Investment Opportunities Offered by Investor Emotions

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Abstract:

Recent research suggests that investor emotions influence security pricing. Taking advantage of the insights provided by these studies, we construct several investment strategies to determine whether information on emotions can be used to generate investment outperformance. We identify strategies that are highly profitable, even after taking account of the transactions costs and risks associated with implementation. While emotions can be used to outperform the market, our findings suggest that emotions have a contemporaneous influence on security prices. This brings into question whether market valuations truly reflect the valuation of the firm.

Keywords: Emotions, Investment Strategy, Investor Decision Making, Earnings Announcement; Asset Pricing

JEL Classification: G4, G14

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Recent research suggests that investor emotions influence security pricing. Taking advantage of the insights provided by these studies, we construct several investment strategies to determine whether information on emotions can be used to generate investment outperformance. We identify strategies that are highly profitable, even after taking account of the transactions costs and risks associated with implementation. While emotions can be used to outperform the market, our findings suggest that emotions have a contemporaneous influence on security prices. This brings into question whether market valuations truly reflect the valuation of the firm.

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1. Introduction

A common route to new investment ideas is that an academic(s) undertakes research into the association between some market, firm or investor characteristic and future stock returns. Depending on the findings, this subsequently results in the characteristic being incorporated into the investment strategy of portfolio managers. As an example, legend has it that the establishment of the first small-cap mutual fund was a direct result of an early presentation of the first study that identified a small-cap (i.e., illiquidity) premium (Banz, 1981). One investor characteristic that has only recently become the focus of analysis is investor emotions. This has been fuelled by the release in 2012 of accessible (and now subscription-based) data on investor emotions[1]. Of particular interest are the findings of Bird et al. (2023a, 2023b), which suggest that investor emotions have a continual influence on stock prices and provide insights into how emotions might be exploited in an investment strategy.

This study explores how investor emotions influence stock prices with the objective of determining whether such insights provided can be incorporated into investment strategies that yield profitable outcomes. Four valuable insights are derived from our analysis. First, it strengthens our understanding of how emotions impact individuals when making investment decisions. Second, it provides a direct test of Fama's (1965a, 1965b, 1970) seminal Efficient Market Hypotheses (EMH) - as an efficient market precludes being able to use available information to generate excess returns. Third, it provides important insights into how investors react when making pricing errors that have major implications for our understanding of the efficiency of markets over time. Fourth, it provides evidence of major economic interest to investment professionals as to how they might exploit the opportunities presented by human emotions (and other contributing factors related to asset mispricing).

Our primary finding is that information on investor emotions can be used to generate sizable investment outperformance, even after allowance is made for implementation costs and the risks introduced into investment portfolios. Our findings suggest a link between emotions and asset pricing, revealing how investors are influenced by their environment in a way that raises questions about the true efficiency of markets. Finally, our findings will also be of interest to investors as they are suggestive of opportunities to predict future movement in stock prices.

This study is structured as follows. The next section discusses emotions and how they influence investor decision-making. Section 3 outlines the data and research design. In Section 4, we develop and measure

[1] In 2012 Thomson Reuters launched version one of the MarketPsych Indices providing emotions data on companies reported on a minute-by-minute, hourly, and daily basis, based on analysis of the social and news media.

the performance of various investment strategies based on what we know to date about how emotions influence investor decision-making. The final section provides summary comments that highlight both the extent and nature of the mispricings caused by emotions.

2. Emotions and Investor Decisions

Over the last several decades, many studies have been conducted that analyze how individual traits influence investor behavior and asset pricing. One of the most discussed traits studied over this period has been sentiment, with DeLong et al. (1990) being the first to raise the possibility of investor behavior being influenced by sentiment. Baker and Wurgler (2006) and Tetlock et al. (2008), using different approaches for estimating sentiment, showed that their measure had a discernible influence on the valuation of individual firms and the market. Mian and Sakarguruswamy (2012), using the Baker and Wurgler (2016) sentiment measure; Seok et al. (2019) using South Korean data, and Karampatsas et al. (2023), using a measure for sentiment derived from Tweets, all found that sentiment impacted on how investors responded to earnings news.

