiment. We conduct a new direct test of whether a positive emotional state on the part of traders increases asset prices and whether fear lowers them. We also analyze the change in traders' emotional states in response to the activity they experience. There are three treatments in our experiment: Happy, Fearful, and Neutral, corresponding to the incidental mood that is induced at the outset of the sessions. Moods are induced with 360-degree videos shown in virtual reality using wireless headsets. The effectiveness of the particular videos we use in inducing the desired emotions has been established in prior studies (Kugler et al., 2020; Medai and Noussair, 2021; Nguyen and Noussair, 2022) and is revalidated with a manipulation check with our participants. The methodology of virtual reality, with its immersive experience, provides a more intense mood induction than traditional methods (Markowitz and Bailenson, 2023; Chirico et al., 2018; Liao et al., 2024; Ding et al., 2018).

After the mood induction, participants trade in a continuous double-auction market, where they exchange shares of an asset that pays a stochastic dividend. In some sessions there is only one market, and in other sessions there are two consecutive markets. We compare the price and trading volume of the shares across treatments. We hypothesize that the Happy treatment would lead to higher prices and that the Fearful condition would generate lower prices than the Neutral condition.

[1] The terms "emotion" and "mood" are sometimes used interchangeably, presumably because they share similar physiological manifestations and subjective experience. However, as Scherer (2000) and Capra (2004) emphasize, emotions are short-lived, relatively intense, and have a proximate cause. Moods do not have these three features. As we describe later, our treatments induce moods. In this paper we use the term "emotional state" as a collective term to describe the overall effect of any mood and emotions currently affecting our participants. Thus, while our experimental treatments induce moods, at any given time a trader's emotional state is the result of both current mood and any emotions currently being experienced.

We then consider the reverse directional relationship, the effect of market activity on emotional state. These emotional states are integral in nature and are a consequence of activity in the market.[2] We include surveys at the beginning and at the end of the first market to measure the change in the self-reported emotional state of traders due to market activity. We hypothesize that those who earn more in the market experience an increase in Joviality and a decrease in Fear relative to those who earn less.[3]

We find that inducing moods does not affect asset prices or quantities traded in the market. The amount of trade and volatility is unrelated to mood. However, there is a strong relationship between market activity and *subsequent* emotional state, suggesting that this directional relationship is the main factor creating the correlation between emotional states and market prices. The findings lead us to the conjecture that higher market prices in the field, because they typically indicate greater investor earnings, lead to positive emotional states, rather than the other way around. Similarly, lower prices cause fear on the part of traders, rather than vice versa.

2 Related literature

The correlation between aggregate societal measures of mood and asset price movements is well-established in empirical work. Bollen et al. (2011) find that Twitter mood predicts subsequent stock market movements. Gilbert and Karahalios (2010) report that the level of anxiety of posts on the blog site *Live Journal* predicts price declines. Griffith et al (2020), studying a 24-hour rolling average score of references in the news and social media, find that fear, gloom and stress predict negative market returns and joy predict positive returns. Subramaniam and Chakraborty (2021) observe that values of a COVID-19 fear index constructed from Google trends correlate negatively with stock returns. Edmans et al. (2022) report that when more happy songs are listened to on Spotify, the stock market performs better.

There are some research studies that report causal relationships, where an exogenous event that affects stock prices is presumed, though not shown, to affect the emotional state of traders. Hirshleifer and

[2] Emotions can be categorized into (1) integral emotions, which result from the task at hand, and (2) incidental emotions, which originate from another source. See Rick and Loewenstein (2008) for a discussion. The distinction is important when considering the effect of emotions on behavior. For example, Ferrer and Ellis (2021) find that incidental anger increases risk perception, while integral anger has the opposite effect. In our study, our treatments induce incidental moods, but the emotional state of a trader at any time reflects both incidental mood and integral emotions.

[3] The term *Joviality* in this paper is (following Watson et al., 1988) an index composed of average responses to how Cheerful, Joyful, Happy, Excited, Enthusiastic, and Energetic one reports feeling on a scale of 1 - 5. The components of the index of *Fear* are how Afraid, Frightful, Shaky, Nervous, and Scared one reports feeling.

Shumway (2003) find that stock returns are higher on sunny days. Kamstra et al. (2003) find that returns are higher in seasons with more daylight. Shafi and Mohammadi (2020) observe that investors contribute less crowdfunding on cloudy days. Edmans et al. (2007) find that losses of a national team in important international soccer matches lower stock returns. Curatola et al. (2016) replicate the effect with World Cup matches specifically. All five studies interpret their results as showing that emotions affect prices but provide no direct independent evidence for this channel. That is, emotions are not measured but rather only conjectured to be the channel whereby the various events affect asset prices. In our view, the price effects observed in these studies could reflect a change in market value without the emotions or moods of market participants being involved at all. Good weather or a sport victory presumably causes a positive mood on the part of investors, but they can also affect the profitability of businesses as people may go out and spend more when the weather is good than when it rains or to celebrate a home team victory. Asset prices might increase in response to this real activity, rather than from the emotional states themselves.

A number of prior laboratory experimental studies have investigated related issues. Lahav and Meer (2012) conduct the first experiment, to our knowledge, to study the connection between emotions and markets. Their experimental design consists of two treatments, Positive and Neutral. In the Positive treatment, participants view a 5-minute comedy video, while in the Neutral treatment, there is no video. They then trade in an asset market of the type introduced by Smith et al. (1988), which is known to produce price bubbles. They observe higher prices in the Positive than in the Neutral condition. In a follow-up paper, Lahav and Meer (2022) report that both positive and negative affect increase prices. However, in both the 2012 and 2022 studies, their results are based on two total sessions per treatment, so we view their findings as preliminary rather than conclusive. Andrade et al (2016) conduct a similar experiment, and use videos designed to induce different emotions. They study the effect of excitement and calm relative to a control condition with a neutral video. They observe higher prices in their Excitement condition than in the other two treatments. However, Huber et al. (2024) are unable to replicate this finding with a larger sample and instead find no effect of excitement on price levels. In our view, because of these disparate results in this literature, the question of whether emotional state causally affects market outcomes remains open. The second question we consider concerns the reverse relationship, whether market activity affects emotional state. This relationship is not considered by either Lahav and Meer nor by Andrade et al., and to our knowledge we are presenting the first experimental evidence on this question.

There is also some prior experimental work correlating emotional state and market outcomes. Breaban and Noussair (2018) use FaceReader technology to track emotional states as manifested in facial expressions, under the experimental paradigm of Smith et al. (1988). Breaban and Noussair find that a more positive overall valence of the emotional state of the participants before the market opens predicts higher prices, while fear predicts lower prices. An increase of fear in the facial expression of a trader predicts that the trader will make a sale in the next 5 seconds. Summers and Duxbury (2012) consider the emotional states that accompany the disposition effect, the tendency to sell assets that have increased in price more readily than those that have decreased. Summers and Duxbury find that sales of winners are accompanied by elation while the retention of losing shares correlates with regret, an emotion emerging from a feeling of responsibility. Bossaerts et al. (2024) investigate the role of heart rate variability in trader performance. Earnings are higher for participants whose changes in heart rate anticipate their order submissions, and lower for those whose heart rate responds to their trades. For a more comprehensive survey of the literature on the connection between emotions and asset market behavior see Duxbury et al. (2020). In the same paper, they also report an experiment in which they observe that fear is associated with both price increases and decreases.[4]

An asset is in essence a risky lottery since its future value is uncertain. The experimental results regarding how emotional state affects the willingness to take financial risks are mixed and have led to competing theories. One view is that a positive emotional state causes a greater appetite for risk, and a negative state increases risk aversion. Johnson and Tversky (1983) propose the Affective Generalization Hypothesis, which asserts that a positive emotional state leads to more optimistic beliefs about the outcomes of random events and thus increases observed risk taking. On the other hand, the Mood Maintenance Hypothesis (Isen, 1987) claims that a positive emotional state leads an individual to attempt to preserve their current situation, and thus to avoid risk taking. Empirical studies have supported both models and there is no consensus on the relationship between the valence of an individual's emotional state and her propensity to take risks.

In finance, many interesting studies consider an association between market *sentiment* and asset prices. For example, Da et al. (2015) study Internet search data from the US and find that mentions of

[4] This paper draws a distinction between anticipatory and anticipated emotions, within the integral category. Anticipatory emotions precede decisions to buy and sell while anticipated emotions follow the purchase or sale decision. In Duxbury et al (2020)'s framework, fear is typically an anticipatory emotion.

negative economic terms, such as “recession”, “unemployment”, and “bankruptcy” predict decreases in returns. Jacoby et al. (2024) document a similar relationship for more recent data from China. Huang et al. (2015) propose an index of investor sentiment that predicts cross-sectional stock returns. However, in this literature, sentiment refers to beliefs about the future performance of an asset or the broader economy rather than an emotional state on the part of traders. In our work, we are interested in the impact of the emotional state of traders as distinct from their beliefs about the future prospects of the asset.

While this is the first study to use virtual reality (VR) in conjunction with experimental asset markets, it has been used for emotion induction in other research applications. Markowitz and Bailenson (2023) review studies that have used virtual reality during the period between 2015 and 2020 in psychology and computer science to study the effect of emotions. They conclude that videos shown in virtual reality provide stronger emotion induction than those shown in the conventional two-dimensional format. Chirico et al. (2018) report that VR videos are more effective in creating awe than conventional 2D videos in a direct comparison. Liao et al. (2024) find that VR videos are more effective than 2D videos in inducing fear. Ding et al. (2018) report that VR videos are more effective than 2D videos in creating excitement, nervousness, hostility, and jitteriness.

3 Experimental design

3.1 Procedures

We conducted 42 sessions at the Economic Science Laboratory at the University of Arizona. All 309 participants were undergraduate students at the university. Males constituted 51.58% of subjects. Participants were recruited via an online system. All students enrolled in the online database were eligible to sign up for the experiment, and spots were allocated on a first-come first-served basis. Each individual was only allowed to participate in one session. Between 5 and 8 participants took part in each session (see Table 1 for more details). Series 1 consisted of 18 sessions, 6 sessions under each treatment, and each session lasted on average 40 minutes. Participants earned an average of 18.6 dollars, including a 10-dollar show-up fee. Series 2 consisted of a total of 24 sessions, 8 under each treatment. On average, each session lasted 65 minutes. Participants earned 21.9 dollars on average, including a 5-dollar show-up fee.[5] All

[5] We targeted an hourly payment of at least $20. With initial endowments of 3 shares and an expected dividend of 92 francs/share, plus 2250 in cash, average earnings are 2526 ECU in Series 1. Based on the conversion rate of 300 francs to 1

procedures were approved by the Institutional Review Board of the University of Arizona (protocol number: 21-07-ECON, approved 9/4/2021).[6]

The sequence of events in a session is illustrated in Figure 1. Each session began with a 10-minute practice period during which subjects learned to trade in a computerized double auction market (Smith, 1962) using the z-Tree platform (Fischbacher, 2007). In this practice period, there were no incentives and the outcomes did not count for payment. After this practice period, they completed an abbreviated PANAS-X survey (Watson and Clark, 1994) in which they indicated how strongly they currently felt various emotions on a scale of 1 (not at all) to 5 (extremely strongly). The survey allows several emotional indices, including those for Joviality, Fear, Hostility, and Sadness, to be constructed (see Appendix B.2).

Subjects were then shown a video, which differed by treatment. All participants in a given session viewed the same video. To view their video, subjects put on Oculus Quest™ virtual reality headsets. The videos are fully immersive and shown in 360 degrees from the point of view of the subject. In the Neutral treatment, all subjects viewed a field of flowers from the perspective of an observer seated in the middle of the field. In the Happy treatment, the individual was surfing in the South Pacific among large waves with tropical islands in the background. The Fearful treatment placed individuals on a tightrope walking across a deep canyon. The same videos have been successfully employed to induce the same targeted moods in a number of other studies (Kugler et al, 2020; Noussair and Seaback, 2023).[7] After the video, subjects completed the PANAS-X survey again, with the questions randomly reordered. Comparison of the survey responses before and after viewing the video allows us to verify that the videos created the intended moods without generating other, unwanted emotions.

Next, subjects participated as traders in a 15-minute-long market where they could exchange shares of an asset. We will refer to this market as Market 1. Trading was in terms of experimental currency (called francs), which was convertible to US Dollars at the end of the experimental session at an exchange rate of

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dollar, subjects would earn on average $8.42 from the market. With a show up fee of $10, average earnings would be $18.42, which is close to the $18.6 average realized in the 40-minute sessions. In Series 2, there were expected earnings of $16.92 from the market, and the projected session length was one hour, so we decreased the show-up fee to $5 to make the expected hourly payment $21.92.

[6] The study was not pre-registered because it was initiated in 2020, before pre-registration became a norm in experimental economics. However, we believe that it is obvious given the setup of the experiment, that the hypotheses listed in Section 3.2 are the ones originally intended and not advanced after the data were gathered. We also believe that the analyses that we conducted are those are standard given the structure of the data. We have reported all the tests that we conducted.

[7] As of this writing, the videos can be found at https://www.youtube.com/watch?v=MKWWhf8RAV8 (Happy) https://www.youtube.com/watch?v=JtAzMFcUQ90 (Fearful), and https://www.youtube.com/watch?v=SmhuzTzUKQY (Neutral).

