The Journal of Psychology and Financial Markets
2002, Vol. 3, No. 4, 218–226

"Buy on the Rumor:" Anticipatory Affect and Investor Behavior

Richard L. Peterson

This article demonstrates a relationship between investor psychology and security pricing around anticipated events. Taking a multidisciplinary approach, we pull together research in the finance, psychology, and neuroscience literature. Event studies in the finance literature demonstrate anomalous security (stock, commodity, bond, or option) price movements around the dates of anticipated events. From the neuroscience literature we demonstrate correlations between reward anticipation and the arousal of affect (feelings, emotions, moods, attitudes, and preferences). From the cognitive psychology literature we extract evidence for the central role of affect in motivating investing behavior. We briefly outline an investment strategy for exploiting the event-related security price pattern described by the trading strategy "buy on the rumor and sell on the news."

The trader aphorism "buy on the rumor and sell on the news" (BRSN) describes a strategy for exploiting a frequently observed financial market price pattern. BRSN is characterized by security prices rising prior to and falling subsequent to positively anticipated events. Security prices are, paradoxically, often observed to decline following an event outcome that is equal to or better than "expectations." We argue that investor expectations of rewarding event outcomes are inflated by a neuro-affective biasing process. A disproportionate number of positively anticipated events will yield disappointing event outcomes.

Investors often gamble on both an event outcome and on the anticipated price appreciation of that outcome. Anticipation of reward generates a positive affect state, which motivates increased risk-taking and purchasing behaviors. As the anticipated potential reward approaches in time, investors' positive affect is increasingly aroused. Following delivery of the expected reward, investors' affect regresses to neutral. This post-event net decrease in positive affect leads to more risk-averse, protective investing behaviors such as selling (corresponding with the new, less positive, affect state).

Many investors are not aware that a positive event outcome does not necessarily cause security price appreciation. Their high levels of risk exposure may surprise naive investors when the euphoric affect that guided the accumulation of their high-risk positions dissipates following the event. Their diminished euphoria motivates increased caution (risk aversion) and investment repositioning (selling) of high-risk positions. In this market environment, a general increase in selling causes negative price pressure. But price decline alone increases investors' negative affect and risk aversion.

Several technical considerations are relevant to this discussion. There is often a price impact from news about future security-related events. According to the efficient market theory, investors quickly price security-relevant news. For the BRSN pattern to represent price inefficiency, the news about the event must have a delayed impact on investing behavior. We do not have sufficient documentation to validate the existence of the BRSN pattern as an anomaly. We generalize statistical evidence of event-related anomalies from other studies to support our model. And we do not discuss cognitive biases here. For descriptions of individual judgment biases inconsistent with rational decision-making, (Hilton [2001], Shiller [1998], and Kahneman and Riepe [1998]). We use research directly linking affect states to behavior. To simplify, we refer to anxiety and depression as negative affect states and to euphoria and relief as positive affect states.

This article is structured as follows. We discuss the movements of Apple Computer Inc.'s stock (AAPL) around its MacWorld trade shows and the rise and fall of the Chinese B-share markets in early 2001 to provide illustrative evidence of the BRSN pattern in a variety of market situations. We review pricing anomalies related to a general conformity in investor behavior such as under- and overreaction. We explain the effects of anticipatory affect on cognitive judgment and decision-making. After integrating psychology and neuroscience research findings with reward anticipation and pursuit, we attribute the BRSN pattern to the influence of anticipatory affect and disappointment on investor behavior. Finally, we briefly outline a hypothetical investment strategy for exploiting the BRSN pattern.

Richard Peterson is a psychiatric resident at San Mateo County Health Center and director of Marketpsych.com.

Requests for reprints should be sent to: Richard L. Peterson, M.D., Psychiatry Resident, San Mateo County Health Center, 222 W. 39th Ave., San Mateo, CA 94403. Email: Richard@Peterson.net

BRSN Examples

There are a surprising variety of both securities and events with which to illustrate the BRSN pattern. First we demonstrate a BRSN pattern surrounding Apple Computer Inc.'s (AAPL) MacWorld trade show on January 7, 2002. Next we demonstrate the remarkable price appreciation prior to and the price fall subsequent to the deregulation of the Chinese B-share markets in June 2001. Barberis and Thaler [2001] and Dreman [2001] discuss another striking example of the BRSN pattern, the Palm Inc. spin-off from 3Com Inc. in March 2000. The BRSN pattern is also seen in Pixar Inc. stock around the studio's movie releases (Tam [2001]).

AAPL often demonstrates a BRSN pattern around its trade shows. The following excerpt is from a *Wall Street Journal* article on January 3, 2002, four days before Apple's anticipated new iMac unveiling at the 2002 MacWorld trade show:

The Cupertino, California, company's stock increasingly has been caught in a strange cycle: In recent years, the shares have run up strongly in advance of product debuts —and declined thereafter. In a December study from Morgan Stanley, analyst Gillian Munson found that in three of five cases after Apple launched a new computer since 1997, its shares slipped. Of those three occasions, the stock fell an average 19% in the ensuing six months, she noted.

