The Effect of Prior Beliefs and Outcomes on Information Processing in an Investment Experiment

By

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April 16, 2007

Abstract

A number of behavioral finance theories (e.g., Daniel, et al. (1998)) posit that investors adhere to their beliefs about their investments in spite of new information. This paper reports the results of an investment experiment which shows that subjects' processing of information is biased by their prior beliefs in a manner that depends on prior investment outcomes. Specifically, their perception of new information is more strongly biased in favor of their prior preferred assets when they incur losses than gains. This asymmetric bias may help explain empirical patterns such as loser momentum and suggests modifications to models of biased belief persistence in markets.

JEL Classifications: D89; G19

Keywords: Experimental finance; Behavioral finance; Information processing; Confirmation Bias; Momentum

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Introduction

One of the main hypotheses of behavioral finance is that biased processing of information can lead to suboptimal investment behavior and anomalous market pricing.[1] Academic finance is now faced with the challenge of distinguishing between several potential explanations, both behavioral and rational, for these anomalies.[2] Laboratory experiments can help distinguish between competing explanations in that they permit the observation of variables that are unobserved in market data. For example, a number of investment experiments have attempted to directly observe inferences to study how overconfidence (Glaser, Langer, and Weber (2003)), representativeness (Bloomfield and Hales (2002)), and other sampling biases (Nelson, et al. (2001)) affect investment behavior and pricing.

Our experiment also observes inferences related to investments and, in particular, investigates how information processing is affected by prior beliefs and preferences. One motivation for studying this issue comes from behavioral finance theories which conjecture that investors adhere to their beliefs about assets in spite of new information. For example, the model of Daniel, Hirshleifer, and Subrahmanyam (1998) posits that the bias of favoring information that confirms prior beliefs over information that contradicts them leads to momentum in asset prices. This "confirmation" bias has been documented by cognitive psychologists in studies such as Lord, Ross, and Lepper (1979) which document how new information tends to reinforce prior opinions.[3] The theory of motivated reasoning in cognitive psychology also provides a framework for how beliefs

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1 Among the biases posited to influence financial investment are overconfidence, representativeness, conservatism, anchoring, confirmation bias, and availability. See Barberis and Thaler (2003) for a description of these biases and associated finance models.

2 Examples of explanations for anomaly such as momentum.

3 Daniel, Hirshleifer, and Subrahmanyam (1998) actually model self-attribution bias (i.e., attributing successes but not failures to one's ability), but confirmation bias is equivalent in their model in that it creates overreaction to confirming information and underreaction to disconfirming information. Our experiment focuses more on the perception of information and confirmation bias rather than the perception of self though we do make an attempt to study this issue in section 3.3.

and preferences affect information processing whereby people passively accept desirable information but actively scrutinize undesirable information in order to contradict it.[4] This asymmetry in how people collect and distort information based on its desirability was confirmed in an experimental accounting study by Hales (2006). Subjects in this experiment made earnings estimates which exhibited motivated reasoning in that they were more biased when they faced losses than gains in their investments in these companies.

In our experiment, subjects played a stock-picking game where they placed bets on which of two stocks would have a higher return in the subsequent week. Specifically, they allocated funds to a double-or-nothing bet that their chosen stock would outperform the other, and this game was played repeatedly over six weeks. We also asked subjects whether or not they had observed any new information regarding these stocks and if so, whether they would characterize this news as good, bad, or neutral.

We find that subjects' processing of information was distorted in favor of their prior beliefs and was more strongly biased when they incurred losses than gains; specifically, their perception of new information regarding their favored stock from the prior week became inflated when they lost the bet. For example, we find that subjects reported better news about their favored stock on average after losing the bet than after winning. In addition, they did not report their non-favored stock as having significantly better news than their favored stock when they lost the bet even though the non-favored stock had outperformed the favored. Finally, subjects observed information regarding these stocks more frequently after a loss than a win. These results indicate that subjects engaged in motivated reasoning in their information processing related to their favored stock, i.e., they actively observed and distorted new information about this stock more

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[4] See Kunda (1987, 1990), Ditto and Lopez (1992), Ditto, et al. (1998, 2003).

after an undesirable than after a desirable outcome. They did not seem to engage in this biased reasoning regarding the non-favored stock, however, indicating that that they framed their decision as choosing a good stock rather than avoiding a bad stock.