300 francs per dollar. Traders were endowed with 2250 francs and 3 shares of the asset. At the end of the market, each share of the asset paid a one-time dividend d drawn from {20, 44, 104, 200}, with each value equally likely. As the dividend was the only source of intrinsic value of the shares, the fundamental value of one share was equal to the expected value of the dividend, E(d) = 92.[8]

Continuous double auction rules (Smith, 1962) were in effect in the market. To trade a share, traders could both post bid and ask offers in real time, as well as accept offers that other traders submitted. When an offer was accepted, a trade was made, and the transaction price was displayed on the computer screen for all other traders to see. A trader could trade as frequently as they desired, as long as they had sufficient money and shares to complete the trade. Short-selling and borrowing were not permitted. A trader's final earnings in the market equaled their original money endowment, plus the dividends earned from shares, plus the net profit from the purchase and sale of shares.

After the close of trading, subjects were informed of the number of shares they held, the dividend, and their own earnings in the market. They then completed the PANAS-X survey for the last time, and finally a questionnaire regarding their demographics. Comparison of Survey 0 (administered before the video is viewed) and Survey 1 (after the video is viewed but before Market 1 opens) measures the mood generated from the video. Comparison of Survey 0 and Survey 2 (after Market 1 closes) allows us to measure the effect of activity in the market on each subject's emotional state. It allows the effect of the video, which exists in Survey 1 but dissipates by the time that Survey 2 is administered, to be excluded, leaving only the effect of the market to influence the comparison.

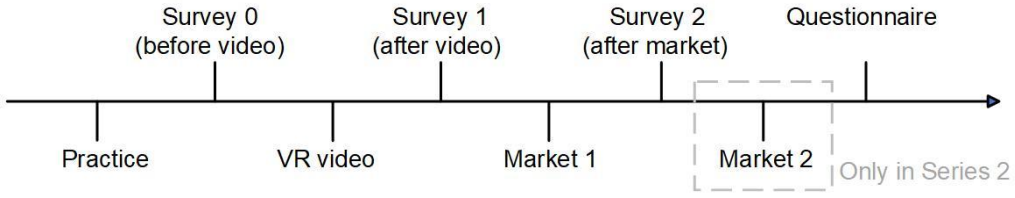


Figure 1. Timeline of the experiment

[8] The experimental design isolates the effect of prices from that of earnings. The final earnings, totaled over all traders depend on dividend levels and not on price levels. Individual earnings depend in part on the prices of the transactions that an individual makes. If it is the case that in the field higher prices are associated with positive emotions, the most plausible causal channel is that the higher prices are generating greater earnings for the average investor. In the experiment, we isolate this channel by designing the market to completely separate price levels from average earnings levels. On the other hand, if emotions respond to price levels rather than earnings, the experiment would allow us to observe such an effect.

In Series 1 of the sessions, conducted in 2021 and 2022, the above constituted the totality of activity in a session. In Series 2, conducted between 2024 and 2026, subjects traded in a second market after the last PANAS-X survey. In this second market, which will refer to as Market 2, the starting endowments were reinitialized at the same level as in Market 1. The dividend distribution was also the same as in the first market.

In total, we have 14 sessions of Market 1 per treatment. This gives us a power of .65 to detect a large effect (Cohen, 1988) of .8 standard deviations (Faul et al., 2007). This is relatively high power compared to most experimental studies of markets, where each observation is quite costly in terms of monetary expense. Figure 1 illustrates the sequence of events in each session, and Table 1 reports some summary information regarding the sessions.[9]

3.2 Hypotheses

The experiment is designed to test the following two hypotheses regarding the causal relationship between emotions and market activity. As described in Section 1, a number of previous studies and much commentary have suggested that positive emotions on the part of traders would cause higher prices. The first hypothesis is that our treatments would exhibit price differences reflecting this effect.

Hypothesis 1. *In Market 1, prices are the highest under the Happy treatment, followed by Neutral, followed by Fearful.*

[9] Since the two series were conducted during and after the COVID-19 pandemic, it is possible that initial emotional state may be more negative in Series 1, which took place during the pandemic, especially in terms of Joviality, Sadness and Fear. We checked whether subjects' initial emotional states are different between the two series. The average value of *Joviality0* (the suffix 0 indicates that the emotion is measured before the video is shown) in Series 1 is 2.806, and in Series 2 is 2.705 (two-sided *t*-test, $p = 0.366$). The average value of *Fear0* in Series 1 is 1.557 while in Series 2 it is 1.644 (two-sided *t*-test, $p = 0.301$). *Sadness0* averages 1.531 in Series 1 and 1.574 in Series 2 (two-sided *t*-test, $p = 0.605$). The averages are all very close in magnitude and not significantly different between the two series.

We also test whether the market data from the two series can be pooled. Specifically, we test whether the price level, average quantity traded, the number of offers to buy, the number of offers to sell, and volatility differs between Series 1 and 2 for each treatment, using t-tests. The first of the only two significant differences is that under the Neutral treatment, Series 2 has a significantly higher trading price than Series 1 (two-sided *t*-test, $p = 0.004$), but is not significant after Bonferroni correction for the 15 tests is applied. The second is that in the Happy treatment, Series 1 has higher number of offers to buy than Series 2 (two-sided *t*-test, $p = 0.027$), but this is also not significant after a Bonferroni correction is applied.

Table 1. Summary of the experimental sessions

	Time period conducted	Average completion time (minutes)	Average earnings (dollars)	Treatments	Number of sessions	Number of participants
Series 1	Fall 2021, Spring 2022	40	18.6	Fearful	6	48
				Happy	6	44
				Neutral	6	43
Series 2	Fall 2024, Fall 2025, Spring 2026	65	21.9	Fearful	8	58
				Happy	8	59
				Neutral	8	57

Our second hypothesis is that there is also a causal relationship in the opposite direction. The most plausible mechanism for how market prices influence emotional state is through their effect on trader earnings. Greater earnings cause a greater level of Joviality and a lower level of Fear. We do not assert that prices, per se, would influence emotional state.

Hypothesis 2. *(a) Greater individual earnings in Market 1 are associated with increases in Joviality. (b) Greater individual earnings in Market 1 are associated with decreases in Fear.*

4 Results

4.1 Manipulation check

We first consider whether our induction of moods was successful. To be specific, we verify that the videos induce the intended moods without generating other, unwanted emotional states. Figure 2 displays the average changes in four mood indices (Fear, Joviality, Hostility, and Sadness) in each treatment from

before and after subjects viewed the video.[10,11] We employ *t*-tests and place the 95% confidence intervals for the mean change in each variable on the graph. The results show that the Fearful video significantly increased subjects' Fear by 0.414 ($p < 0.001$) on a scale of 1 – 5 and did not generate a significant increase in Joviality, Hostility, or Sadness. The Happy video increased subjects' Joviality level by 0.302 ($p < 0.001$) and did not increase other emotion indicators.[12] Subjects did not show any significant changes in any of the four emotion indices in the Neutral treatment after the video.[13] Hence, our manipulation of moods worked as intended: The Happy treatment increased Joviality and the Fearful treatment increased Fear with no other positive effects observed.

4.2 The effect of moods on market activity

4.2.1 Market level analysis

We now consider the effect of induced moods on transaction prices in Market 1.[14] In the left panel of Figure 3 we report the market price, averaged across sessions in each treatment, with 95% confidence intervals for the treatment means. In all treatments, the average trading prices are far above the fundamental value of the shares, which is 92. The Neutral sessions have an average price of 341.68, followed by Happy (295.37) and Fearful (280.53).[15] Pairwise *t*-tests indicate that prices do not significantly differ between any pair of treatments. A one-sided test of the hypothesis that the average

[10] For the absolute values of the emotion indices from Survey 0 (before the video is shown) and Survey 1 (after the video) see Appendix A.1.

[11] Although the pre-video Joviality level is higher than the other mood indices in all treatments, there remained room for the video to increase participants' Joviality. In the Happy treatment, only 10 out of 103 participants had an initial Joviality greater than or equal to 4 out of a maximum of 5.

[12] The Happy video significantly decreased the average value of the Fear, Hostility, and Sadness indices in this sample. In other studies in which the same video has been employed (Nguyen and Noussair, 2022; Medai and Noussair, 2021; Noussair and Seaback, 2023) it did not have these effects. This means that for this study, it might be possible to interpret the effect of the Happy treatment as a condition of increased Happiness *and* of reduced Fear, Anger, and Sadness. However, this change in interpretation does not affect our main result that we fail to find any effect of emotional state on market price levels.

[13] Table A1 in the Appendix reports the average emotion indices before and after the video is viewed in each treatment. The average Fear after the video in the Fearful treatment is 2.011, which is significantly higher than that in the Happy treatment of 1.351 (two-sided *t*-test, $p < 0.001$) and the Neutral treatment of 1.474 (two-sided *t*-test, $p < 0.001$). The average Joviality after the video is 3.074 in the Happy treatment, significantly higher than the 2.689 in the Fearful treatment (two-sided *t*-test, $p = 0.009$) and the 2.627 in the Neutral treatment (two-sided *t*-test, $p = 0.003$).

[14] Transaction prices are the prices of the completed transactions. This measure does not include the offers that are submitted but not accepted in the calculation of the average price.

[15] In the experimental asset market literature, there are numerous examples of studies in which trading at prices higher than the maximum possible realization of the dividend is typical. The most prominent is the "bubble" literature based on the work of Smith et al. (1988). If a speculative bubble arises, demand is based on future resale prices, not on beliefs about future dividends, so there is no reason for the maximum possible dividend to act as a limit on the price at which trade can occur. Our relatively high cash-to-asset ratio, in which a relatively large amount of cash is available to make purchases, is conducive to high prices (Caginalp et al, 2001). We deliberately set the cash level to be high to permit a large range of possible market prices. This allows scope for the mood manipulations to influence price levels.

prices in Neutral and Fearful are equal yields $p = 0.228$, between Happy and Neutral results in $p = 0.720$, and between Happy and Fearful reports $p = 0.419$. Similar results are obtained by using Mann-Whitney tests (one-sided $p = 0.245$, 0.677, and 0.391, respectively) and a Jonckheere-Terpstra test to test whether the three groups exhibit the hypothesized relationship of Happy > Neutral > Fearful.[16] A permutation test yields $p = 0.407$ for the order Happy > Neutral > Fearful, JT = 283. When restricting the analysis to the first three minutes or first minute of each session, when the mood induction presumably has its strongest effect, there is also no significant difference between any pair of treatments for any of the above tests (see Appendix A.2 and Figure A1). Therefore, manipulating traders' emotions does not significantly change market prices. Our first result is that we reject Hypothesis 1.

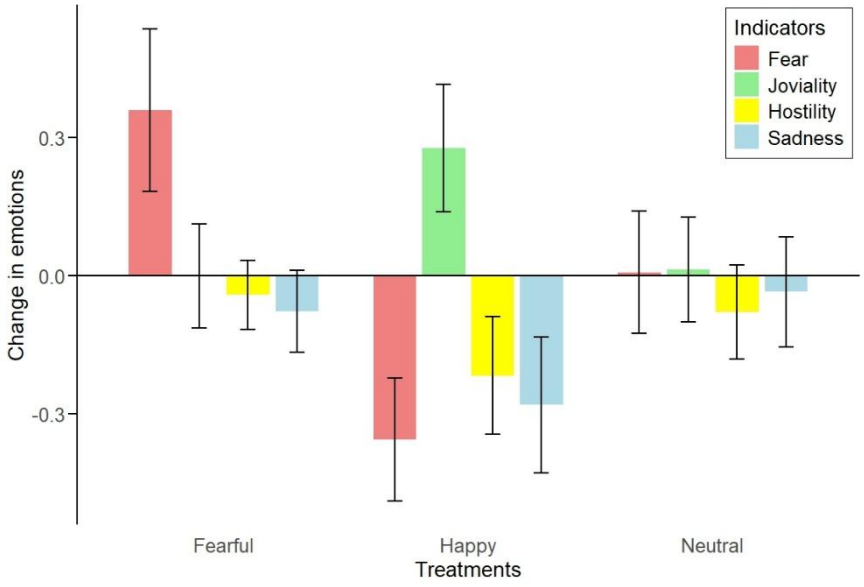
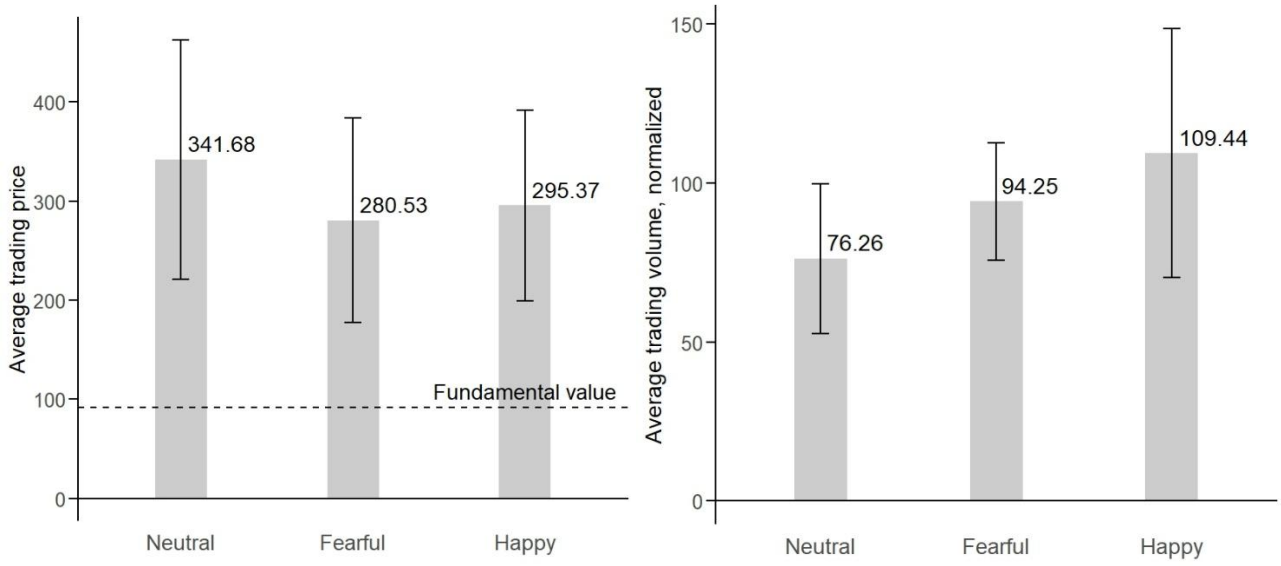


Figure 2. Manipulation check

Notes: The bars represent the changes in the mood indices, calculated as after-video values minus before-video values. We then compute the average changes in each treatment. The 95% confidence intervals for the mean change are given with each bar.