The more recent interest in the influence of emotions on asset pricing has been facilitated by computing advancements better enabling the identification of emotions from the textual analysis of written documents. A prime example of this being the Thomson Reuters MarketPsych Indices (TRMI), which provide a comprehensive data base on a range of emotions that individual holds with respect to specific firms gathered from textual analysis undertaken of postings on the news and social media. The existence of this data has enabled researchers to extend their interest beyond sentiment to examine the influence that emotions have on investor behavior. However, the finance literature remains muddled as to the distinction between the two, and frequently uses the words interchangeably in their scholarly articles. For example, the Griffith et al. (2019) study, despite basing their analysis on the TRMI emotions data, frequently switches between using the words sentiment and emotions when discussing their findings. This confusion is at variance with the behavioral science literature, where it is well established that emotions *and* sentiment are quite distinct behavioral traits. Two important differences being emotions has a much shorter duration, but a much greater intensity, than sentiment. Emotions tend to spike over very short periods, whereas sentiment tends to trend for several months (Bird et al., 2023a). Emotions are typically more intense than sentiment and so more difficult to suppress when making decisions largely because emotions operate at a subconscious level (Stets, 2006). However, it also should be recognised that the two are not totally independent. Indeed, it is well recognised in advertising that creating a series of positive emotions towards a product will contribute to creating a much longer-lasting positive sentiment towards the product. Hence, emotions might be best viewed as causing short-term blimps around a sentiment trend line but also being one of many contributing factors to the shape of

that trend line. The fact that there are many contributors to sentiment can be gleaned from the various sentiment measures in the finance literature. Baker and Wurgler (2006) based their sentiment measure on financial metrics; Shumway (2010) used economic variables to proxy for sentiment, while Hengelbrock et al. (2013) derived their measure of sentiment from survey data. The diversity of these measures is evident with none of them directly incorporate emotions as one of the contributing factors- (Sibley et al., 2016)

To understand the contribution of this paper, it is critical to recognise that emotions and sentiment are distinct personal traits, each of which has its own characteristics (e.g., Rapp 2019). Consequently, it would be a mistake to assume that the accumulated findings as to how sentiment impacts on investor decision making equally applies to the association between emotions and investor behavior. In recent years, we have witnessed an increasing interest in the link between emotions and asset prices. Griffith et al. (2019) used a VAR framework with TRMI data for a limited number of emotions and found that they have a small impact on prices. Using the Chinese stock market bubble as a background, Taffler et al. (2022) highlight the link between emotions experienced by investors and stock market performance in the boom/bust cycle of an asset price bubble. Vamossy (2021) measured average emotions in the 10 days leading up to earning news announcements and found that high emotions before the announcement often lead to a reversal in the announcement period. In a recent study, Cao et al. (2023) showed that an index that measures anger, "reliably" predicts index futures returns.

By far, the most comprehensive analysis on emotion and asset prices are two recent studies by Bird et al. (2023a, 2023b) which examined `both the direct impact that emotions have on asset prices and the indirect impact that they have through the influence that emotions have on how investors react to new information. Their model is illustrated in Exhibit 1. The first of their two studies examines the influence of emotions on asset prices around the time of an earnings announcement. Their research considers four types of positive (+) emotions, five types of negative (-) emotions, the aggregate of the positive emotions, the aggregate of the negative emotions, and the overall aggregate of the nine emotions[2].

They find strong evidence to suggest, in the case of the direct channel, that both the level and changes in the levels of positive (negative) aggregated emotions have a positive (negative) influence on asset prices. Furthermore, they found that positive emotions amplify the effect of favourable earnings news, while negative emotions diminish their impact. Additionally, each positive individual emotion—particularly optimism and joy—mirrors the influence of aggregated positive emotions. In contrast,

[2] The four positive emotions are optimism, joy, trust, and love/hate, while the five negative emotions are stress, gloom, fear, anger, and conflict.

stress and gloom are the primary negative emotions affecting investor behavior, with fear exerting minimal impact. The study conclusively shows that emotions are crucial in shaping investor behavior and influencing asset prices.