Finally, there is evidence that these biases affected not only stated perceptions but also investment behavior in our experiment. We find the surprising result that subjects had significantly greater probability of betting on their prior favored stock after a loss than after a gain. Hence, these stated perceptions did not simply represent "posturing" on the part of subjects to make themselves feel better in the face of a loss. Our study is the first to confirm that people are willing to make decisions with actual economic stakes based on distortions caused by motivated reasoning.

These findings are important because they indicate that models of biased belief persistence in investments need to be modified for this asymmetry in biases between wins and losses. In the model of Daniel, Hirshleifer, and Subrahmanyam (1998), for example, investors have a symmetric response to both desirable and undesirable information in the direction of their prior beliefs. In other words, they overreact to confirming information as much as they underreact to contradictory information, creating equal momentum in positive and negative return directions. Our results indicate that investors beliefs should be more persistent when losing money so that momentum ought to be stronger for loser than winner stocks. Several papers have documented the fact that momentum is driven primarily by persistence in losers (e.g., Chan (2003)). Though some studies have argued that this "loser momentum" persists because of short-sales contraints on arbitrageurs (e.g., Ali and Trombley (2006)), others argue that the profitability of momentum strategies remains economically significant even after accounting for these costs (e.g., Bushee and Raedy (2005)). Our results suggest that motivated reasoning in investments may also contribute to slow incorporation of information for loser stocks.

Our findings may help explain other empirical patterns as well such as the disposition effect since motivated reasoning should make investors more reluctant to

accept new information and less willing to sell off stocks after losses. Finally, this experiment suggests new predictions related to market patterns. For example, short-sellers ought to be more reluctant to accept good news than bad about their shorted stocks since this positive news causes them to lose money. Hence, one testable implication of our experimental results is that stocks with higher short interest should exhibit stronger momentum in the positive return direction as a result of short sellers' motivated reasoning.

The remainder of this paper proceeds as follows. Section 1 reviews the related literature. Section 2 outlines the experimental method and hypotheses. Section 3 describes our experimental results, and section 4 concludes.

1 Literature Review and Motivation

To date there are a number of experimental studies which characterize biased inferences and perceptions in a financial investment setting. Glaser, Langer, and Weber (2003) find that financial professionals are overconfident in estimating future confidence intervals of artificially generated price data but are underconfident in providing probability estimates of regimes. In a similar experimental setting, Bloomfield and Hales (2002) test the Barberis, Shleifer, and Vishny (1998) of representativeness and conservatism by asking subjects to forecast the next increment of a random walk. They confirm that investors overreact to changes preceded by a lack of reversals and underreact to changes preceded by a long period of reversals. Nelson, Bloomfield, Hales, and Libby (2001) characterize how information strength and weight impact inferences and confidence in financial markets. Their experimental findings are consistent with Griffin and Tversky (1992) in that subjects are excessively influenced by information strength and not enough by its weight. Other experimental studies analyze the impact of exogenous information on the

trading behavior of experimental subjects but do not directly observe individual inferences. For example, there are experiments which study the effect of informational frames on investment decision-making. Similarily, Kirchler, Maciejovsky, and Weber (2005) investigate the impact of framed "objectively irrelevant information" on individual investment behavior and find that trading behavior is consistent with the disposition effect.

No experiments have yet studied the persistence of prior beliefs in an investment setting in spite of evidence from experimental psychology of excessive adherence to such beliefs and financial market theories based on these biases. The principal behavioral theory of belief persistence in markets is that of Daniel, Hirshleifer, and Subrahmanyam (1998). Their model posits that the bias of favoring information that confirms prior beliefs over information that refutes them can lead to momentum in asset prices. There are also behavioral models of overconfidence (DHS (1998), Odean (1998)) and conservatism (Barberis, Shleifer, Vishny (1998)) where these biases lead to adherence to previously formed beliefs. This excessive adherence in turn leads to underreaction in asset prices to new information.