Result 1. *Incidental Joviality and Fear among traders do not affect market transaction prices and trading volume. Hypothesis 1 is not supported.*

[16] The alternative hypothesis is that the price in Happy is greater than or equal to the price in Neutral, and the price in Neutral is greater than or equal to the price in Fearful, with at least one of the inequalities being strict.



(a) Average price (b) Average trading volume

Figure 3. Market-level price and trading volume, Market 1

Notes: The bars in panel (a) represent the average trading prices, calculated by averaging the prices of all transactions in Market 1 in each session and then taking the average across all sessions within each treatment. The bars in panel (b) are the average trading volumes in Market 1 across all sessions within each treatment. The 95% confidence intervals for the means are given on each bar.

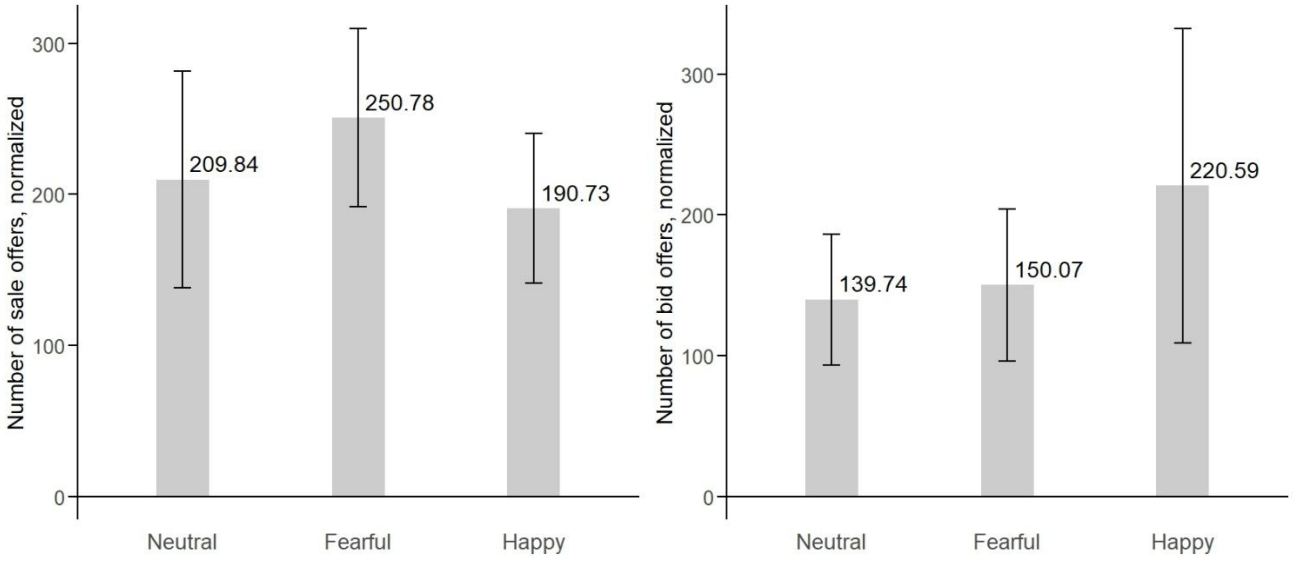
Apart from the average trading price, we also investigate the influence of mood on other measures of market activity, including the number of trades, the number of offers traders propose, and market volatility. Since the sessions differ in the number of participants, with more participants implying more aggregate transactions and more offers submitted, in the rest of the session level analysis, we normalize the trading volume and number of offers variables. For these variables, we report the raw data times 8 divided by the number of actual participants (i.e. the per capita values times 8) and only report this normalized data unless otherwise specified.

The emotion manipulations also have no effect on the volume of trade. The right panel of Figure 3 displays the average trading volume in each treatment. While each market has a total stock of up to 24 shares that traders hold at any time, the average number of trades is considerably higher than this level in all treatments. In the 15-minute life of the asset, each share is traded on average 3 to 5 times. The high volume of trade, coupled with the high prices, indicates that a large amount of speculative trading was taking place. The average volume under Neutral does not significantly differ from Fearful (two-sided t-test, $p = 0.250$) or Happy (two-sided t-test, $p = 0.166$). The trading volume in Fearful also does not differ

significantly from that in Happy (two-sided *t*-test, $p = 0.497$). Two-sided Mann-Whitney tests show that the difference between the Neutral and Happy treatments ($p = 0.085$) and between Neutral and Fearful ($p = 0.103$) do not differ significantly from each other.

In principle, a trader's emotional state may influence their *intention* to sell or buy, but the total number of realized trades may not reflect this intent. The number of offers submitted (including sale offers and bid offers) in each treatment is a measure that arguably more accurately captures the willingness to trade. The difference in the average number of offers among treatments is shown in Figure 4. We do not observe that more offers to sell are submitted on average in the Fearful condition compared to Neutral (two-sided *t*-test, $p = 0.396$; Mann-Whitney test, $p = 0.130$) and Happy (two-sided *t*-test, $p = 0.139$; Mann-Whitney test, $p = 0.118$). Traders in the Happy condition do not submit significantly more bid offers than those in the Neutral treatment (two-sided *t*-test, $p = 0.201$; Mann-Whitney test, $p = 0.581$). The difference between Happy and Fearful is also not statistically significant (two-sided *t*-test, $p = 0.275$; Mann-Whitney test, $p = 0.613$). Overall, there is thus scant evidence that emotions drive activity in the market. Focusing on the first three minutes or the first minute of the market period only, in which the effect of the emotion induction is presumably at its strongest, obtains qualitatively similar results (see Appendix A.2).

The presence of fear is often associated with volatility, and we test whether such a link exists here. We use the standard deviation of the transaction prices within a market as a measure of its volatility. The average volatility by treatment is reported in Figure 5. The Fearful treatment has the lowest volatility, but the differences between treatments are not statistically significant (two-sided *t*-test, $p = 0.566$ between Neutral and Fearful, $p = 0.505$ between Fearful and Happy). There is no indication that inducing Fear increases volatility. The analysis of the first three minutes in Appendix A.2 yields similar results.



(a) Average number of sale offers (b) Average number of bid offers

Figure 4. Market-level offers submitted, Market 1

Notes: The bars in panel (a) represent the average number of sale offers across all sessions within each treatment. The bars in (b) are the average number of bid offers across all sessions within each treatment. The 95% confidence intervals are given on each bar. The number of submitted offers on the session level are normalized to account for the different numbers of participants in each session.

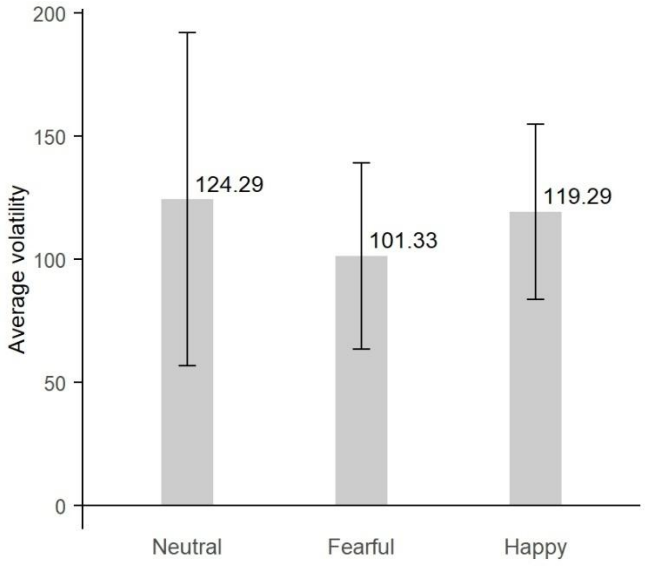


Figure 5. Market-level volatility, Market 1

Note: The bars represent the average volatility within each treatment. The volatility in a market is calculated as the standard deviation of transaction prices over the entire market. The 95% confidence intervals are given on each bar.

4.2.2 Individual level analysis

We now analyze how individual traders' behavior correlates with their measured emotional state, according to the PANAS-X surveys administered before the market opens. This is a correlational analysis rather than one of causal inference. This is because we are using measured emotional states of individuals that in part reflect factors other than our mood induction. This is in contrast with the treatment comparisons reported earlier that allow for causal inference from the random assignment of individuals into different emotional states.

The results from OLS regressions of the determinants of individual traders' outcomes in Market 1 are reported in Table 2. The errors are clustered at the session level to account for potential correlations in the error terms, as we observe traders' behavior is highly correlated within a session, as is typical in asset market experiments. *Ntrade1* is the number of trades an individual makes (including both sales and purchases) in the first market. *Price1* is the average price at which the individual concludes their trades, divided by 100 to make the size of its coefficients comparable across analyses. *Share1* denotes the number of shares an individual holds at the end of the first market. *Offer* is the total number of offers submitted by the subject, including both ask (sale) offers and bid offers. We further decompose this variable into *OfferSell* and *OfferBuy* to distinguish a subject's offers to sell and buy. We also consider how the emotional states affect traders' performance, measured by earnings from the market, denoted as *Earning1*.

The independent variables *ΔJoviality1* (= *Joviality1 - Joviality0*) and *ΔFear1* (= *Fear1 – Fear0*) are obtained by subtracting the PANAS-X survey score before the video is shown from the score afterwards. These are measures of incidental moods induced by the video. Session fixed effects are included in some regressions where the dependent variables typically take on greatly differing average values across sessions, such as price level and volume of trade. For descriptive statistics of the variables used in the regressions, see Appendix A.3.

The results show that an individual's Joviality is uncorrelated with a higher average price for that individual's trades (one-sided t-test, $p = 0.768$). This means that traders who are relatively jovial[17] compared to others in their session do not trade at higher prices. Fear does not exhibit a correlation with

[17] The regression includes a fixed effect of session on price level, since prices differ greatly among different sessions. Thus, a positive coefficient on Joviality would indicate that relatively jovial participants *within* their session tended to trade at high prices relative to other traders in the same sessions.

lower price level, either (one-sided *t*-test, $p = 0.244$). The correlation coefficients between *Price1* and *ΔJoviality1* is -0.022, and between *Price1* and *ΔFear1* is -0.014, showing that prior mood is uncorrelated with transaction price. We do not find a correlation between Joviality or Fear and trading prices.[18]

Table 2. Trader emotions and subsequent market activity in Market 1

	(1) *Price1*	(2) *Ntrade1*	(3) *Share1*	(4) *Offer*	(5) *OfferSell*	(6) *OfferBuy*	(7) *Earning1*
ΔJoviality1	-0.038	0.262	-0.400	3.657	-0.776	4.433	-0.019
	(0.051)	(1.344)	(0.206)	(10.003)	(2.778)	(9.528)	(0.123)
ΔFear1	-0.045	-2.310	0.065	2.964	2.520	0.444	-0.153
	(0.064)	(1.461)	(0.198)	(8.186)	(4.857)	(5.164)	(0.152)
Constant	0.796**	19.747**	3.018**	51.530**	25.723**	25.807**	2.472**
	(0.065)	(1.467)	(0.025)	(7.611)	(4.908)	(4.044)	(0.165)
Session FE	Y	Y	N	Y	Y	Y	Y
R^2	0.921	0.521	0.008	0.168	0.185	0.155	0.026
N	307	309	309	309	309	309	309

Notes: OLS regressions. The unit of observation is the individual subject. Standard errors (in parentheses) clustered at the session level. * and ** represent $p < 0.05$, and $p < 0.01$ respectively. *Price1* is the average transaction price in Market 1. *Ntrade1* is the number of units the subject traded in Market 1. *Share1* is the number of units held at the end of Market 1. *Offer* is the number of offers submitted by the subject, including the sale offers *OfferSell* and bid offers *OfferBuy*. *Earning1* is individual earnings from Market 1. *ΔJoviality1 and ΔFear1* are changes in the value of the emotion indices between Survey 0 (before video) and Survey 1 (before Market 1). The significance of the coefficients of *ΔJoviality1* and *ΔFear1* in column (1) are evaluated with one-sided tests to reflect our directional hypotheses.

An individual's emotional state is also uncorrelated with the number of trades they make. In column (2), the coefficients of *ΔJoviality1* and *ΔFear1* are insignificant (two-sided *t*-test, $p = 0.846$ and 0.121, respectively). Those who gain more Joviality during the video do not hold more shares at the end of the

[18] An alternative specification would be to include treatment dummies rather than session Fixed Effects, see Table A3 in appendix. Estimating this regression with *Price1* as the dependent variable yields coefficients for the Happy treatment of -0.470 (one-sided $p = 0.725$), and for the Fearful treatment of -0.687, (one-sided $p = 0.191$), not significant at conventional levels.

market period (two-sided t-test, $p = 0.058$), though the effect is close to significant, and there is also no effect associated with Fear (two-sided t-test, $p = 0.745$). We also do not find that more jovial subjects are more active, or more fearful subjects are less active, in the market. Columns (4)-(6) show that the total number of offers submitted (including sale offers and bid offers) are not affected by *ΔJoviality1* and *ΔFear1*. Finally, Column (7) shows that the change in emotional state is uncorrelated with individual earnings from the market. Overall, the results do not reveal a robust pattern supporting the notion that trader emotions correlate with subsequent market activity.