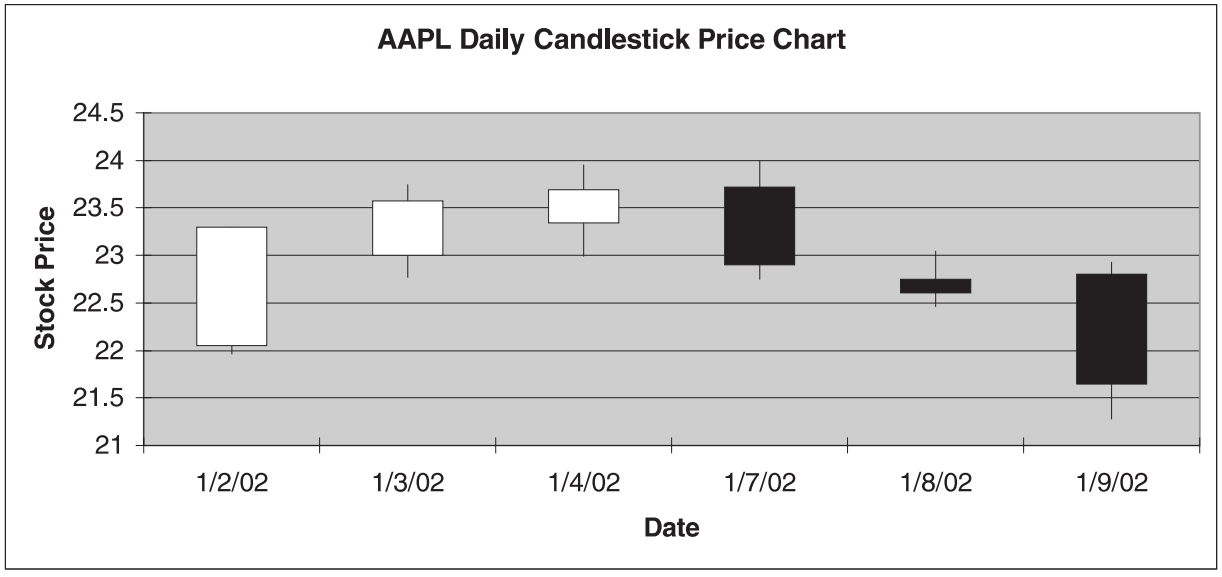
This time around, the peculiar pattern could well be happening again. Apple's shares have risen steadily in recent weeks, from just under $15 in early October, driven at least in part by anticipation of new products at Macworld. At 4 p.m. Wednesday in Nasdaq Stock Market trading, the shares were up a healthy $1.40, or 6.39%, at $23.30 (Tam [2002]).

Figure 1 is an AAPL six-day price chart that shows the BRSN pattern. *AAPL shares reached a six-week high* on Monday, January 7, 2002, the morning of the new iMac release, and declined more than 15% in the five days following the trade show. *The Wall Street Journal* article describing this situational BRSN pattern for AAPL shares did not prompt adequate arbitrage to inhibit the pattern from recurring.

Another large-scale BRSN pattern developed in the spring and summer of 2001 in the Chinese B-share stock markets. Historically, the Chinese B-share markets were reserved for foreign investors (and their U.S. dollars). The Chinese A-share markets were open to local investors (and their yuan). The B-share markets were undervalued compared to the A-share markets. In fact, shares on the B-share markets typically traded for between one-half and one-fifth their price on the A-share markets as of mid-February 2001. The Chinese government announced on February 19, 2001, that it would deregulate the B-share markets on June 1. CNN.com, on February 20, 2001, hailed the move, and predicted great profits for B-market investors ("China B-Market Move Hailed by Analysts" [2001]).

"This is an extremely positive step," says Merrill Lynch chief economist Andy Xie. "It's going to significantly boost trading volumes and liquidity, and it will encourage investors to arbitrage in the markets, which will lead to much greater efficiency." Xie says there is $60 billion held in bank deposits in China, which is unable to be traded because of the former restrictions [dollars only in B-share markets]. He adds that the B-share market is worth just $8 billion and has only 114 firms listed on its boards —many of them poor quality — while the A-share market is worth closer to $600 billion ("China B-Market Move Hailed by Analysts" [2001]).

FIGURE 1
Daily AAPL Price Chart (Open, High, Low, Close) From January 2 to January 9, 2002.



The Chinese markets were the world's best performing in 2000 ("China…" [2001]). Many Chinese investors were flush with cash and optimistic about their economic future. The consequences of $60 billion potentially flowing into a market capitalized at $8 billion are enormous. The risks of such a market deregulation were largely unknown and there was little global experience with such a situation. Via arbitrage, the flood of money into the B-share market should have equalized the share prices of companies trading on both the A and B markets, raising the B shares and lowering the A shares.

But as June 1 approached, the B-share indices (Shanghai and Shenzhen) appreciated rapidly. Figure 2 is a daily closing price chart depicting the Shanghai B-share index. Both the Shanghai and Shenzhen B-share indices reached their all-time highs during the first fifteen minutes of trading on June 1, 2001. Expectations of quick profit were too high, however, and investor disappointment led to B-share selling that continued for several months. Figure 2 depicts three months of pre-event stock index rises and post-event declines that illustrate the classic BRSN pattern.