Belief persistence has been documented in experimental psychology in several forms, including confirmation bias and manifestations of motivated reasoning. Confirmation bias refers to the process whereby an individual interprets ambiguous evidence as confirmation of his or her hypothesis. This cognitive bias was first documented by Wason (1960) and has since been studied extensively in the psychology literature in the context of processing new information in formation of political opinions on the death penalty (Lord, Ross, and Lepper, 1979), the safety of nuclear technology (Plous, 1991), and the formation of social stereotypes (Darley and Gross, 1983). Motivated reasoning was first modeled theoretically by Kunda (1990) as the process by which personal

motivation influences the cognitive processes and representations utilized in order to obtain a desired conclusion. Since the initial work of Kunda (1990), several papers have studied applications and evidence of motivated reasoning. For example, Ditto and Lopez (1992) find that people are less critical, and more willing, to accept information which supports a desired or existing beliefs than information which is inconsistent with such beliefs. Redlawsk (2002), in a study of the individual political decision-making process, finds support for a conjecture put forth by Lodge and Taber (2000) that individuals expend both time and effort to counterargue information which is inconsistent with their personal beliefs. While motivated reasoning as a cognitive bias has become an integral part of the cognitive psychology literature, it has been scarcely studied in the behavioral finance literature.

Our paper is most closely related to that of Hales (2006), which studies motivated reasoning in an accounting environment. In his experiment, subjects forecast the earnings of an unknown NYSE firm in which they were given either a long or short position. Hales' analysis finds that subject forecasts were affected in a manner consistent with motivated reasoning. Namely, their forecasts were more biased, either upward to long positions and downward for short positions, when they faced a loss on their investment position than when they faced a gain. While our experiment studies similar issues, it differs in several important ways. First, Hales' experiment has an accounting orientation in that it studies the effect of exogenous preferences on reported inferences. Our experiment, in contrast, studies the effect of prior beliefs on subsequent inferences and choices in a pure investment setting where subjects have choice over their positions. Our dynamic investment game also allows us to study whether these stated perceptions affect actual investment behavior. It is conceivable that these perceptions could simply represent posturing by subjects to make themselves feel better in the face of a loss. The literature on belief persistence has yet to study whether subjects are willing to make

decisions based on these stated convictions. Our experiment allows us to study whether investment decisions and outcomes in one week influence both perceptions and investment behavior in the following week.

2 Experimental Design

2.1 Investment Game and Questions

Our experiment consisted of an investment game and related questions administered on a website and repeated each week over six weeks. In addition, subjects completed a one-time survey for their psychological and demographic characteristics. We performed the experiment twice, once in the fall semester from November 3 until December 14 of 2003 and once in the spring semester from March 1 until April 18 of 2004. There were 53 subjects in the fall and 101 subjects in the spring who played the game at least one week and 35 subjects in the fall and 74 in the spring who played all six weeks due to attrition in the game. All subjects were students in finance classes at Penn State University. Of these students, 142 undergraduates and 12 MBA students played at least one week and 99 undergraduates and 10 MBA's played all six weeks.

The investment game consisted of a portfolio allocation decision where subjects were each endowed with 1000 points ($10 USD), which they could allocate between two double-or-nothing bets and cash. The first bet was called the "stock bet" where subjects were given a pair of stocks and could bet on which of the two stocks would have a higher return in the subsequent week. If they picked the correct stock, they would double the money allocated to this bet. The "chance bet" served as a benchmark bet and was an i.i.d. double-or-nothing bet with a 50% chance of winning or losing, based upon the powerball lottery drawing of the subsequent week. Subjects could allocate their money in any way between these two bets and cash except that shortsales were restricted.

After subjects made their portfolio decisions, they answered a series of questions on the website. First, subjects were asked to provide their subjective probability that their favored stock would outperform the other to measure overconfidence in stock selection. If subjects allocated zero to the stock bet, they could answer "no opinion" to this question. Second, they were asked to characterize any new information they had observed in each stock with the following choices: good new information, bad new information, neutral new information, and no new information observed. Subjects were also asked to rate their mood and characterize it, but the objective of these questions was to study the impact of mood on trading. Screenshots of the website are provided at the end of the document.

We asked the subjects to play the game and answer these questions on our website each weekend (from Friday at 5 pm until Monday at 9 am) for six consecutive weeks. They bet on returns for the following market week from Monday at 9:30 am until Friday at 4 pm. Subjects could play anytime during the weekend, and their decisions were registered on Monday at 9 am. The website provided information on outcomes and earnings from prior weeks as well as links to the yahoo finance pages for the two stocks of the stock bet although there were no restrictions on information subjects could use. We paid subjects the sum of whatever they earned in the game from their bets and cash allocations each week in one lump sum after the end of the experiment.