4.3 The effect of market activity on emotions

To test Hypothesis 2, we investigate whether market outcomes affect subjects' emotions. We first verify that the effects of the VR videos have fully dissipated by the end of the first 15-minute market.[19] Therefore, we apply two measures to assess the emotions generated from the market: (1) The absolute emotional state, measured by the last PANAS-X survey which subjects completed after the close of Market 1 (*Joviality2* and *Fear2*), and (2) the change between the first PANAS-X survey taken before the video from the last one taken after Market 1 has ended (*ΔJoviality2* = *Joviality2* – *Joviality0* and *ΔFear2* = *Fear2* – *Fear0*). This change isolates the effect of the market on emotional state. It allows the effect of the video itself, which exists in Survey 1 but dissipates by Survey 2, to be excluded. The mean level of *Joviality2* is 2.685, while the mean of *Fear2* is 1.524. Δ*Joviality2* ranges from -2.833 to 2.340, with an average of -0.055. Δ*Fear2* has a minimum of -2.8 and a maximum of 2.6, with an average of -0.101. See Appendix A.3 for other descriptive statistics.

As independent individual-level variables characterizing market activities, we consider the number of trades an individual made (*Ntrade1*), the average trading price of that individual divided by 100 (*Price1*), the number of shares they held at the close of the market (*Share1*), and their earnings divided by 1,000 (*Earning1*), in Market 1. In additional specifications, reported in Table A8 in the Appendix, we show that market volatility also has no effect on Fear and Joviality. The results are shown in Table 3. While our

[19] We test whether the effects of the videos disappear by comparing the difference between the first PANAS-X survey (Survey 0, before the video) and the last one (Survey 2, after Market 1) across treatments. If the effect of the video dissipates, then the difference in the average measured emotional state between the two timepoints should be the same across the three treatments. One-way Anova tests show that we fail to reject the null hypothesis that the mean differences across all three treatments are equal: $p = 0.631$ for Joviality, 0.287 for Fear, 0.101 for Hostility, and 0.287 for Sadness (each individual participant is one observation). This full dissipation of emotions is important to confirm as Masters et al. (2025) show that a fear induction can carry over into new activities and that naturalistic stimuli, such as those in our videos, have a relatively strong tendency to do so. Ku (2008a, 2008b) observed a similar effect for regret.

hypotheses concern the effects of *Joviality* and *Fear*, we also report regression results on the determinants of Hostility and Sadness, in Table A11 in the Appendix.

Table 3. The effect of market activity on emotions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Joviality2	*Joviality2*	*ΔJoviality2*	*ΔJoviality2*	*Fear2*	*Fear2*	*ΔFear2*	*ΔFear2*
Earning1	0.127^{*+}	0.124*	0.154^{**+}	0.136^{**+}	-0.116^{**+}	-0.125^{**+}	-0.112^{**+}	-0.111^{**+}
	(0.054)	(0.054)	(0.037)	(0.037)	(0.038)	(0.038)	(0.032)	(0.032)
Price1		0.038		-0.008		0.029		-0.002
		(0.031)		(0.021)		(0.021)		(0.018)
Ntrade1		-0.003		-0.004		-0.000		-0.005*
		(0.003)		(0.003)		(0.002)		(0.002)
Share1		0.006		-0.020		-0.013		0.015
		(0.022)		(0.013)		(0.012)		(0.011)
Constant	2.364**	2.310**	-0.446**	-0.223	1.818**	1.795**	0.182	0.249
	(0.144)	(0.218)	(0.105)	(0.153)	(0.118)	(0.145)	(0.096)	(0.133)
R^2	0.023	0.034	0.059	0.073	0.042	0.053	0.050	0.074
N	285	283	285	283	285	283	285	283

Notes: OLS regressions. The unit of observation is the individual subject. Robust standard errors are reported in parentheses. * and ** represent $p < 0.05$, and $p < 0.01$, respectively. + denotes $p < 0.05$ after Bonferroni correction for multiple regressors. *Joviality2* and *Fear2* are the emotion indices from Survey 2 (after Market 1). *ΔJoviality2 and ΔFear2* are changes in the value of the emotion index between Survey 0 (before video) and Survey 2. *Earnings1* is subject's final money balance after dividend payment in Market 1. *Ntrade1* is the number of units traded in Market 1, *Price1* is the average transaction price in Market 1. *Share1* is the number of units held at the end of Market 1. The significance of the coefficients of *Earning1* are evaluated with one-sided tests to reflect our directional hypotheses. *N* is smaller than the number of participants, since in three sessions a computer error caused the data from the last PANAS-X survey and demographic questionnaire to be lost. The sample size in regressions including *Price1* is smaller as some subjects did not make any trades in the market.

We find that an individual's emotional state is consistently affected by their *Earnings*. Specifically, column (1) shows that for every additional 1,000 francs earned, a subject's Joviality increases by 0.127 (one-sided *t*-test, $p = 0.010$). After controlling for other variables characterizing market activity in column (2), we obtain very similar results: Joviality increases by 0.124 (one-sided *t*-test, $p = 0.011$) per 1000 francs. The results are robust to using a relative measure of emotions in Columns (3) and (4). Higher earnings also reduce Fear. An increase of 1,000 francs in earnings reduces Fear by 0.116 in column (6) (one-sided *t*-test, $p = 0.002$), or by 0.125 using the relative measure in column (8) (one-sided *t*-test, $p < 0.001$). All these effects are statistically significant, indicating that higher earnings in the market tend to make people happier and less fearful. The similarity of results obtained using both absolute and relative measures of emotions provides further evidence that it is the market activity that induces changes in emotions. Hypothesis 2 is strongly supported. Other variables describing market activity, including trading price, trading volume, and shares held, do not exhibit a systematic correlation with emotional state. We also regress *Price1* alone on these emotion indicators and do not find a robust pattern (see Appendix A.4, Table A7). These results suggest that in the field, it is not high prices that affect investors' emotional state, but rather the greater earnings typically associated with the higher prices.

We summarize our evaluation of Hypotheses 2a and 2b with the following statement.

Result 2. *Market outcomes affect subjects' emotions through earnings. Higher individual earnings are associated with increases in Joviality and decreases in Fear. Hypotheses 2a and 2b are strongly supported.*

We now consider whether the way in which the earnings were accrued affect emotions differently. We distinguish between earnings from (1) Actions and (2) Luck. Earnings from actions consist of income earned over and above what an individual would have earned in expectation by simply holding on to their initial endowment of shares and cash until the close of the market. Earnings from actions are calculated as follows:

Earnings from Actions = money balance at market close before dividend – initial money endowment + (shares held at market close – initial share endowment)×expected dividend.

Earnings from luck include the value of the endowment (money and shares) and how much the realized dividend differs from the expected dividend. Earnings from luck are out of subjects' control. These earnings are calculated as:

Earnings from Luck = initial money endowment + initial share endowment × expected dividend + (shares held at market close)×(realized dividend – expected dividend).

The two sources of earnings add up to *Earning1*, the total earnings of a trader in the market.[20] To study how each source of earnings contributes to emotional state, we regress our measures of Joviality and Fear at the end of Market 1 on earnings from actions (divided by 1000, *Act1*) and earnings from luck (divided by 1000, *Luck1*) in Market 1. The variable *Act1* ranges from -2.482 to 4.821, reflecting the large variation in market performance among subjects. *Luck1* ranges from 1.734 to 4.578, with the difference among subjects mainly due to shares held and the realized dividend. The results are reported in Table 4. Interestingly, Joviality and Fear are affected by different sources of earnings. While both random luck and own actions contribute to changes in Joviality, the source of an individual's Fear is instead their purchases and sales in the market. Losing (earning less) money from trade makes subjects significantly more fearful.

4.4 Emotional state and activity in Market 2

We have shown that incidental emotions do not exert a causal effect on traders' behavior. We now consider whether emotions generated *from* the first market correlate with activity in the second market. This is a correlational relation since those individuals whose emotions are affected more by the first market are not random. The analysis considers Series 2 only, in which traders participated in a second market, referred to as Market 2. The emotion surveys administered prior to Market 2 enable us to examine whether emotional changes during the previous market period correlate with subsequent trading behavior.

The OLS regression results are reported in Table 5. The standard errors are clustered at the session level. To measure the integral emotions emerging in the first market, we use the change between the first PANAS-X survey (before the video) and the last one (after the end of Market 1). This measure excludes the emotions generated from the video, which have dissipated by the time of the last survey. *Price2* is the

[20] Within market 1, all the "Earnings from Luck" occur at the end of the market. This means that luck has no knock-on effects in the current market since it cannot influence auctions. On the other hand, while the Earnings from Luck can depend on prior actions, the actions can only influence the variance of "Earnings from Luck" not it's expectation, which is always 0. Selling all of one's shares ensures that the earnings from luck equal 0 with 0 variance, while accumulating shares increases the variance of Earnings from Luck while maintaining a mean of 0.

subject's average transaction price in the second market, divided by 100. *Ntrade2* is the number of trades the participant made in the second market. *Share2* is the number of shares one held at the end of the second market. We control for variables describing the individual's behavior in the first market, since they capture idiosyncratic individual trading tendencies. Session fixed effects are included in the regressions for *Price2* and *Ntrade2* to account for heterogeneity in average prices and transaction volumes among sessions.

The results show that the Joviality generated from the first market does not correlate with the transaction price in the second market (two-sided *t*-test yields $p = 0.591$ in column (1)). This is the case regardless of whether *Earning1*, or *Act1* and *Luck1*, is included in the specification. There is some evidence that Fear generated from the first market may be correlated with *higher* trading prices, the opposite direction than might be anticipated, though this result is not robust to differences in specification or to Bonferroni correction The coefficient of Fear is significant in Column (3) (two-sided *t*-test $p = 0.041$), but not in Columns (1) and (2) (two-sided *t*-tests yield $p = 0.077$ and 0.145, respectively). Furthermore, as shown in Table A13 in the Appendix, this effect is not robust to controlling for other emotions. The pattern indicates that it is the earnings in Market 1, not the emotional states that they may create, that may be affecting behavior. Indeed, the correlation coefficient between *Price2* and *ΔJoviality2* is 0.001, and that between *Price2* and *ΔFear2* is 0.055, showing that the integral emotions emerging from Market 1 and subsequent price level are uncorrelated.

ΔJoviality2 and *ΔFear2* do not correlate significantly with the number of trades. Neither *ΔJoviality2* nor *ΔFear2* are significant correlates of the final number of shares held under any of the specifications. As can be seen in Table A13 in the Appendix, including Hostility and Sadness in the specification does not result in any emotion being a significant influence on any of the market variables. Overall, we find no convincing evidence that integral emotions correlate with subsequent trader behavior. While the relationship is not causal, the lack of a correlation between emotional state prior to the open of Market 2 and subsequent market behavior, bolsters our confidence in the lack of support of Hypothesis 1.

Table 4. Emotional state as a function of different sources of earnings

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Joviality2	*Joviality2*	*ΔJoviality2*	*ΔJoviality2*	*Fear2*	*Fear2*	*ΔFear2*	*ΔFear2*
Act1	0.103	0.093	0.139^{**+}	0.114^{**+}	-0.114^{**+}	-0.126^{**+}	-0.102^{**+}	-0.096^{**+}
	(0.056)	(0.054)	(0.037)	(0.038)	(0.041)	(0.042)	(0.032)	(0.033)
Luck1	0.493^{*+}	0.511*	0.378^{**+}	0.411^{**+}	-0.145	-0.111	-0.256*	-0.293*
	(0.210)	(0.217)	(0.136)	(0.139)	(0.132)	(0.139)	(0.123)	(0.126)
Price1		0.044		-0.004		0.030		-0.005
		(0.031)		(0.021)		(0.021)		(0.018)
Ntrade1		-0.003		-0.004		-0.000		-0.005^{**+}
		(0.003)		(0.003)		(0.002)		(0.002)
Share1		-0.002		-0.026		-0.013		0.019
		(0.021)		(0.013)		(0.013)		(0.012)
Constant	1.436**	1.338*	-1.011**	-0.914*	1.892**	1.760**	0.546	0.706*
	(0.535)	(0.576)	(0.348)	(0.369)	(0.342)	(0.363)	(0.318)	(0.319)
R^2	0.036	0.048	0.067	0.085	0.042	0.053	0.056	0.082
N	285	283	285	283	285	283	285	283

Note: OLS regressions. The unit of observation is the individual subject. Robust standard errors are reported in parentheses. * and ** represent $p < 0.05$, and $p < 0.01$ respectively. + denotes $p < 0.05$ after Bonferroni correction for multiple regressors. *Joviality2* and *Fear2* are the emotion indices from Survey 2 (after Market 1). *ΔJoviality2 and ΔFear2* are changes in the value of the emotion indices between Survey 0 (before video) and Survey 2. For the independent variables, subjects' earnings from Market 1 are decomposed into earnings from actions (*Act1*) and earnings from luck (*Luck1*). *Ntrade1* is the number of units traded in Market 1, *Price1* is the average transaction price in Market 1. *Share1* is the number of units held at the end of Market 1. *N* is smaller than the number of participants, since in three sessions a computer error caused the data from the last PANAS-X survey and demographic questionnaire to be lost. The sample size in regressions with price is smaller as two subjects did not trade at all.