BRSN Evidence

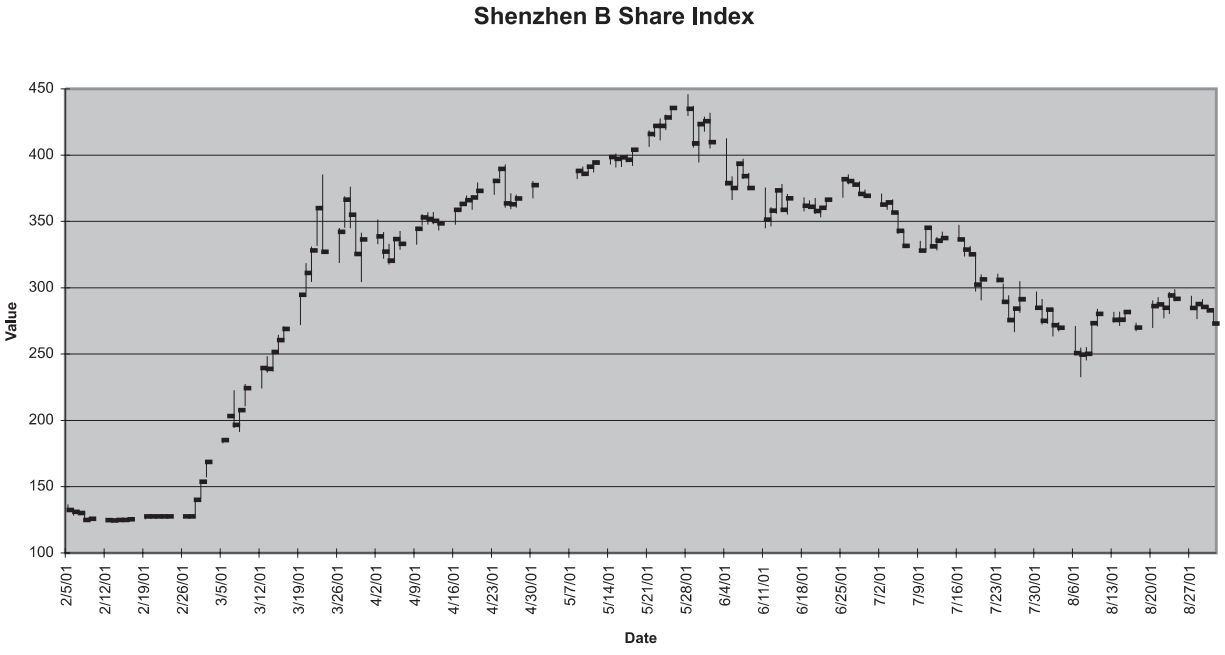
Recent research shows periods of non-random price movements in the financial markets around security-related events. Comprehensive reviews of asset pricing anomalies are available in Hirshleifer [2001] and Barberis and Thaler [2001]. A review of studies documenting event-related market inefficiencies (specifically under- and overreaction) is found in Daniel, Hirshleifer, and Subrahmanyam [1998].

Most event studies analyze data from unexpected rather than expected events. Trueman, Wong, and Zhang [2001] analyze a large sample of positively anticipated earnings announcements. The authors focused on security price movements around the earnings releases of 393 Internet firms over 1,875 firm quarters between January 1998 and August 2000 (the height of the Internet stock bubble). They showed that purchasing an Internet stock five days before its earnings release, and then selling it at the open the day after the release yielded an average market-adjusted return of 4.9%. Shorting the same stock at the open the day after its earnings release yielded 6.4% when the short was covered at the market close five days later.

Unexpected Events: Under- and Overreaction

Market anomalies with neuro-affective causality similar to the BRSN pattern are documented in the literature on under- and overreaction and momentum anomalies. We argue that investor event anticipation arouses the innate neural networks governing reward pursuit. An unexpected event does not predictably activate this network. We believe that consistently anomalous security price movements following unexpected events indicate an undefined neuro-affective process related to surprise. In event studies of surprising unex-

FIGURE 2
Daily Closing Price of the Shenzhen B-Share Index From February 5, 2001 Through August 31, 2001.



pected events, under- and overreactions to news shocks are well-documented.

Psychological models of the overreaction, underreaction, and momentum anomalies are common. Barberis, Shleifer, and Vishny [1998] formulate a model of security price over- and underreaction to information when investor judgment is biased by conservatism and the representativeness heuristic. Daniel, Hirshleifer, and Subrahmanyam [1998] explain event-related security price anomalies according to the cognitive biases of investor overconfidence and self-attribution. Daniel and Titman [2000] explain the superior returns of a momentum investing strategy over the past thirty-five years as the result of investors' overconfidence bias. Dreman and Lufkin [2000] present evidence that investor under- and overreaction exist and are part of the same psychological process. And, finally, Shiller [1998] suggests that descriptions of over- and underreaction are not likely to be good psychological foundations for a general theory of economic behavior, as cognitive biases don't identify the behavioral motivations that cause price anomalies.

Behavioral Conformity

This section discusses the influence of investor behavior on price movement. Stereotyped investor behaviors emerge out of innate neural networks. Groupwide anticipatory affect induces conformity in investment strategies (e.g., the timing of buying and selling), which minimizes mathematical complexity in security prices and contributes to price trends. We discuss evidence for this type of herding behavior during price trend formation.

Oxford mathematicians Johnson et al. [2001] developed a contrarian trading strategy that bet against the directional trading activity of the majority of market agents in the USD/yen forex market during the preceding hour. In their experiment, they closed their position at the end of the subsequent hour, obtaining an approximately 54% prediction success rate from 1990 to 1999. This simple strategy of betting against the price pressure from the previous hour yields statistically non-random accuracy. Chan [2001] found that a large stock price change, unsupported by news, on average was followed by a statistically anomalous price trend reversal over the next month. Both studies illustrate the price trend reversals that often occur when a majority of market agents follow the same investing strategy unsupported by new information.