The two stocks in each stock pair were matched to have similar risk characteristics in order to remove any differences in expected return or predictability in their relative returns. Specifically, the two stocks were in the same industry according to their 3-digit SIC code as well as the same quintile among CRSP stocks for their three-factor loadings and their three-factor squared residual based on regressions of monthly returns from the prior sixty months of available data.[5] There were 9 pairs in the fall study

5 Lo and Mackinlay (1988) find that the idiosyncratic component of risk is unpredictable (based on prior returns) for weekly returns.

and 9 pairs in the spring, which are listed in table 1. Each subject in this paper's sample was given the same pair of stocks to bet on every week.[6]

2.2 Hypotheses

The confirmation bias literature in psychology documents that people tend to believe that new information confirms their prior beliefs. Hence, we conjecture that subjects will perceive news as justifying their prior choice of stock:

> *H1*: Subjects will report news about their favored stock as being better than their unfavored stock from the previous week.

The literature on motivated reasoning says that people unthinkingly accept information that is consistent with their preferences and scrutinize information that is inconsistent. We conjecture, therefore, that subjects' processing of information will be dependent on whether they have won or lost the stock bet. If subjects process information rationally, they should perceive news for their favored stock as being better than for their non-favored stock when they win and vice versa when they lose. If subjects view this information skeptically when they lose, we predict that the former relationship will hold while the latter will not.

> *H2*: Subjects will report news about their favored stock as being better on average than their non-favored stock from the previous week if they won the stock bet, but will *not* report news about their non-favored stock as being better on average than their favored stock if they lost.

In addition, the quality of news for the favored stock ought to be better, on average, when the subject has won than when she has lost whereas the reverse is true for

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6 Another subsample was given an alternating pair, i.e., one pair on odd weeks and another pair on even weeks. We reserve this subsample to later address how information processing in one pair affects processing in the other.

the non-favored stock if information processing and observation is rational and impartial. If subjects exhibit motivated reasoning, however, their view of the favored stock should be inflated while their view of the non-favored stock should be deflated when they lose. Hence, we conjecture that neither of these rational relationships ought to be observed in our experiment:

H3: Subjects will *not* report news for their favored stock to be better, on average, if they won the stock bet than if they lost. Similarly, subjects will *not* report news for their non-favored stock to be worse, on average, if they won the stock bet than if they lost.

Motivated reasoning also predicts that subjects ought to scrutinize and examine information more when they have lost than when they have won. We conjecture, therefore, that:

H4: Subjects will observe more information in both stocks, on average, if they lost the stock bet than if they won.

3 Results

To study our hypotheses, we analyze the following measures of reported news quality and observation. The first variable measures whether or not information was observed for the favored and non-favored stock of the prior week, and the remainder measure the quality of news reported, if any:

- Obsfrequency_(non)favored: 1 if news observed for the (non-)favored stock for subject-week, 0 if news not observed
- Qualitynews_(non)favored: 1 if good news reported for the (non-)favored stock, 0 if neutral news, and -1 if bad news

- Goodnews_(non)favored: 1 if good news reported for the (non-)favored stock, 0 otherwise
- Badnews_(non)favored: 1 if bad news reported for the (non-)favored stock, 0 otherwise

In order to analyze our data involving repeated observations from the same subject, we first compute time-series averages of our dependent variables for each subject then compute cross-sectional averages across subjects. Our interest is in testing the hypotheses from section 2 by studying differences in averages of our dependent variables.

Table II presents summary statistics of both the portfolio allocation decision and the subject reported news quality and observations. As seen in Panel A, approximately half of the funds (48%) allocated during the experiment were invested in the stock bet, while the remainder was allocated in smaller amounts to the chance bet (21%) and the risk-less cash payout (31%).

3.1 Information Processing

Panel B presents summary statistics of the reported news quality and observation, the dependent variables of our analysis. This level of investing in the stock bet coupled with the fact that experiments subjects reported observing news regarding the favored and non-favored stock over 50% of the time (54.3% and 54.9% respectively) strengthen the validity of our experimental analysis. Experimental subjects have committed a significant portion of their experimental wealth to the stock bet and are actively collecting information relevant to the experiment. Finally, the majority of the news reports were characterized as good news for both the favored (61.4%) and the non-favored stocks (62.3%) whereas only a small fraction were characterized as bad news (7.6% for the favored and 9% for the non-favored stock).