Table 5. Relation between emotional state and subsequent market activity: Market 2

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Price2	*Price2*	*Price2*	*Ntrade2*	*Ntrade2*	*Ntrade2*	*Share2*	*Share2*	*Share2*
ΔJoviality2	-0.030	-0.041	-0.069	-0.031	0.016	-0.040	0.011	0.138	0.086
	(0.055)	(0.067)	(0.058)	(0.743)	(0.898)	(0.936)	(0.171)	(0.156)	(0.197)
ΔFear2	0.086	0.093	0.139*	1.942	1.906	2.185	-0.222	-0.309	-0.266
	(0.057)	(0.050)	(0.064)	(1.206)	(1.243)	(1.123)	(0.273)	(0.261)	(0.243)
Price1	-0.080	-0.085	0.533**+						
	(0.190)	(0.196)	(0.085)						
Ntrade1				0.826**+	0.824**+	0.885**+			
				(0.105)	(0.110)	(0.055)			
Share1							0.551**+	0.526**+	0.520**+
							(0.081)	(0.086)	(0.077)
Earning1		0.024			-0.099			-0.309*	
		(0.043)			(0.703)			(0.123)	
Act1			-0.002			-0.041			-0.389*
			(0.042)			(0.603)			(0.145)
Luck1			-0.565			0.006			1.491
			(0.317)			(1.973)			(1.101)
Constant	5.839**	5.834**	2.149*	-7.092**	-6.843*	-2.171	1.332**	2.194**	-2.316
	(1.591)	(1.609)	(0.807)	(1.422)	(2.574)	(5.093)	(0.243)	(0.433)	(2.840)
Session FE	Y	Y	N	Y	Y	N	N	N	N
R^2	0.872	0.872	0.583	0.817	0.817	0.872	0.277	0.293	0.319
N	171	171	171	174	174	174	174	174	174

Note: OLS regressions. The unit of observation is the individual subject. Standard errors (in parentheses) are adjusted for clustering at the session level. * and ** represent $p < 0.05$, and $p < 0.01$, respectively. + denotes $p < 0.05$ after Bonferroni correction for multiple regressors. The coefficients on Earnings1 are significant at p < .005 in equations (3) – (6).Only Series 2 data is used. *Price2* is the average transaction price in Market 2. *Ntrade2* is the number of units traded. *Share2* is the number of units held at the end of Market 2. We control for the lagged dependent variables *Price1*, *Ntrade1*, and *Share1*. *Earning1* is subject's final money balance after dividend payment in Market 1. It is decomposed into earnings from actions (*Act1*) and earnings from luck (*Luck1*). *ΔJoviality2 and ΔFear2* are changes in the value of the emotion indices between Survey 0 and Survey 2. Column (1) - (3) have a smaller sample size because some subjects did not make any trades.

5 Discussion

The belief that the emotional state of market participants is correlated with market prices is widely held and well-supported with empirical evidence. A number of studies find a relationship between events

that affect both aggregate mood and stock returns, and trader mood is thought to be the mediator of the relationship. However, the financial, economic, or psychological foundation for a causal relationship whereby positive moods on the part of traders *cause* market prices to be higher or fear *causes* prices to be lower is not clear. In this study, we use the laboratory to randomly assign individuals drawn from the same population into different moods to test for a causal relationship between trader emotional state and market outcomes. Groups of traders in different emotional states participate in markets with an identical structure, so that the causal effect of moods can be isolated. We detect no causal relationship in the data between the mood of traders at the open of a market and subsequent prices.[21]

On the other hand, we find a strong relationship between market outcomes and subsequent emotional state. Higher earnings result in an increase in Joviality and a decrease in Fear. In the field, higher prices and earnings go hand in hand, since most investors have long positions and earn more when prices increase. However, in our experiment, in which average earnings depend only on the final dividend instead of prices, the price level has no effect on emotional state. This suggests that market euphoria in the field when prices increase is a consequence of traders accruing greater earnings rather than of the high prices themselves. Fear on the market would stem from traders responding to losing money rather than to low prices per se. We find no evidence for the notion that price volatility is a cause of trader fear.

We conclude with some thoughts on distinguishing emotions from beliefs about the future prospects of an investment. The term *sentiment* is widely used in finance to refer to beliefs about future returns. For example, optimism about an asset is a property of beliefs about future asset prices, not of an emotional state. These sentiments are not emotions, as they are understood in psychology. More optimistic beliefs about the future market value of an asset would presumably lead to greater demand for the asset and thus an increase in prices. Outcomes of events such as sporting matches and weather conditions may influence beliefs about the real economy and it is these beliefs that lead to higher asset prices, as individuals are more likely to go out for shopping and entertainment when the weather has been good or when a home team has won a big game.

More generally, correlations between prices and aggregate emotional states may be caused by third variables, such as beliefs about future valuations, that affect both asset prices and emotional states.

[21] Recall that our study had a 65% chance of detecting an effect of .8 standard deviations. This means that it is possible that there may be an effect of that size and the 35% chance that we fail to detect it has been realized. Alternatively, it remains possible that there is an effect of emotion on market price that is too small for our design to detect.

Optimistic beliefs about future returns may cause a positive emotional state on the part of those holding the asset, as their positions are viewed as more profitable. As prices of the asset increase in response to the optimistic beliefs, positive emotions are also experienced by those holding the asset or those purchasing the asset during the upward trend in prices, resulting in a positive correlation between the valence of traders' emotional states and price level. Fear operates in a symmetric manner when beliefs are pessimistic. This results in a correlation between prices and traders' emotional states. However, our results suggest that trader emotions are not *causing* the price changes. Rather, they are *consequences* of the price changes themselves or of beliefs that the prices are going to change. Although our experiment is not designed to demonstrate relationships with third variables, future experimental studies can study the mutual interactions between beliefs, emotions, and prices.

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Appendix A Supplemental analyses, tables and graphs

A.1 Manipulation check

In this appendix, we report the average values of four emotion indices before and after the video was viewed in each treatment. The data confirm that the Fearful video increased Fear, the Happy video increased Joviality, and the Neutral video did not generate any change in either Fear or Joviality. The Neutral video did decrease the level of Hostility, while the Happy video reduced the average levels of Fear, Hostility, and Sadness.

Table A1. Average values of emotion indices before and after the video is shown

Treatment		Joviality	Fear	Hostility	Sadness
Fearful	Before	2.789	1.597	1.434	1.585
	After	2.689	2.011**+	1.377	1.514
Happy	Before	2.772	1.705	1.413	1.602
	After	3.074**+	1.351**+	1.209**+	1.316**+
Neutral	Before	2.685	1.514	1.423	1.478
	After	2.627	1.474	1.303*	1.425

Note: The values are the emotion indices, averaged across all participants in a treatment before and after the video is shown. The symbols *, ** indicate that mean value is different before and after the video at $p < 0.05$, 0.01 respectively. + denotes $p < 0.05$ after Bonferroni correction for multiple tests.

A.2 Analysis of the first three minutes and the first minute of Market 1

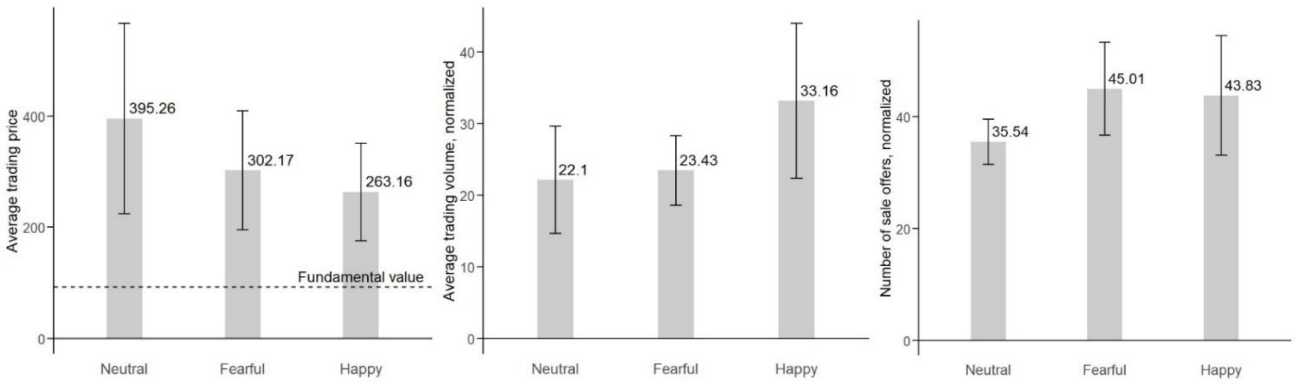
In this appendix, we evaluate Hypothesis 1 for the first three minutes of Market 1, when the mood induction would presumably have its strongest effect. In addition to price differences, we consider whether the volume of trade and the number of offers to buy and sell differs across treatments.

Figure A1 shows the prices, trade volume, number of offers to buy and to sell, as well as volatility in each treatment, averaged across sessions, for the first three minutes of Market 1. There are no significant differences between treatments. A one-sided test of the hypothesis that the average prices in Neutral and Fear are equal yields $p = 0.187$, between Happy and Neutral yields $p = 0.905$, and between Happy and Fearful yields $p = 0.707$. Similar results are obtained by using Mann-Whitney tests (one-sided $p = 0.307$,

0.725, and 0.643, respectively) and a Jonckheere-Terpstra test to test whether the three ordered groups exhibit a trend (a permutation test yields $p = 0.600$ for the order Happy > Neutral > Fearful, JT = 304).

In the first three minutes, although the Happy condition appears from Figure A1 to have more trades than Neutral, the difference is not statistically significant (two-sided *t*-test, $p = 0.111$). The Neutral condition does not significantly differ in terms of the number of trades from Fearful (two-sided *t*-test, $p = 0.120$). Two-sided Mann-Whitney tests show that the difference between the Happy and Neutral treatments is close to significant ($p = 0.066$), but the difference in transaction volume between Neutral and Fearful is not ($p = 0.280$).

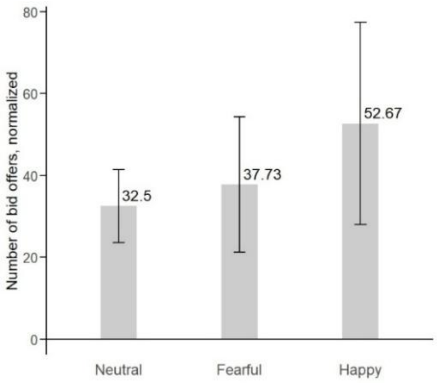
Regarding the number of sale offers, bid offers, and volatility, more offers to sell are submitted on average in the first three minutes of Fearful condition compared to the Neutral condition (two-sided *t*-test, $p = 0.055$), but this difference is not significant at conventional levels. Happy treatment traders do not propose more sale offers compared to Neutral (two-sided *t*-test, $p = 0.168$). Traders in the Happy condition do not submit more bid offers than in the Neutral condition (two-sided t-test, $p = 0.144$), the difference between Fearful and Neutral is also not statistically significant (two-sided *t*-test, $p = 0.590$). Volatility also does not differ across treatments (two-sided *t*-test, $p = 0.927$ between Fearful and Neutral, $p = 0.672$ between Happy and Neutral).