Similar investing behaviors cause unilateral price pressure and initiate a price trend. Empirical data from studies with MBA students confirm a behavioral tendency to reinforce existing price trends (Schacter et al. [1987]). Individuals in this study increased their purchasing behavior during a market uptrend, but increased their selling behavior when given up-to-date information demonstrating an approximately 25% trend reversal. Both the price trend prior to an event and the post-event trend reversal are reinforced. This study does not explain the psychological mechanisms behind the students' irrational behavior, but it does show the behaviors that reinforce price trends and accelerate brief reversals.

Statistical support for the idea of a general conformity in investor behavior preceding price trend reversals ("contrarianism") comes from Johnson et al. [2001] (on an hourly) and Chan [2001] (on a monthly) basis. Johnson et al. [2001] demonstrate mathematically the behavioral conformity observed by Schacter et al. [1987].

Barberis and Thaler [2001] provide compelling evidence that investors make irrational forecasts of future cash flows. If excessive optimism or pessimism is driving these forecasts, however, earnings announcement dates should provide the impetus for correction. They find anomalous corrective activity following earnings announcements from these companies.

Seasonal and weather factors also seem to contribute to conformity in investor behavior. One common finding shows that cloud cover, as a proxy for negative mood states, reduces purchasing behavior. Hirshleifer and Shumway [2001] find that cloud cover in the city of a major stock exchange is correlated with low daily stock index returns in twenty-six national exchanges (also see Saunders [1993]). Kamstra, Kramer, and Levi [2000a] show that disrupted sleep patterns after transitions to and from daylight savings time are also related to stock returns. Kamstra, Kramer, and Levi [2000b] find that stock returns are significantly related to season, and suggest that deterministic variations in the length of day contribute to this finding.

Affect and Decision-Making

Understanding the affective basis of investing behavior provides insight into the origins of security price trends and reversals. Since behavior arises from judgment and decision-making processes, we examine research into the affective basis of decision-making. Judgment and decision-making are traditionally considered to be consequentialist processes in the social science literature (e.g., expected utility theory). Consequentialism assumes that decision-makers assess the consequences of possible alternatives before deciding on a course of action. Research in the field of cognitive psychology demonstrates systematic irrationalities in human judgment and decision-making inconsistent with consequentialism, however (see citations in Hilton [2001], Shiller [1998], and Kahneman and Riepe [1998], for examples).

But we eschew a general discussion of the cognitive basis of judgment and decision-making here, as it is well documented in recent research (see Loewenstein et al. [2001], Mellers, Schwartz, and Ritov [1999], and Mellers et al. [1997]). Affective models of decision-making such as decision affect theory (Mellers et al. [1997]) or the risk-as-feelings hypothesis (Loewenstein et al. [2001]) considerably expand upon expected utility theory.

Anticipatory affect refers to those immediate, visceral reactions to perceived risk, uncertainty, or potential reward (Loewenstein et al. [2001]). Loewenstein et al. note that feelings about risk and cognitive risk perceptions often diverge. Cognitive assessments of risk tend to focus on both probabilities of possible outcomes and assessments of possible outcome severity. In risky situations anticipatory affective reactions often exert a dominant influence on behavior (over cognition). In addition, emotions often produce behavioral responses that depart from what individuals view as the best course of action.

According to Loewenstein et al. [2001], affective assessments of risk and potential reward are impacted by three factors: the vividness with which consequences can be imagined, personal exposure to or experience with outcomes, and a past history of conditioning. These affective assessments of risk are modified by the time course of the decision, the vividness and associations the risky scenario induces, and one's evolutionary preparedness for certain emotional reactions.

Loewenstein et al. also suggest that fear or worry in the face of risky decisions may be the result of the *possibility* rather than the *probability* of negative consequences. This is because the vividness of a potential reward or catastrophe is more affectively arousing than the probability of it actually occurring. For example, the thought of receiving an electric shock is more emotionally arousing than the actual likelihood of it happening.

Over distant time perspectives, choices reflect a rational preference for a reward according to a log-linear discount rate (Winston and Woodbury [1991]). Myopic discounting refers to the tendency to increasingly favor small proximate rewards over large distant rewards as the time for the small reward approaches. This is because the event is regarded more positively and its rewards pursued more aggressively (hyperbolically) as its time nears. Gray [1999] demonstrates that myopic discounting also occurs during the avoidance of punishment (preference for a larger distant punishment).

Investors deal with the possibilities of loss and reward daily, and must cognitively assess outcome probability and potential severity. Affectively, investors feel possible outcomes more acutely if they are more vivid or imaginable. The vividly imagined possibility of imminently achievable wealth and material success in an impulsive and inexperienced investor will lead to a strong drive to invest in (or buy) the associated security. Likewise, the vividly imagined possibility of personal poverty or market panic will generate the desire to sell. All investors experience the impact of their affect on their behavior, but experienced investors are more likely to cognitively assuage their affect-driven behavioral impulses.

Expectations and Anticipatory Affect

We now examine the role of anticipatory affect in biasing investor expectations. Anticipation is generally studied in relation to single expected events of uncertain outcome (such as a gamble). Anticipation of reward generates a positive affect state, and affect biases decision-making. Frustration of expectations induces negative affect, which incites risk-averse, protective behaviors (such as closing investment positions).