We first study differences in perceptions and observations between the favored and non-favored stock in table III to address H1 and H2. Subjects' unconditional average reported news quality is better (they report both more good news and less bad news) for the favored stock than for the non-favored stock but not significantly so, indicating that any unconditional confirmation bias in our sample is weak. Our results do support H2, however, since subjects report significantly better news in the favored stock than the non-favored stock when they win but do not report significantly worse news when they lose. In fact, they actually report slightly more good news for the favored stock than for the non-favored stock when they lose (i.e., Goodnews_favored – Goodnews_nonfavored is positive though insignificant). This pattern is related to self-attribution bias or the tendency to attribute successes but not failures to one's ability. Namely, subjects view themselves as significantly outperforming a benchmark when they win but not significantly underperforming when they lose.

Table IV provides further evidence of motivated reasoning for the favored stock but not for the non-favored stock. Namely, subjects report news for their favored stock to be better when they lose the bet than when they win even though rational and impartial information processing dictates the opposite. We find no evidence of motivated reasoning for the non-favored stock, however, since subjects report news to be significantly better for this stock when they lose than when they win consistent with impartial data collection and rationality.

We believe that the absence of motivated reasoning for the non-favored stock indicates that subjects frame their decision as choosing a good stock rather than avoiding a bad one and consequently "care" more about the favored than the non-favored stock. One can see some evidence of this framing from table III where subjects observe more news about the favored than the non-favored stock when they lose, i.e., Obsfrequency_favored – Obsfrequency_nonfavored conditional on a loss is positive.

In addition, we examine whether reported news in sensitive to actual news as proxied by [impounded in] the return on the stock that week. Differences in average reported quality of news between positive and negative returns are reported in table V. One can see that reported news quality for the non-favored stock is sensitive to returns since subjects report significantly better news (both significantly more good and less bad news) for positive than for negative returns. Reported news quality for the favored stock, however, is not sensitive to returns since they do not report significantly better news for positive than for negative returns (and in fact report more slightly more bad news for positive than for negative returns). This insensitivity appears to result from the fact that subjects inflate their view of the favored stock and ignore relevant disconfirming information when they lose the bet.

From table IV, we see support for H4 or increased scrutiny when subjects lose the bet as a result of motivated reasoning. Namely, subjects observe more information for the favored stock when they lose than when they win, i.e., Obsfrequency_favored conditional on a win minus conditional on a loss is negative and statistically significant at p=4.85%. For the non-favored stock, subjects also observe more news when they lose than when they win, though this difference is statistically insignificant. Finally, we examine whether or not subjects' inflated view of the favored stock for a loss is a result of data collection or interpretation. In other words, are subjects selectively collecting better news when they lose or simply experiencing distorted perceptions of this news? To this end, we study whether subjects collect more good (positive return) news and less bad (negative return) for the favored stock when they lose. Table IV shows no evidence for this hypothesis. Namely, subjects collect only insignificantly more positive return news and actually collect significantly *more* negative return news when they lose versus when they win. We conclude, therefore, any apparent motivated reasoning is caused by distortions in data interpretation and not collection.

3.2 Betting Persistence

Our results beg the question of whether subjects' distorted reports of news actually influence investment behavior. We have found that their perception of news for the favored stock is inflated when they lose, but does this stated perception make them more likely to choose the same stock in the next period?

3.3 Self-Attribution Bias

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4 Discussion and Conclusion

We have found that information processing for investments is affected by prior dispositions toward assets and that perceptions become biased when investors suffer losses, consistent with the concept of motivated reasoning from psychology. In addition, these biases affect not only stated perceptions but also investment behavior. There are a number of implications that can be extracted from our findings. First, we found that subjects exhibited motivated reasoning only for their favored and not for their non-favored stock. We conjecture, therefore, that investors do not feel the same attachments toward assets that are avoided as for positions that are chosen or actively sought. Hence, investors will not exhibit the same cognitive biases for stocks sold as with stocks bought or actively sold short.

Our results may help explain certain documented patterns in markets and also suggest new predictions related to those patterns. For example, motivated reasoning in investments may help explain investors' propensity to hold on to loser stocks, i.e., the disposition effect. Our results indicate that the disposition effect may not simply be a product of intrinsic preferences, but may also reflect a bias in inferences resulting from an [excessive] attachment to prior beliefs. If this idea is indeed valid, one would expect to

see investor's exhibit greater disposition effect when they invest more in information to form these beliefs [and consequently form greater attachment to their beliefs/inferences].