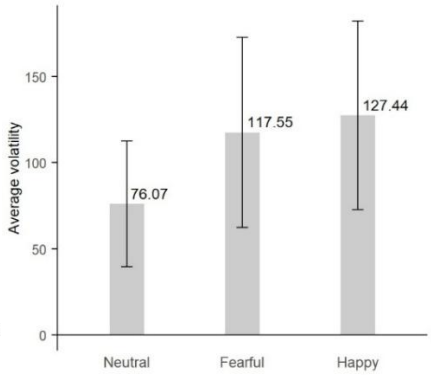
(a) Average price

(b) Average trading volume

(c) Average number of sale offers



(d) Average number of bid offers

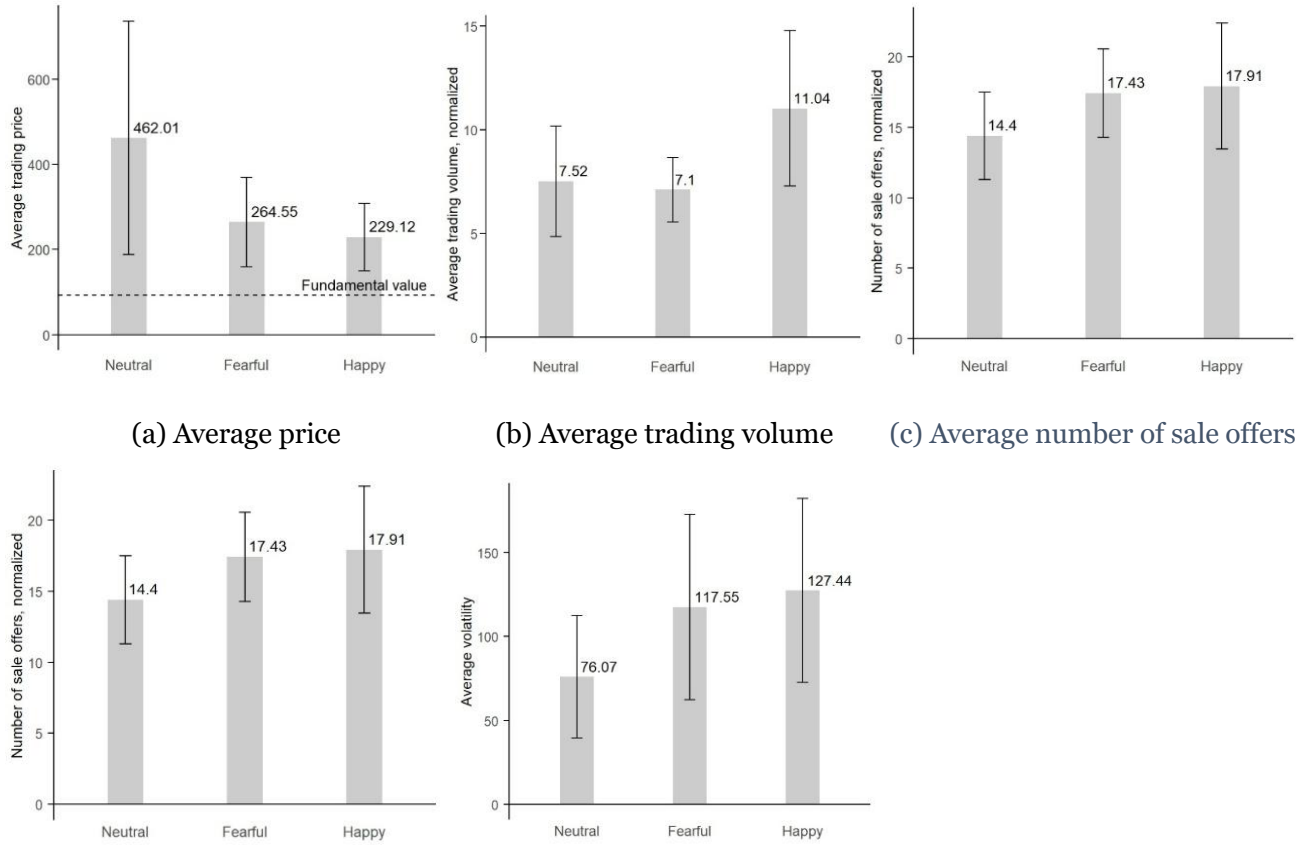


(e) Average volatility

Figure A1. Average values of market variables in first three minutes of Market 1

Note: The bars in panel (a) are the average trading prices in the first three minutes of Market 1, calculated by averaging the prices of all transactions in the first three minutes of each market and then taking the average across all sessions within each treatment. Panel (b) are the average trading volumes (normalized) across all sessions in the first three minutes of Market 1. Panel (c) represents the average number of sale offers (normalized) submitted in the first three minutes of Market 1, calculated by averaging the number of sale offers in the first three minutes of each session and then taking the average across all sessions within each treatment. Panel (d) contains the average number of bid offers (normalized) submitted in the first three minutes of Market 1 across all sessions within each treatment. Panel (e) shows the average price volatility, which is the standard deviation of trading prices in the first three minutes. The 95% confidence intervals for the means are given with each bar.

We also consider the very first minute of Market 1 on its own. Of the five market variables, price, volume of trade, number of offers to buy, number of offers to sell, and volatility, two-sided t-tests indicate that none are significantly different between any two treatments. The closest is from a test that the Happy and Fearful treatments have a different number of trades taking place (two-sided t-test, $p = 0.069$). The averages and confidence intervals for the 5 variables in each treatment are reported in Figure A2.



(a) Average price (b) Average trading volume (c) Average number of sale offers

(d) Average number of bid offers (e) Average volatility

Figure A2. First minute trading variables in Market 1

Note: The bars in panel (a) represent the average trading prices in the first minute of Market 1, calculated by averaging the prices of all transactions in the first minute of each market and then taking the average across all sessions within each treatment. The bars in panel (b) are the average trading volumes (normalized) across all sessions in the first minute of Market 1. The bars in panel (c) represent the average number of sale offers (normalized) submitted in the first minute of Market 1, calculated by averaging the number of sale offers in the first minute of each session and then taking the average across all sessions within each treatment. The bars in panel (d) are the average number of bid offers (normalized) submitted in the first minute of Market 1 across all sessions within each treatment. The bars in panel (e) are average price volatility, which is the standard deviation of trading prices in the first minute. The 95% confidence intervals for the means are given with each bar.

A.3 Descriptive statistics of variables used in the regressions

Table A2. Descriptive statistics of variables

Variable	Obs.	Mean	Std. dev.	Min	Max
Ntrade1	309	23.638	19.032	0	120
Ntrade2	174	17.897	19.739	0	112
Price1	307	3.072	2.042	0	12.45
Price2	172	2.7	1.489	.14	7.5
Share1	309	3	3.469	0	19
Share2	174	3	3.184	0	18
Earning1	309	2.541	1.221	.02	7.419
Act1	309	0	1.184	-2.482	4.821
Luck1	309	2.541	.319	1.734	4.578
Joviality1	309	2.797	1.083	1	5
Joviality2	285	2.685	1.043	1	5
ΔJoviality1	309	.048	.748	-2.333	2.66
ΔJoviality2	285	-.055	.798	-2.833	2.34
Fear1	309	1.617	.798	1	4.8
Fear2	285	1.524	.713	1	4.6
ΔFear1	309	.011	.77	-3.8	2.6
ΔFear2	285	-.101	.626	-2.8	2.6
Hostility2	285	1.568	.821	1	7.75
ΔHostility2	285	.14	.766	-2.75	6.75
Sadness2	285	1.503	.693	1	4.25
ΔSadness2	285	-.068	.644	-3.5	2.75

Note: The unit of observation is the individual subject. *Ntradej* is the number of units traded in market *j* (*j* = 1, 2), *Pricej* is the average transaction price in market *j*. *Sharej* is the number of units held at the end of market *j*. *Earning1* is the sum of the number of units held at the end of market 1 times the dividend realization of the asset plus the cash held at the end of the market. This is decomposed into earnings due to actions (*Act1*) and earnings due to luck (*Luck1*). The market variable names ending in 1 indicate the first market, those ending in 2 the second market. An emotion variable ending in 1 indicates it was measured before Market 1, and ending in 2 indicates it was measured after Market 1. *Δ* is a change in the value of an emotion index. A *Δ* variable ending in 1 refers to a difference between Survey 0 and Survey 1, and when ending in 2 refers to between Survey 0 and Survey 2. See Appendix B.2 for the calculations of emotion indices.

A.4 Additional regressions

This appendix contains a number of tables that are referred to in the text. Table A3 uses treatment dummy variables (Neutral dropped as baseline) to replace the individual emotion indices in Table 2. We find no treatment effect on the individual level for any variables of interest. Table A4 contains the same specifications as shown in Table 2 but with a dummy variable for Series 1 included as an independent variable. It shows that the dummy variable is a significant correlate of some of the dependent variables, but the addition of the variable does not affect the main result that the Fear and Joviality variables have no effect on any of the dependent variables that is significant even at the uncorrected conventional level of $p < 0.05$.

Table A5 also reports the same specifications as shown in Table 2 but with the Hostility and Sadness indices included as independent variables. The estimates show that Hostility and Sadness do not correlate significantly with the dependent variables and their inclusion does not render Joviality or Fear significant. Table A6 is a similar exercise but with General Positive Affect and General Negative Affect included instead. To construct these variables, we averaged all the responses in our abbreviated PANAS that were included in the indices for General Positive Affect and General Negative Affect proposed by Watson and Clark (1994). The estimates reveal that these general indices of valence are not significant correlates of the outcome variables.

Table A7 shows estimates of the effect of the trading price in Market 1 on the level of Joviality and Fear after the market closes. The estimates are all insignificant, indicating that earnings, rather than prices, are the driver of emotional reactions to the market. Table A8 includes the specifications from Table 3, but with the addition of market Volatility as an independent variable. The results in the table indicate that Volatility is not a significant determinant of emotional state, and its inclusion does not change the fact that Earnings are a highly significant determinant.

Table A9 contains the same specifications as shown in Table 3 but with a dummy variable for Series 1 included as an independent variable. It shows that the dummy variable is a significant correlate of Joviality though not of Fear. However, the addition of the variable does not affect the main result that earnings are a robust correlate of both Fear and Joviality.

Table A10 provides estimates of the effect of a number of variables on the General Positive and Negative Affect indices. It shows that Earnings is the sole variable that is significant, positively related to Positive Affect and negatively related to Negative Affect. Table A11 contains estimates of the effect of market variables in Market 1 on Hostility and Sadness. It shows that the level of earnings negatively affects Hostility and Sadness, while other market outcome variables exhibit no effect on emotions. Table A12 reports estimates from similar specifications except that earnings are decomposed into those from actions and those from luck. The table reveals that it is lower earnings from actions that increase Hostility and Sadness. Table A13 reports similar specifications as Table 5, with the only difference being that Hostility and Sadness are included as independent variables. We find that none of the emotion indices correlate with individual-level outcome variables in Market 2.

Table A3. The effect of treatment on market activity in Market 1

	(1)	(2)	(3)	(4)	(5)	(6)
	Price1	*Ntrade1*	*Offers*	*OfferSell*	*OfferBuy*	*Earning1*
Fearful	-0.687	4.717	6.520	5.289	1.231	-0.041
	(0.777)	(3.766)	(9.730)	(6.087)	(4.710)	(0.060)
Happy	-0.470	8.039	7.491	-2.842	10.332	0.017
	(0.779)	(5.931)	(11.932)	(5.765)	(8.075)	(0.068)
Constant	3.467**	19.340**	44.150**	26.560**	17.590**	2.550**
	(0.619)	(2.992)	(7.700)	(4.789)	(3.149)	(0.044)
R^2	0.020	0.030	0.002	0.010	0.009	0.000
N	307	309	309	309	309	309

Note: OLS regressions. The unit of observation is the individual subject. Standard errors (in parentheses) are clustered at the session level. * and ** represent $p < 0.05$ and $p < 0.01$ respectively. *Price1* is the average transaction price in Market 1. *Ntrade1* is the number of units the subject traded in Market 1. *Offer* is the number of offers submitted by the subject, including the sale offers *OfferSell* and bid offers *OfferBuy*. *Earning1* is individual earnings from Market 1. *Fearful* is a dummy variable indicating the subject belongs to the Fearful treatment, *Happy* is a dummy variable indicating the Happy treatment. Session fixed effects and the regression on *Share1* are dropped due to collinearity.

Table A4. The effect of changes in Joviality and Fear on individual behavior in Market 1, dummy for series 1 included

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Price1	*Ntrade1*	*Share1*	*Offer*	*OfferSell*	*OfferBuy*	*Earning1*
ΔJoviality1	-0.038	0.262	-0.413	3.657	-0.776	4.433	-0.019
	(0.051)	(1.344)	(0.210)	(10.003)	(2.778)	(9.528)	(0.123)
ΔFear1	-0.045	-2.310	0.062	2.964	2.520	0.444	-0.153
	(0.064)	(1.461)	(0.197)	(8.186)	(4.857)	(5.164)	(0.152)
Series1	0.160	-2.032^{**+}	0.104	-3.769	-2.020*	-1.749	0.213^{**+}
	(0.109)	(0.361)	(0.061)	(1.918)	(0.914)	(1.536)	(0.048)
Constant	0.796**	13.252**	2.974**	27.827**	17.032**	10.794**	2.334**
	(0.065)	(0.448)	(0.024)	(2.403)	(1.497)	(1.387)	(0.049)
Session FE	Y	Y	N	Y	Y	Y	Y
R^2	0.921	0.521	0.009	0.168	0.185	0.155	0.026
N	307	309	309	309	309	309	309

Note: OLS regressions. The unit of observation is the individual subject. Standard errors (in parentheses) clustered at the session level. * and ** represent $p < 0.05$ and $p < 0.01$ respectively. + denotes $p < 0.05$ after Bonferroni correction for multiple regressors. *Price1* is the average transaction price in Market 1. *Ntrade1* is the number of units the subject traded in Market 1. *Share1* is the number of units held at the end of Market 1. *Offer* is the number of offers submitted by the subject, including the sale offers *OfferSell* and bid offers *OfferBuy*. *Earning1* is individual earnings from Market 1. *ΔJoviality1 and ΔFear1* are changes in the value of the emotion indices between Survey 0 (before video) and Survey 1 (before Market 1). *Series1* is a dummy variable and takes the value of 1 if the subject participated in Series 1 of the study. The significance of the coefficients of *ΔJoviality1* and *ΔFear1* in column (1) are evaluated with one-sided tests to reflect our directional hypotheses.

Table A5. The effect of changes in Joviality and Fear on individual behavior in Market 1, Hostility and Sadness indices included in specifications

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Price1	*Ntrade1*	*Share1*	*Offer*	*OfferSell*	*OfferBuy*	*Earning1*
ΔJoviality1	-0.025	-0.038	-0.364	2.791	-0.878	3.669	0.031
	(0.048)	(1.339)	(0.234)	(8.011)	(2.670)	(7.264)	(0.128)
ΔFear1	-0.059	-1.995	0.023	3.428	2.665	0.763	-0.216
	(0.068)	(1.576)	(0.224)	(9.708)	(5.162)	(7.132)	(0.162)
ΔHostility1	0.079	-1.876	0.150	-10.958	-0.158	-10.800	0.183
	(0.101)	(2.102)	(0.635)	(13.151)	(4.117)	(13.551)	(0.236)
ΔSadness1	-0.010	0.305	0.080	9.448	-0.637	10.085	0.148
	(0.086)	(1.604)	(0.463)	(7.872)	(3.300)	(6.488)	(0.201)
Constant	0.826**	19.035**	3.047**	48.267**	25.586**	22.682**	2.562**
	(0.081)	(1.816)	(0.055)	(9.895)	(5.054)	(8.094)	(0.189)
Session FE	Y	Y	N	Y	Y	Y	Y
R^2	0.921	0.522	0.009	0.174	0.185	0.167	0.036
N	307	309	309	309	309	309	309

Note: OLS regressions. The unit of observation is the individual subject. Standard errors (in parentheses) clustered at the session level. * and ** represent $p < 0.05$, and $p < 0.01$ respectively. *Price1* is the average transaction price in Market 1. *Ntrade1* is the number of units the subject traded in Market 1. *Share1* is the number of units held at the end of Market 1. *Offer* is the number of offers submitted by the subject, including the sale offers *OfferSell* and bid offers *OfferBuy*. *Earning1* is individual earnings from Market 1. *ΔJoviality1*, *ΔFear1*, *ΔHostility1*, and *ΔSadness1* are changes in the value of the emotion indices between Survey 0 (before video) and Survey 1 (before Market 1). The significance of the coefficients of *ΔJoviality1* and *ΔFear1* in column (1) are evaluated with one-sided tests to reflect our directional hypotheses.