MacGregor et al. [2000] find that subjective affect and imagery influence judgment in predicting industry group financial performance. They speculate that affect and imagery may be the only reliable judgmental bases when information about a financial offering is vague, and so vague information about alternatives may lead to heavier reliance on affective assessments.

Evidence from the psychology literature indicates that both desiring and expecting an outcome biases memory retrieval and actual memories (McDonald and Hirt [1997]). Participants prompted to expect an undesired outcome gave no weight to the expectancy in recall and seemed to actively attempt to refute the implications by recalling inconsistent information more accurately. BRSN may be such a consistent pattern because it represents a powerful correlation between our desires (security price appreciation) and our expectations (imminent monetary reward). When expectations and desires are synchronized, dissonant perceptions arouse mental defense mechanisms to guard against anxiety.

Mellers, Schwartz, and Ritov [1999] discovered that individuals can accurately forecast the emotions they will feel after either outcome of a gamble. Investors may correctly anticipate how they will feel if the outcome of an investment is negative, but they may not be aware of or they may deny the potential difficulty in controlling their behavior when that outcome arouses strong reactive affect states.

McDonald and Hirt [1997] report that affective preference correlates with self-forecasts of investing behavior. Mellers et al. [1997] find that gamblers typically use the strategy of selecting the monetary gamble associated with the better expected feeling. People prefer the gamble that, on average, gives them the greatest emotional satisfaction (Mellers, Schwartz, and Ritov [1999]). There is evidence that affective preferences

drive buying and selling behaviors as well (van Raaij, van Veldhoven, and Warneryd [1988]). Anticipation of security-related reward induces positive affect. Investors are thus predisposed to invest in securities they feel good about and for which they can anticipate a rewarding future event.

Reward Pursuit

Recent neuroscience and neuro-imaging literature demonstrates the arousal of brain regions associated with affect during the anticipation of punishment or reward. The brain's affective reward centers generate the subjective positive emotions associated with reward. The negative emotions associated with punishment are generated by the affective punishment centers. Affect arousal is proportional to the size (quantity) of the anticipated reward and the desire for the reward (Miller and Cohen [2001]).

The behaviors generating the BRSN patterns in the markets may have unconscious affective origins. Information can be cognitively analyzed at an emotional/affective level without reaching awareness (Amini et al. [1996]). Knutson et al. [2001] found subcortical localization of affect states during brain scans in subjects offered monetary reward incentives. Conscious awareness of activity in biological affective centers is often limited to vague subjective experiences of "feelings." During anticipation of monetary reward, the brain's affective circuits may direct behavior independently from awareness and cognitive control.

During laboratory gambling experiments, the brain's affective centers are responsive to changes in both the size and probability of a potential reward. Changes in the size (quantity) of a potential reward or punishment are more emotionally activating than proportional changes in the probability of receiving the reward or punishment (Miller and Cohen [2001]). The activity of the affective centers in functional MRIs increases proportionally to the size of anticipated rewards or punishments (see Breiter et al. [2001] and O'Doherty et al. [2001]).

Increasing the size of an anticipated monetary reward leads to both higher self-reported pre-reward ratings of "happiness" and increased affective reward center activity in the brain (Knutson et al. [2001]). Miller and Cohen [2001] found that the desire for the reward also increases affect arousal proportionally.

Mellers et al. [1997] designed experiments to measure individual affect states after a gamble. In the first series of experiments, the authors measured emotional response to receiving a cash reward or punishment. They found that as the probability of receiving a monetary reward *decreased*, the level of expressed elation when receiving the reward *increased*. The inverse was true for punishments. They also found that surprising wins are more elating than expected wins, and surprising losses are more disappointing than expected losses (Mellers, Schwartz, and Ritov [1999]).

Neuro-imaging demonstrates the difference in affective arousal between expected and unexpected monetary gain. The affective centers of the brain show no increased activity from the baseline upon receipt of a monetary reward if the subject has been conditioned to expect it (Schultz, Dayan, and Montague [1997], Berns et al. [2001], Miller and Cohen [2001], and Suri and Schultz [2001]). A signal of imminent delivery of the reward will arouse positive affect, but the delivery of the expected reward itself will not change the affect state (Spanagel and Weiss [1999]). As a subjective correlate to these observations, Mellers et al. [1997] found that the reported experience of elation when receiving a reward is decreased if the reward was expected.

Suri and Schultz [2001] found that an *unexpected* cue signaling the imminent delivery of an unexpected reward is as affect-arousing as the delivery of the unexpected reward itself. We conclude that unexpected news of a positive security-related event is affectively arousing, but, again, occurrence of the event itself is less so.

Interestingly, when a conditioned stimulus (cue) is delivered but is not followed by the expected reward, then the brain shows *inhibited* activity (decreased dopaminergic neuronal firing) in the reward-oriented neural circuitry at the precise time the reward was expected to occur (Schultz, Dayan, and Montague [1997]).

Positive affect drives purchasing behavior (van Raaij, van Veldhoven, and Warneryd [1988]). We assert that the reduction of positive affect (secondary to termination of positive anticipatory affect after expected reward delivery) will lead to decreased purchasing (from its pre-event, positive affect-induced level). Following an expected event outcome and in the absence of proximate good news to anticipate, any decrement in affect state will prompt post-event *selling* behavior.

Disappointment

In the first half of the BRSN scenario, some informational cue is circulating among investors heralding the future occurrence of a positive event (the reward). Receiving this cue generates a positive emotional reaction in investors. Positive affect both biases outcome probability assessments and incites investors (particularly inexperienced ones) to gamble on the event outcome. The use of inflated probability assessments (expectations) of potential reward predisposes investors to post-event disappointment.