As mentioned in the introduction, our results may also be related to the fact that momentum is stronger for loser stocks than for winner stocks. Although there is some evidence that short-sales constraints contribute to momentum in stock returns (e.g., Ali and Trombley (2005)), several studies find that these costs do not fully account for the profitability of momentum strategies (e.g., Bushee and Raedy (2005)). Our results suggest that loser momentum may not be caused entirely by short-sales constraints, but that motivated reasoning may also contribute to slow incorporation of information for loser stocks. If our hypothesis is true, short-sellers should be reluctant to accept good news about their investments because it causes them to lose money. One way of testing this hypothesis, therefore, is to determine whether stocks with high short interest have momentum in the positive return direction.

Overall our findings suggest not only empirical predictions, but also modifications to existing theories of biases in investments. For example, the model of Daniel, Hirshleifer, and Subrahmanyam (1998) ought to be adjusted for the fact that biased belief persistence is more substantial when investors lose money, which would enrich the model's predictions. There may also be some hope of eventually connecting behavioral models of preferences that generate the disposition effect (e.g., Barberis and Xiong (2006)) to behavioral models of biased inferences in a single framework since our findings indicate that the same psychological drivers may be generating both.

Table I

Experimental Stock Pairs

Stock Pairs represent the 17 possible pairs of stocks presented to experimental subjects during the portfolio allocation decision. *Stock Pairs* were generated by matching the two stocks by three-factor loadings, idiosyncratic volatility, and 3-digit SIC code.

Stock Pair	Stock A	Stock B
1	Dell	Apple
2	Texas Instruments	Cisco
3	Kellogg	Ralcorp
4	Exxon Mobil	Chevron Mobil
5	Wal Mart	BJ's Wholesale
6	Southwest Airlines	Fedex Corp
7	Bristol-Myers Squibb	Alberto Culver Co
8	Knight-Ridder	Scripps E.W. Co
9	Ruby Tuesday	Applebee's
10	Deswell Industries	Tupperware
11	Yellow Corp	USA Truck
12	Coors Adolph	Diageo
13	Corning	Scientific Atlanta
14	Vodafone	Nippon Tel
15	Sportsline Com	Identix
16	Mercury Interactive	Siebel Systems
17	Wendy's Intl.	Ryan's Family Steakhouse

Table II
Summary Statistics

Panel A presents summary statistics of portfolio allocation variables. *Stock* is the average amount allocated to the "stock bet", *Chance* is the average amount allocated to the "chance bet", and *Cash* denotes the average amount allocated to the riskless cash payout. *Panel B* presents summary statistics of reported news quality and observations. Obs-(non)fav has value 1 if news was observed for the (non-)favored stock and value 0 otherwise. News-(non)fav has value 1 if good news was reported for the (non-)favored stock, value 0 if neutral news was reported, and value -1 if bad news was reported. Good-(non)fav has value 1 if good news was reported for the (non-)favored stock and value 0 otherwise. Bad-(non)fav has value 1 if bad news was reported for the (non)favored stock and value 0 otherwise. For both panels, *N* refers to the number of subject observations.

Panel A: Portfolio Allocation Decisions

Variable	N	Mean	Standard Deviation	Min	Max
Stock	147	484.3	295.6	0	1000
Chance	147	209.6	207.5	0	1000
Cash	147	306.1	319.4	0	1000

Panel B: Reported News Quality and Observation

Variable	N	Mean	Standard Deviation	Min	Max
Obs-fav	124	0.543	0.431	0	1
Obs-nonfav	124	0.549	0.445	0	1
News-fav	85	0.538	0.508	-1	1
News-nonfav	80	0.533	0.511	-1	1
Good-fav	85	0.614	0.392	0	1

Panel B Continued: Reported News Quality and Observation

Variable	N	Mean	Standard Deviation	Min	Max
Good-nonfav	80	0.623	0.391	0	1
Bad-fav	85	0.076	0.207	0	1
Bad-nonfav	80	0.09	0.203	0	1

Table III
Differences in Information Processing between Favored and Non-favored Stocks