Table A6. The effect of positive and negative affect on individual behavior in Market 1

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Price1	*Ntrade1*	*Share1*	*Offer*	*OfferSell*	*OfferBuy*	*Earning1*
ΔPA1	-0.116	-0.749	-0.694	9.755	3.522	6.232	-0.114
	(0.108)	(1.463)	(0.373)	(8.163)	(3.421)	(5.433)	(0.213)
ΔNA1	-0.047	-0.714	0.149	9.410	7.108	2.301	-0.047
	(0.109)	(1.421)	(0.344)	(10.182)	(7.028)	(4.465)	(0.266)
Constant	0.739**	13.646**	2.778**	31.627**	18.464**	13.163**	2.338**
	(0.070)	(0.535)	(0.129)	(2.559)	(1.704)	(1.339)	(0.087)
Session FE	Y	Y	N	Y	Y	Y	Y
R^2	0.890	0.641	0.026	0.190	0.204	0.175	0.015
N	173	174	174	174	174	174	174

Note: OLS regressions. The unit of observation is the individual subject. Standard errors (in parentheses) clustered at the session level. *and ** represent $p < 0.05$, and $p < 0.01$ respectively. *Price1* is the average transaction price in Market 1. *Ntrade1* is the number of units the subject traded in Market 1. *Share1* is the number of units held at the end of Market 1. *Offer* is the number of offers submitted by the subject, including the sale offers *OfferSell* and bid offers *OfferBuy*. *Earning1* is individual earnings from Market 1. *ΔPA1* and *ΔNA1* are the changes in positive affect and negative affect between Survey 0 (before video) and Survey 1 (before Market 1). Positive affect contains alert, attentive, determined, enthusiastic, and excited. Negative affect contains afraid, scared, nervous, irritable, hostile.

Table A7. The effect of trading price in Market 1 on Joviality and Fear at the end of the market

	(1)	(2)	(3)	(4)
	Joviality2	*ΔJoviality2*	*Fear2*	*ΔFear2*
Price1	0.045	-0.001	0.029	0.007
	(0.032)	(0.021)	(0.020)	(0.019)
Constant	2.549**	-0.048	1.434**	-0.122
	(0.122)	(0.085)	(0.075)	(0.063)
R^2	0.008	0.000	0.007	0.001
N	283	283	283	283

Note: OLS regressions. Robust standard errors are reported in parentheses. * and ** represent $p < 0.05$ and $p < 0.01$ respectively. *ΔJoviality2 and ΔFear2* are changes in the value of the emotion index between Survey 0 (before video) and Survey 2 (after Market 1). *Joviality2* and *Fear2* are the emotion indices from Survey 2. *Price1* is the average trading price for that subject in Market 1.

Table A8. The effect of volatility in Market 1 on Joviality and Fear at the end of Market 1

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Joviality2	*Joviality2*	*ΔJoviality2*	*ΔJoviality2*	*Fear2*	*Fear2*	*ΔFear2*	*ΔFear2*
Earning1	0.127^{*+}	0.123*	0.155^{**+}	0.137^{**+}	-0.116^{**+}	-0.126^{**+}	-0.112^{**+}	-0.111^{**+}
	(0.054)	(0.054)	(0.037)	(0.037)	(0.038)	(0.039)	(0.032)	(0.032)
Volatility1	-0.013	-0.111	0.043	0.130	-0.007	-0.095	0.003	0.015
	(0.071)	(0.089)	(0.053)	(0.066)	(0.044)	(0.061)	(0.037)	(0.054)
Price1		0.070		-0.046		0.057*		-0.006
		(0.041)		(0.026)		(0.028)		(0.025)
Ntrade1		-0.003		-0.004		-0.000		-0.005^{**+}
		(0.003)		(0.003)		(0.002)		(0.002)
Share1		0.006		-0.019		-0.013		0.015
		(0.022)		(0.013)		(0.012)		(0.011)
Constant	2.381**	2.345**	-0.500**	-0.263	1.827**	1.824**	0.178	0.245
	(0.181)	(0.223)	(0.122)	(0.155)	(0.128)	(0.145)	(0.101)	(0.134)
R^2	0.023	0.038	0.061	0.083	0.042	0.060	0.050	0.074
N	285	283	285	283	285	283	285	283

Note: OLS regressions. The unit of observation is the individual subject. Robust standard errors are reported in parentheses. * and ** represent $p < 0.05$ and $p < 0.01$ respectively. + denotes $p < 0.05$ after Bonferroni correction for multiple regressors. *Joviality2* and *Fear2* are the emotion indices from Survey 2 (after Market 1). *ΔJoviality2 and ΔFear2* are changes in the value of the emotion index between Survey 0 (before video) and Survey 2. *Earnings1* is a subject's final money balance after dividend payment in Market 1. *Volatility1* is the standard deviation of the trading price in the session where the subject was at (session-level variable). *Ntrade1* is the number of units traded in Market 1, *Price1* is the average transaction price in Market 1. *Share1* is the number of units held at the end of Market 1. The significance of the coefficients of *Earning1* are evaluated with one-sided tests to reflect our directional hypotheses. *N* is smaller than the number of participants, since in three sessions a computer error caused the data from the last PANAS-X survey and demographic questionnaire to be lost. The sample size in regressions including *Price1* is smaller as some subjects did not make any trades in the market.

Table A9. The effect of market variables on individual Joviality and Fear, dummy variable for series included

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Joviality2	*Joviality2*	*ΔJoviality2*	*ΔJoviality2*	*Fear2*	*Fear2*	*ΔFear2*	*ΔFear2*
Earning1	0.125^{*+}	0.122*	0.153^{**+}	0.134^{**+}	-0.115^{**+}	-0.124^{**+}	-0.111^{**+}	-0.110^{**+}
	(0.054)	(0.053)	(0.036)	(0.036)	(0.038)	(0.038)	(0.031)	(0.031)
Series1	0.301^{*+}	0.390^{**+}	0.210*	0.222*	-0.104	-0.071	-0.056	-0.069
	(0.121)	(0.128)	(0.093)	(0.098)	(0.082)	(0.089)	(0.071)	(0.072)
Price1		0.068*		0.009		0.024		-0.007
		(0.032)		(0.022)		(0.023)		(0.018)
Ntrade1		-0.002		-0.003		-0.000		-0.005^{**+}
		(0.003)		(0.003)		(0.002)		(0.002)
Share1		0.005		-0.020		-0.013		0.015
		(0.021)		(0.013)		(0.012)		(0.011)
Constant	2.252**	2.057**	-0.524**	-0.366*	1.856**	1.841**	0.203	0.294*
	(0.153)	(0.232)	(0.111)	(0.163)	(0.123)	(0.159)	(0.104)	(0.147)
R^2	0.043	0.064	0.075	0.090	0.047	0.055	0.052	0.076
N	285	283	285	283	285	283	285	283

Note: OLS regressions. The unit of observation is the individual subject. Robust standard errors are reported in parentheses. * and ** represent $p < 0.05$, and $p < 0.01$ respectively. + denotes $p < 0.05$ after Bonferroni correction for multiple regressors. *Joviality2* and *Fear2* are the emotion indices from Survey 2 (after Market 1). *ΔJoviality2 and ΔFear2* are changes in the value of the emotion indices between Survey 0 (before video) and Survey 2. *Earnings1* is subject's final money balance after dividend payment in Market 1. *Series1* is a dummy variable and takes the value of 1 if the subject participated in Series 1 of the study. *Ntrade1* is the number of units traded in Market 1, *Price1* is the average transaction price in Market 1. *Share1* is the number of units held at the end of Market 1. The significance of the coefficients of *Earning1* are evaluated with one-sided tests to reflect our directional hypotheses. *N* is smaller than the number of participants, since in three sessions a computer error caused the data from the last PANAS-X survey and demographic questionnaire to be lost. The sample size in regressions including *Price1* is smaller as some subjects did not make any trades in the market.

Table A10. The effect of market activity on positive and negative affect

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	PA2	*PA2*	*ΔPA2*	*ΔPA2*	*NA2*	*NA2*	*ΔNA2*	*ΔNA2*
Earning1	0.064	0.070	0.097**+	0.088*	-0.125**+	-0.130**+	-0.081*+	-0.071*
	(0.057)	(0.057)	(0.036)	(0.035)	(0.042)	(0.044)	(0.032)	(0.035)
Price1		0.053		-0.045		0.027		-0.019
		(0.036)		(0.023)		(0.025)		(0.020)
Ntrade1		-0.002		-0.005		-0.001		-0.002
		(0.004)		(0.003)		(0.002)		(0.002)
Share1		0.029		-0.008		-0.001		0.024
		(0.025)		(0.016)		(0.018)		(0.014)
Constant	2.948**	2.718**	-0.388**	-0.051	1.961**	1.905**	0.189*	0.223
	(0.158)	(0.254)	(0.110)	(0.160)	(0.129)	(0.199)	(0.103)	(0.156)
R^2	0.008	0.037	0.040	0.069	0.055	0.064	0.036	0.061
N	174	173	174	173	174	173	174	173

Note: OLS regressions. The unit of observation is the individual subject. Robust standard errors are reported in parentheses. * and ** represent $p < 0.05$, and $p < 0.01$ respectively. + denotes $p < 0.05$ after Bonferroni correction for multiple regressors. *PA2* and NA*2* are the positive affect and negative affect indices from Survey 2 (after Market 1). *ΔPA2 and ΔNA2* are changes in the value of the indices between Survey 0 (before video) and Survey 2. Positive affect contains alert, attentive, determined, enthusiastic, and excited. Negative affect contains afraid, scared, nervous, irritable, hostile. *Earnings1* is subject's final money balance after dividend payment in Market 1. *Ntrade1* is the number of units traded in Market 1, *Price1* is the average transaction price in Market 1. *Share1* is the number of units held at the end of Market 1. The significance of the coefficients of *Earning1* are evaluated with one-sided tests to reflect our directional hypotheses. Only contains Series 2 data. The sample size in regressions including *Price1* is smaller as one subject did not make any trades in the market.

Table A11. The effect of market activity on Hostility and Sadness

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Hostility2	*Hostility2*	*ΔHostility2*	*ΔHostility2*	*Sadness2*	*Sadness2*	*ΔSadness2*	*ΔSadness2*
Earning1	-0.149**+	-0.153**+	-0.084**+	-0.082**+	-0.134**+	-0.143**+	-0.056	-0.053
	(0.034)	(0.034)	(0.027)	(0.026)	(0.034)	(0.034)	(0.032)	(0.035)
Price1		0.017		-0.020		0.001		-0.016
		(0.022)		(0.021)		(0.021)		(0.018)
Ntrade1		0.001		-0.001		0.000		-0.001
		(0.002)		(0.003)		(0.002)		(0.002)
Share1		-0.011		0.005		-0.015		0.008
		(0.013)		(0.014)		(0.011)		(0.010)
Constant	1.944**	1.911**	0.353**	0.413**	1.842**	1.911**	0.073	0.119
	(0.104)	(0.152)	(0.086)	(0.131)	(0.103)	(0.137)	(0.096)	(0.137)
R^2	0.052	0.056	0.019	0.023	0.059	0.065	0.012	0.017
N	285	283	285	283	285	283	285	283

Note: OLS regressions. Robust standard errors are reported in parentheses. * and ** represent $p < 0.05$, and $p < 0.01$ respectively. + denotes $p < 0.05$ after Bonferroni correction for multiple regressors. *Hostility2* and *Sadness2* are the emotion indices from Survey 2 (after Market 1). *ΔHostility2 and ΔSadness2* are changes in the value of the emotion index between Survey 0 (before video) and Survey 2. *Ntrade1* is the number of units traded in Market 1, *Price1* is the average transaction price in Market 1. *Share1* is the number of units held at the end of Market 1.