Gray [1971] did research on the affective and physiological experiences related to the absence of an ex-

pected reward ("frustrated expectations"). Gray found that, in rats, the physiological signs of frustrated expectations are identical to those of punishment. Rats' behavioral and physiological changes indicated a profound anxiety or fear state when they did not receive a stimulus-cued reward of the same size that they had been conditioned to expect. Gray noted that delivering a food reward smaller than expected induced an anxiety state, even if the reward was more than the rats were capable of eating. A parallel affect state (anxiety) may exist in investors when their bloated event expectations are not met, even when an event outcome is positive overall for the security. This secondary anxiety from "not-as-good-as-expected" news may contribute to post-event selling behavior.

Mellers et al. [1997] demonstrate the negative affect induced when a monetary gain is less than expected. They discovered that in 50/50 gambles, gains can be disappointing if a greater gain has been missed, and losses elating if a larger loss has been avoided. Perceptions and framing effects determine the resulting affect state of the participants. Positive affective responses result from the outcome being greater than the anticipated gain. Neutral or negative reactions follow if the outcome is equal to or worse than the highest anticipated gain.

Since many security investors are, in fact, gambling on the security price when they invest prior to a potentially rewarding security-related event, negative post-event security price movement (even in the case of better-than-expected event outcomes) will lead to disappointment and predispose investors to sell.

When the expected event outcome occurs, no affect is aroused. Anticipatory positive affect vanishes at the time of reward delivery, thus there is a net decrease in positive affect state to a more neutral level. Isen [1990] reports that positive affect increases risk-taking behaviors when possible negative consequences are not prominent in the decision frame. Assuming that positive affect and risk-taking increase proportionally, we assert that a decrease in positive affect will decrease risk-taking behaviors and increase fiscal conservatism. These shifts motivate readjustment of the portfolio to accommodate the new (decreased) risk tolerance. Any decline in affect state increases cognitive awareness of risks and leads to portfolio readjustment within parameters of individual risk tolerance.

Event Selection

Investor anticipation of loss or reward is often reflected in behavior. Our BRSN-based investment strategy relies on a collection of both qualitative and quantitative indicators. Qualitatively, we look for an event with vivid potential consequences (e.g., a blockbuster new product) and the possibility of a large reward for investors. We would prefer that the event and its potential rewards be well-known among naïve, inexperienced investors. Ideally, the event would stand out as offering unique opportunities and rewards without obvious risks. Media reports should highlight the positive opportunity embodied in the event and pay little attention to the potential downside.

Quantitatively, we wait to observe market-adjusted positive price movements prior to the event. Sustained positive price pressure indicates buying in anticipation of the event. If the buying accelerates as the event approaches, then we have evidence of myopic discounting and affect-driven buying. Securities with high ratios of short interest are vulnerable to short squeezes during this pre-event period. Option premiums and volume often increase anomalously prior to the event.

Events that are anticipated in security prices include earnings reports, product releases, trade show presentations, and FDA meetings. On a global scale, national elections, government economic and commodity data releases, Federal Reserve Board announcements, government policy decisions, and G7 or OPEC policy statements may incite anticipatory and reactive security price movements.

To ensure that the probability for pre-event price rise and post-event price decline is high, we need to find a security-related event that meets all of our criteria (summarized below):

- A vivid and easily imagined potential reward.
- Wide public recognition of the potential reward.
- Minimal dissemination of information about the event's risks.
- Minimal investor conditioning to or experience with the event's risks.
- Representation as a relatively novel and unique phenomenon.
- No other salient security-related events in the peri-event period.
- Acceleration of upward price movement as the event approaches.
- Above-average security trading volume.

Two strategies can be followed to exploit the BRSN pattern. The comprehensive strategy includes buying the security before the positively anticipated event. If a positive market-adjusted price movement occurs, we enter a long position. The security can then be sold immediately prior to the event and shorted immediately following the event. But a simpler strategy is to forgo pre-event purchasing and just to short the security immediately following the event. By staying out of the market during the event, unnecessary risk is eliminated.

As a rule of thumb, the number of days of anomalous price increases prior to the event is generally equivalent to the number of days of anomalous price declines following the event. One should cover the

post-event short position for the same period of time that the security had anomalously risen (market-adjusted) prior to the event. We recommend diversification while following this strategy, because many attempts to profit from the BRSN pattern fail. BRSN is frequently referenced in hindsight, and exploiting it is not easy.

Discussion

The first task of this article was to present examples of and statistical evidence for repeating, anomalous security price movements surrounding anticipated events. We use the aphorism "buy on the rumor and sell on the news" (BRSN) to describe this pattern. We discuss the role of affect in driving investment behavior and biasing expectations, and outline a strategy for identifying and exploiting investors' event-related expectations in the markets.

We also explain the relevance of recent research in finance (event studies and overreaction), mathematics (price reversals and complexity), psychology (affect and decision-making), and neuroscience (anticipation and expectancy) to our model of BRSN. Johnson et al. [2001] demonstrate a correlation between investor behavior and repeating patterns in the financial markets. We cite evidence that affect directs the formation of expectancies and subsequent behavior during the anticipation of reward from monetary gambles, and thus link investors' emotional states to their investment behavior.