This table presents unconditional and state conditional differences in perception between favored and non-favored stocks. *Qualitynews_favored – Qualitynews_nonfavored* represents the mean difference in reported news between the favored and non-favored stock. *Goodnews_favored – Goodnews_nonfavored* represents the mean difference in good news reported for the favored and non-favored stock. *Badnews_favored – Badnews_nonfavored* represents the mean difference in bad news reported for the favored and non-favored stock. *Obsfrequency_favored – Obsfrequency_nonfavored* represents the mean difference in news being observed reported for the favored and non-favored stock. *State* is conditioning variables for which each difference variable is recalculated. *Win* includes all observations where the favored stock outperformed the non-favored stock. *Loss* includes all observations where the non-favored stock outperformed the favored stock. *Positive* and *Negative* denote the respective returns of the favored and non-favored stocks.

Variable	Unconditional	Win	Loss	Positive	Negative
Qualitynews_favored – Qualitynews_nonfavored	0.04 (0.351)	0.11* (0.091)	-0.01 (0.815)	-0.07 (0.165)	0.14** (0.046)
Goodnews_favored – Goodnews_nonfavored	0.02 (0.530)	0.07* (0.082)	0.01 (0.832)	-0.05 (0.194)	0.07 (0.139)
Badnews_favored – Badnews_nonfavored	-0.02 (0.321)	-0.04 (0.319)	0.02 (0.342)	0.02 (0.412)	-0.07* (0.057)
Obsfrequency_favored – Obsfrequency_nonfavored	-0.01 (0.482)	-0.03 (0.331)	0.04 (0.144)	-0.03 (0.314)	-0.03 (0.476)

*,**, *** denotes significance at the 10%, 5% and 1% level respectively

Table IV
Differences in Information Processing between Wins and Losses

Table IV presents differences in perception variables between *Win* and *Lose* states.

Variable	Win - Loss	Win - Loss | Positive returns	Win - Loss | Negative returns
Qualitynews_favored	-0.1997**	-0.3594***	-0.2045
	(0.0137)	(0.0032)	(0.1512)
Goodnews_favored	-0.1384**	-0.2865***	-0.1364
	(0.0323)	(0.0035)	(0.2599)
Badnews_favored	0.0613*	0.0729	0.0682
	(0.0548)	(0.1353)	(0.1615)
Qualitynews_nonfavored	-0.3415***	-0.3636***	0.0333
	(0.0001)	(0.0003)	(0.8525)
Goodnews_nonfavored	-0.2516***	-0.2980***	-0.0111
	(0.0000)	(0.0002)	(0.9136)
Badnews_nonfavored	0.0899**	0.0657*	-0.0444
	(0.0365)	(0.0820)	(0.6679)
Obsfrequency_favored	-0.0844**	-0.0741	-0.1325*
	(0.0485)	(0.1959)	(0.0852)
Obsfrequency_nonfavored	-0.0053	-0.0417	-0.0577
	(0.8911)	(0.4163)	(0.4367)

*,**, *** denotes significance at the 10%, 5% and 1% level respectively

Table V
Differences in Information Processing between Positive and Negative Returns

Table V presents differences in perception variables between *Positive* and *Negative return* states.

Variable	Positive - Negative	Positive - Negative | Win	Positive - Negative | Loss
Qualitynews_favored	0.0442 (0.2069)	0.0263 (0.4153)	0.1290* (0.0726)
Goodnews_favored	0.0493 (0.1486)	0.0614 (0.3147)	0.1129** (0.0384)
Badnews_favored	0.0051 (0.3888)	0.0351* (0.0674)	-0.0161 (0.3268)
Qualitynews_nonfavored	0.2753*** (0.0001)	0.1607* (0.0855)	0.1000 (0.1119)
Goodnews_nonfavored	0.1726*** (0.0007)	0.1071 (0.1084)	0.0600 (0.2074)
Badnews_nonfavored	-0.1027*** (0.0026)	-0.0536 (0.1715)	-0.0400 (0.1537)
Obsfrequency_favored	-0.0228 (0.5615)	0.0570 (0.3898)	-0.0244 (0.6825)
Obsfrequency_nonfavored	-0.0299 (0.3626)	-0.0326 (0.5469)	0.0156 (0.7048)

*,**, *** denotes significance at the 10%, 5% and 1% level respectively

Table VI
Betting Persistence

TO BE ADDED

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