Table A12. The effect of market activity on Hostility and Sadness, with earnings decomposition

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Hostility2	*Hostility2*	*ΔHostility2*	*ΔHostility2*	*Sadness2*	*Sadness2*	*ΔSadness2*	*ΔSadness2*
Act1	-0.142**+	-0.147**+	-0.080**+	-0.075*	-0.137**+	-0.150**+	-0.059	-0.054
	(0.036)	(0.039)	(0.028)	(0.029)	(0.036)	(0.037)	(0.034)	(0.038)
Luck1	-0.248	-0.229	-0.138	-0.171	-0.090	-0.065	-0.006	-0.035
	(0.150)	(0.169)	(0.149)	(0.163)	(0.129)	(0.135)	(0.109)	(0.111)
Ntrade1		0.016		-0.021		0.002		-0.016
		(0.023)		(0.022)		(0.022)		(0.018)
Price1		0.001		-0.001		0.000		-0.001
		(0.002)		(0.003)		(0.002)		(0.002)
Share1		-0.009		0.007		-0.017		0.008
		(0.015)		(0.016)		(0.012)		(0.011)
Constant	2.195**	2.101**	0.489	0.635	1.731**	1.714**	-0.052	0.076
	(0.397)	(0.466)	(0.394)	(0.443)	(0.333)	(0.356)	(0.282)	(0.291)
R^2	0.034	0.046	0.016	0.019	0.046	0.060	0.011	0.013
N	223	222	223	222	223	222	223	222

Note: OLS regressions. Robust standard errors are reported in parentheses. * and ** represent $p < 0.05$, and $p < 0.01$ respectively. + denotes $p < 0.05$ after Bonferroni correction for multiple regressors. *Hostility2* and *Sadness2* are the emotion indices from Survey 2 (after Market 1). *ΔHostility2 and ΔSadness2* are changes in the value of the emotion index between Survey 0 (before video) and Survey 2. Subject's earnings from Market 1 are decomposed into earnings from actions (*Act1*) and earnings from luck (*Luck1*). *Ntrade1* is the number of units traded in Market 1, *Price1* is the average transaction price in Market 1. *Share1* is the number of units held at the end of Market 1.

Table A13. Relation between emotional state and activity in Market 2

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Price2	*Price2*	*Price2*	*Ntrade2*	*Ntrade2*	*Ntrade2*	*Share2*	*Share2*	*Share2*
ΔJoviality2	0.001	-0.011	-0.060	0.019	0.086	-0.146	0.092	0.211	0.141
	(0.055)	(0.066)	(0.061)	(0.794)	(0.922)	(0.964)	(0.180)	(0.160)	(0.192)
ΔFear2	0.064	0.073	0.124	1.103	1.048	1.819	-0.400	-0.481	-0.398
	(0.077)	(0.073)	(0.066)	(1.366)	(1.429)	(1.322)	(0.377)	(0.377)	(0.337)
ΔHostility2	0.146	0.150	0.032	-0.901	-0.919	-1.162	0.279	0.248	0.170
	(0.136)	(0.135)	(0.121)	(1.081)	(1.099)	(0.916)	(0.465)	(0.456)	(0.444)
ΔSadness2	-0.031	-0.032	0.020	2.887	2.899	1.771	0.300	0.308	0.245
	(0.082)	(0.081)	(0.099)	(1.760)	(1.797)	(1.501)	(0.415)	(0.427)	(0.399)
Price1	-0.081	-0.087	0.534^{**+}						
	(0.189)	(0.196)	(0.085)						
Ntrade1				0.815^{**+}	0.812^{**+}	0.884^{**+}			
				(0.109)	(0.117)	(0.058)			
Share1							0.551^{**+}	0.526^{**+}	0.520^{**+}
							(0.081)	(0.086)	(0.077)
Earning1		0.027			-0.147			-0.304*	
		(0.042)			(0.718)			(0.125)	
Act1			-0.001			-0.070			-0.383*
			(0.041)			(0.589)			(0.145)
Luck1			-0.574			-0.065			1.420
			(0.321)			(1.976)			(1.026)
Constant	5.814**	5.807**	2.168*	-5.956**	-5.576	-1.558	1.332**	2.188**	-2.130
	(1.572)	(1.593)	(0.814)	(1.705)	(3.134)	(5.066)	(0.234)	(0.441)	(2.641)
Session FE	Y	Y	N	Y	Y	N	N	N	N
R^2	0.874	0.875	0.583	0.823	0.823	0.778	0.284	0.298	0.322
N	171	171	171	174	174	174	174	174	174

Note: OLS regressions. The unit of observation is the individual subject. Standard errors (in parentheses) adjusted for clustering at the session level. * and ** represent $p < 0.05$, and $p < 0.01$, respectively. + denotes $p < 0.05$ after Bonferroni correction for multiple regressors. Only Series 2 data is used. *Price2* is the average transaction price in Market 2. *Ntrade2* is the number of units traded. *Share2* is the number of units held at the end of Market 2. We control for the lagged dependent variables *Price1*, *Ntrade1*, and *Share1*. *Earning1* is a subject's final money balance after dividend payment in Market 1. It is decomposed into earnings from actions (*Act1*) and earnings from luck (*Luck1*). *ΔJoviality2*, *ΔFear2*, *ΔHostility2*, and *ΔSadness2* are changes in the value of the emotion indices between Survey 0 (before video) and Survey 2 (after Market 1). Column (1) - (3) have a smaller sample size because some subjects did not trade.

Appendix B Instructions and forms used in the experiment

B.1 Instructions for the computerized market

1. General Instructions

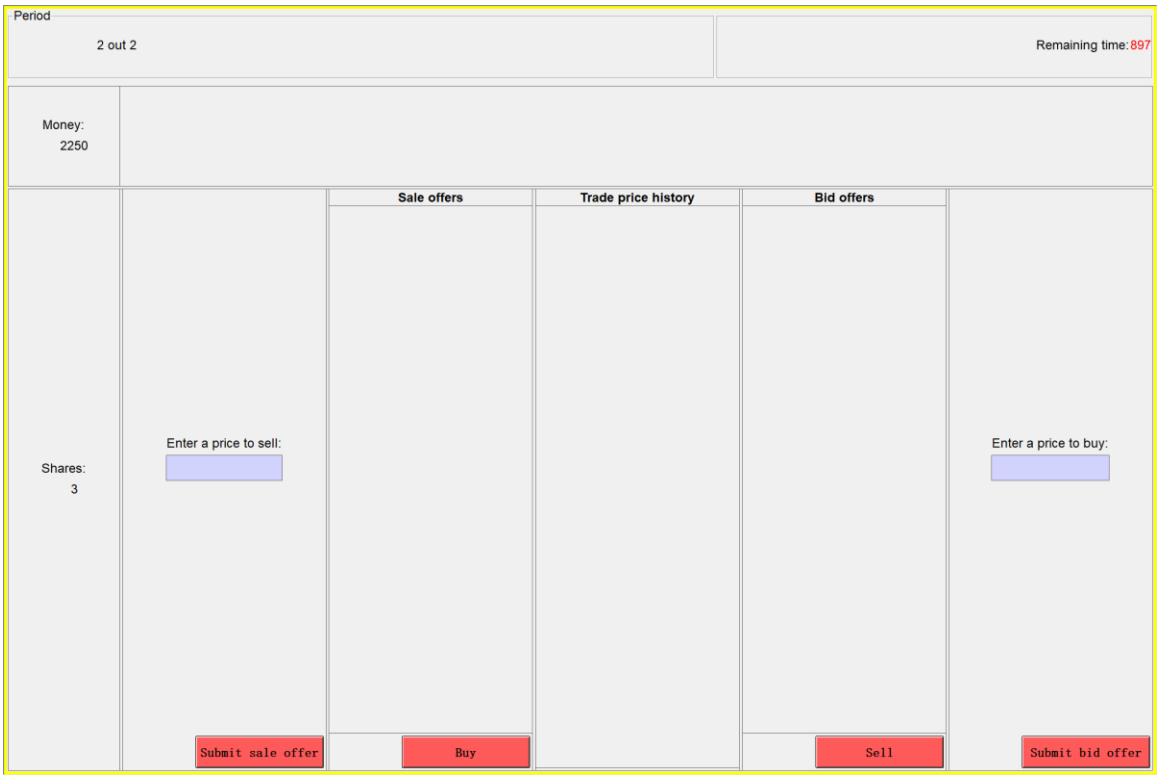
This is an experiment on market decision making. If you follow the instructions carefully, you might earn a considerable amount of money, which will be paid to you in cash at the end of the experiment.

From now on until the end of the experiment, please do not communicate with other participants or use your own electronic devices. Violation of these rules will lead to the exclusion from the study and all payments. If you have any questions, please raise your hand, and I will come to your table to answer your questions in private.

There are **…. participants** in this experiment. All of them are **Traders**. The experiment will consist of **two trading periods**. During each period, you can buy and sell in a market. The currency used in the market is francs, which will be converted into US dollars at an exchange rate of **300 francs for one dollar.**

You will receive **5 dollars** for showing up on time for this study. Your total earnings would be your earnings from the markets, plus your show-up fee.

2. How to use the computerized market



During the trading period, you will see a computer screen like the one shown above. You can use the interface to buy and sell **Shares**. On the top left corner of your screen, you see the **remaining money** you have. On the left-most column, you see the **number of shares** you currently hold.

Selling in the market

If you would like to sell a share, you may use the **"Enter a price to sell"** column (the second column). Enter the price at which you are offering to sell one share, then click **"Submit sale offer"** at the bottom of the column. Your sale price will appear immediately in the third column, entitled **"Sale offers"**.

Note: You can make multiple sale offers. However, if one of your sale offers is accepted, *all other* sale offers from you would disappear.

You can also accept a bid offer to sell a share. Check the **"Bid offers"** column (the second-to-last column). This column displays all the prices from those who want to *buy* a share at. The highest bid price will always be on the bottom of that list and will be highlighted. If you click **"Sell"** at the bottom of this column, you will sell one share for the highest current bid price.

Buying in the market

If you would like to offer to buy a share, you may use the **"Enter a price to buy"** column (the last column). Enter the price at which you are offering to buy one share, then click **"Submit bid offer"** at the bottom of the column. Your bid price will appear immediately in the second-to-last column, entitled **"Bid offers"**.

Note: You can make multiple bid offers. However, if one of your bid offers is accepted, *all other* bid offers from you would disappear.

You can also accept a sale offer to buy a share. Check the **"Sale offers"** column (the third column). This column displays all the prices from those who want to *sell* a share at. The lowest sale price will always be on the bottom of that list and will be highlighted. If you click **"Buy"** at the button of this column, you will buy one share for the lowest current sale price.

When you buy a share, your money decreases by the price of the purchase, and the number of shares you own increases by one. When you sell a share, your money increases by the price of the sale, and the number of shares you own decreases by one.

3. The shares traded in the market

There will be **2 trading periods**. Each period lasts **15 minutes**. During each period, there will be a market open, operating under the rules described previously, in which you are permitted to buy and sell shares. Every trader is endowed with **3 shares AND 2250 francs** at the beginning of a period.

You receive **dividend** for each share you have at the end of the period. At the end of a trading period, **every share you hold will pay you a dividend of 20, 44, 104, 200 francs, each with equal chance**. The computer will roll a 4-sided die to decide your dividend. The dividends are added to your money balance automatically after the period. After the dividend is paid, the market is closed, and the period ends.

4. Your Earnings

Your earnings in one period will equal the total amount of money you have at the end of the period, *after* the dividend has been paid. In other words,

The earnings you will receive = The money you had at the beginning of the period

+ the dividends you received

+ the money you received from sales of shares

- the money you spent on purchases of shares

Your total earnings will be the **sum** of your earnings in the two periods, plus your show-up fee.

Practice Period

Before the formal periods start, we provide a practice period for you to get familiar with the computerized market. The practice period lasts 10 minutes. Try to bid and sell as many times as possible. **The practice period does not count for payment.** If you have any questions, please raise your hand.

B.2 The PANAS-X survey used to measure emotional state

Survey

The survey below consists of several words and phrases that describe different feelings and emotions. Read each item, then **indicate to what extent you feel this way right now** by choosing the appropriate answer on the right-hand side to that word**.** Use the following scale to record your answers:

1	2	3	4	5
Very slightly	A little	Moderately	Quite a bit	Extremely

Afraid ___	Angry ___	Shaky ___	Nervous ___	Attentive ___
Calm ___	Determined___	Alert ___	Excited ___	Concentrating
Frightened ___	Irritable ___	Downhearted ___	Enthusiastic ___	Hostile ___
Cheerful ___	Disgusted ___	Happy ___	Energetic ___	Scared ___
Lonely ___	Joyful ___	Sad ___	Alone___	Relaxed ___

B.3 Calculation of Emotion Indices *(the text in this subsection was not in the text provided to participants):*

The four indices were calculated in the following manner:

Joviality = (Cheerful + Joyful + Happy + Excited + Enthusiastic + Energetic)/6

Fear = (Afraid + Frightened + Shaky + Nervous + Scared)/5

Sadness = (Lonely + Downhearted + Sad + Alone)/4

Hostility = (Angry + Irritable + Disgusted + Hostile)/4

B.4 VR headset instructions

Now, the experimenter is going to bring a VR headset to your desk. There will be a 3-minute video which you are required to watch. After receiving the equipment, please just wear the headset and leave the handle on the desk for now. DO NOT PRESS ANY BUTTON UNTIL INSTRUCTED.

Tip: If you wear glasses, try to put your glasses into the headset *before* wearing the headset.

Use your right hand to hold the handle. There will be a curve pointing from your handle to the front, you can imagine the endpoint of the curve as your mouse pointer. To play the video, target the endpoint of the curve on the "play" button in the middle, then press the button on your handle **below your forefinger**. This is also the only button you need to use in this experiment.

Please stand up when you watch the video. After the video is over, you can sit down and take off the headset, then click on the "OK" button on the computer to proceed. If you have any questions, please raise your hand.

Now, you can go ahead and play the video.

B.5 Additional instructions before the market in the second series of sessions

Now, you are going to participate in the formal trading periods. As a reminder, there will be 2 trading periods. Each period lasts 15 minutes. During each period, there will be a market open, in which you can buy and sell shares. Every trader is endowed with 3 shares AND 2250 francs. At the end of a trading period, every share you hold will pay you a dividend of 20, 44, 104, 200 francs, each with equal chance. The dividends will be added to your money balance automatically.

Your earnings in one period will equal the amount of money you have at the end of the period, after the dividends have been paid. Your total earnings will be the sum of your earnings in the two periods, plus your show-up fee.