Individual events provide a temporal anchor upon which expectations are based. Information has a greater behavioral impact if it is about the near future, has a strongly positive or negative affective quality, is well-known, and has easily visualized potential consequences (Loewenstein et al. [2001]). As an anticipated event approaches in time, awareness of its positive or negative implications increases. Anticipation of probable reward also generates positive affect, which increases investors' risk-taking and purchasing behaviors. Positive affect exaggerates probability estimates of rewarding outcomes. Exaggerated security-related event expectations, when disappointed, precipitate selling.

Occurrence of the anticipated rewarding event decreases an investor's affect state from positive (during reward anticipation) to neutral. This reduction of affect may prompt risk aversion regarding current portfolio weightings, which may have been accumulated while in a positive affect state. Secondary to decreased positive affect, investors may also be driven by a renewed sense of risk aversion to sell excess shares, thus culling risk exposure. Negative price movements lead to anxiety and negative affect in investors, which accelerates risk-averse, protective behaviors.

When the prepared investor is aware of the anticipatory affect surrounding an upcoming event (see the criteria above) and observes an affect-driven price change prior to the event, a BRSN-exploiting investment strategy may be implemented. It is possible that an inverse of the BRSN phenomenon may be found around negatively anticipated events as well. We would expect negative future events with the possibility of large, vividly perceived losses to be preceded by security selling and followed by security buying. There is, however, evidence in Isen [1990] that negative affect has a different influence on cognition than positive affect, so a separate model will likely be necessary to exploit negatively anticipated events.

Because of the large variety of qualitatively similar events that fit our model, it is difficult to gather comprehensive data to test our hypothesis. We assume that the behavior of individuals in simulated stock markets or monetary incentive tasks mirrors that of investors in real-time capital markets. But much data remains to be gathered. The psychological anomalies identified by behavioral finance remain largely unapplied to hedge fund or institutional investment strategies, although there are some institutional exceptions.

Fama [1998] states that finding a workable alternative model to market efficiency is a "daunting task." Such a model would have to specify biases in information processing that cause the same investors to underreact to some types of events and overreact to others. Shiller [1998] suggests that the psychological theories underlying behavioral finance cannot be simplified to the form requested by Fama. In answer to both Fama and Shiller, we suggest that investor affect is the substrate of biased information processing during the anticipation of loss or reward. We further suggest that the brain's affect-oriented neural circuitry is the etiology of many of the stereotyped "irrational" biases identified in the psychology and finance literature. There are sufficient data from event studies of discrete, affectively weighted, anticipated events to illustrate our theory in the financial markets.

We suggest that mathematical descriptions of individual cognitive biases are not useful in forming a comprehensive new paradigm for economic judgment and decision-making. A more systematic neuro-anatomical approach toward clarifying the affective processes biasing judgment and decision-making is needed. We suspect, as do others (Blakeslee [2002]), that affect-based models of judgment and decision-making from neuroscience research will be integral to a generalizable model of economic decision-making.

Acknowledgments

Special thanks to Zhaohui Zhang, Richard Peterson (Sr), Flavia Cymbalista, Ernest Barratt, Alan Louie,

Lou Fleurant, Martin Auster, and Ruth Levine for their suggestions and encouragement.

References

Amini, F., T. Lewis, R. Lannon, A. Louie, G. Baumbacher, T. McGuiness, and E.Z. Schiff. "Affect, Attachment, Memory: Contributions Toward Psychobiologic Integration." *Psychiatry*, 59, (1996), pp. 213–237.

Barberis, N., A. Shleifer, and R. Vishny. "A Model of Investor Sentiment." *Journal of Financial Economics*, 49, (1998), pp. 307–343.

Barberis, N., and R. Thaler. "A Survey of Behavioral Finance." *Handbook of the Economics of Finance*, 2001. First draft of a paper commissioned for this handbook.

Berns, G., S. McClure, G. Pagnoni, and P. Montague. "Predictability Modulates Human Brain Response to Reward." *Journal of Neuroscience*, 21, (2001), pp. 2793–2798.

Blakeslee, Sandra. "Hijacking the Brain Circuits with a Nickel Slot Machine." *The New York Times on the Web*, February 19, 2002.

Breiter, H., I. Aharon, D. Kahneman, A. Dale, and P. Shizgal. "Functional Imaging of Neural Responses to Expectancy and Experience of Monetary Gains and Losses." *Neuron*, 30, (2001), pp. 619–639.

Chan, W.S. "Stock Price Reaction to News and No-News: Drift and Reversal after Headlines." NBER Working Paper Series, 2001.

"China B-Market Move Hailed by Analysts." *CNN.com*, February 20, 2001.

Daniel, K., D. Hirshleifer, and A. Subrahmanyam. "Investor Psychology and Security Market Under- and Overreactions." *Journal of Finance*, 53, (1998), pp. 1839–1886.

Daniel, K., and S. Titman. "Market Efficiency in an Irrational World." NBER Working Paper Series, 2000.

Dreman, D. "Financial Bubbles: Avoiding Their Pitfalls and Maximizing Opportunities." The Institute of Psychology and Markets Conference, New York, New York, October 2001.

Dreman, D., and E. Lufkin. "Investor Overreaction: Evidence that Its Basis is Psychological." *Journal of Psychology and Financial Markets*, 1, (2000), pp. 61–75.

Fama, E.F. "Market Efficiency, Long-Term Returns, and Behavioral Finance." *Journal of Financial Economics*, 49, (1998), pp. 283–306.

Gray, J.A. *The Psychology of Fear and Stress*. New York: McGraw-Hill, 1971.

Gray, J.R. "A Bias Toward Short-Term Thinking in Threat-Related Negative Emotional States." *Personality and Social Psychology Bulletin*, 25, (1999), pp. 65–75.

Hilton, D.J. "The Psychology of Financial Decision-Making: Applications to Trading, Dealing, and Investment Analysis." *Journal of Psychology and Financial Markets*, 2, (2001), pp. 37–53.

Hirshleifer, D. "Investor Psychology and Asset Pricing." *Journal of Finance*, 4, (2001), pp. 1548–1597.

Hirshleifer, D., and T. Shumway. (2001). "Good Day Sunshine: Stock Returns and the Weather." Working paper 2001–3, Ohio State University, 2001.

Isen, A.M. "Positive Affect and Decision Making." In B.S. Moore and A.M. Isen, eds., *Affect and Social Behavior (Studies in Emotion and Social Interaction)*. Cambridge: Cambridge University Press, 1990.

Johnson, N., D. Lamper, P. Jeffries, M. Hart, and S. Howison. "Predictability of Financial Time-Series Using Multi-Agent Games." Oxford University, 2001.

Kahneman, D., and M.W. Riepe. "Aspects of Investor Psychology." *Journal of Portfolio Management*, 24, (1998), pp. 52–65.

Kamstra, M.J., L.A. Kramer, and M.D. Levi. "Losing Sleep at the Market: The Daylight Savings Anomaly." *American Economic Review*, 90, (2000a), pp. 1005–1011.

Kamstra, M.J., L.A. Kramer, and M.D. Levi. "Winter Blues: Seasonal Affective Disorder (SAD), the January Effect, and Stock Market Returns." Working paper, Faculty of Commerce, University of British Columbia, 2000b.

Knutson, B., C.M. Adams, G.W. Fong, and D. Hommer. "Anticipation of Increasing Monetary Reward Selectively Recruits Nucleus Accumbens." *Journal of Neuroscience*, 21, RC159, (2001), pp. 1–5.

Loewenstein, C.K., G.F. Loewenstein, E.U. Weber, and N. Welch. "Risk as Feelings." *Psychological Bulletin*, 2, (2001), pp. 267–286.

MacGregor, D.G., P. Slovic, D. Dreman, and M. Berry. "Imagery, Affect, and Financial Judgment." *Journal of Psychology and Financial Markets*, 1, (2000), pp. 104–110.

McDonald, H.E., and E.R. Hirt. "When Expectancy Meets Desire: Motivational Effects in Reconstructive Memory." *Journal of Personality and Social Psychology*, 72, (1997), pp. 5–23.

Mellers, B.A., A. Schwartz, K. Ho, and I. Ritov. "Decision Affect Theory: Emotional Reactions to the Outcomes of Risky Options." *Psychological Science*, 8, (1997), pp. 423–429.

Mellers, B.A., A. Schwartz, and I. Ritov. "Emotion-Based Choice." *Journal of Experimental Psychology*, 128, (1999), pp. 332–345.

Miller, E.K., and J.D. Cohen. "An Integrative Theory of Prefrontal Cortex Function." *Annual Review of Neuroscience*, 24, 2001, pp. 167–202.

O'Doherty, J., M. Kringlebach, E. Rolls, J. Hornak, and C. Anders. "Abstract Reward and Punishment Representations in the Human Orbitofrontal Cortex." *Nature Neuroscience*, 4, (2001), pp. 95–102.

Saunders, E.M.J. "Stock Prices and Wall Street Weather." *American Economic Review*, 83, (1993), pp. 1337–1345.

Schacter, S., R. Oulette, B. Whittle, and W. Gerin. "Effects of Trend and of Profit or Loss on the Tendency to Sell Stock." *Basic and Applied Social Psychology*, 8, (1987), pp. 259–271.

Schultz, W., P. Dayan, and P.R. Montague. "A Neural Substrate of Prediction and Reward." *Science*, 275, (1997), pp. 1593–1599.

Shiller, R.J. "Human Behavior and the Efficiency of the Financial System." NBER Working Paper Series, 1998.

Spanagel, R., and F. Weiss. "The Dopamine Hypothesis of Reward: Past and Current Status." *Trends in Neurosciences*, 22, (1999), pp. 521–527.

Suri, R.E., and W. Schultz. "Temporal Difference Model Reproduces Anticipatory Neural Activity." *Neural Computation*, 13, (2001), pp. 841–862.

Tam, Pui-Wing. "Apple's Stock May Tumble After New Products Debut." *The Wall Street Journal Online*, January 3, 2002.

Tam, Pui-Wing. "Pixar Takes Investors on Rocky Ride: Studio's Shares Rise Before Release of Films, Then Decline." *The Asian Wall Street Journal*, November 7, (2001), p. M1.

Trueman, B., F.M.H. Wong, and X.-J. Zhang. "Anomalous Stock Returns Around Internet Firms' Earnings Announcements." *Journal of Accounting Research*, 2001.

van Raaij, F., G. van Veldhoven, and K.E. Warneryd. *Handbook of Economic Psychology.* Kluwer Academic Publishers, 1988.

Winston, G., and R. Woodbury. "Myopic Discounting: Empirical Evidence." *Handbook of Behavioral Economics*, 2B, (1991), pp. 325–345.