<<INSERT EXHIBIT 1>>

In their second paper, Bird et al. (2023b) considers the role of emotions in influencing asset prices in the period between quarterly earnings announcements. They examine the extent to which the level of emotions at the time of the announcement and/or the path taken by emotions in the post-announcement period, play a role in determining the behavior of asset prices in the period after the earnings announcement. They find that the path taken by emotions during the post-announcement period plays a major role in influencing asset prices during this period. This result is an important finding, as it brings into question both the profitability of an investment strategy solely based on the level of emotions at the time of an information release, and the extent to which one can rely upon the Post-Earnings Announcement Drift (PEAD) as the basis for a profitable investment strategy. In our paper, we investigate whether these insights can be used to develop a profitable investment strategy that reveals the extent to which mispricings are driven by emotions.

3. Data and Research Design

The sample period extends from the beginning of 1998 to the end of 2017, with the constituent universe of stocks restricted to those included in the S&P 500 Index. The information regarding actual earnings and financial analysts' earnings forecasts is gathered from the I/B/E/S database. Unexpected earnings are calculated by subtracting the median analyst earnings per share forecast available immediately before the release of an earnings announcement from the announced earnings per share and then scaling the difference by the announced earnings per share. If unexpected earnings are equal or greater than zero, then it is classified as good news and if it is negative, it is classified as bad news. The accounting data, including reported earnings, is obtained from the CRSP/COMPUSTAT merged database and sourced through WRDS. The return and price data for the equity market were obtained from CRSP and sourced through WRDS.

We source data on the nine individual emotions from the Thomson Reuters MarketPsych Indices (TRMI) database[3], and we construct three additional emotion measures: aggregate positive emotions, aggregate negative emotions, and aggregate emotions (which is the sum of the positives and negatives). Several studies have already confirmed the effectiveness and accuracy of this database. For example, Michaelides et al. (2015) found that variation of the TRMI metrics matched the data of manually

[3] For a more detailed discussion of the TRMI DATA, see Bird et al. (2023a).

collected sovereign downgrade news. In a separate study, Michaelides et al. (2019) further confirms that the TRMI sentiment index is consistent with manually constructed foreign currency (FX) -related news.

TRMI data is obtained by scanning two million social media sites (e.g., Yahoo! Finance, Stock twits, Blogger, Seeking Alpha, Google News) and 50,000 professional news sites (e.g., *The Wall Street Journal*, *The New York Times*, and *The Financial Times)*. Each posting on these sites is screened to determine its financial relevance to the company to which it relates. If it passes this filter, the posting is processed using the TRMI's linguistic software to determine how much (if anything) it contributes towards the score for each emotion for each individual company. This process results in a score for each of the nine emotions calculated on a minute-by-minute basis from each of the social and news media.

4. Investment Trading Strategies and Performance

When developing the investment strategy, we focus on the two studies above that have examined the impact that emotions have on security valuations both around the time of the release of earnings news and during the post-announcement period. Bird et al. (2023a) found that the extent to which investors would respond to both good and bad earnings news is conditioned by the emotions prevailing at the time of the information release. Importantly, their findings suggest that low positive (negative) emotions will likely dampen investors' response to good (bad) earnings news. An obvious strategy to exploit any resulting mispricings is to purchase shares in companies where there is likely to be an underreaction to a good earnings announcement and to short shares in those companies where there is likely to be an underreaction to a poor earnings announcement. The expectation being to benefit from a subsequent correction to the initial underreaction. Hence the first investment strategy (Emotions1) that we test is:

- Purchase shares in a company that announces good earnings news at a time when positive emotions relating to company are at a low and reverse the transaction after 60 trading days.
- Sell (short) shares in a company that announces poor earnings news at a time when negative emotions are at a low and reverse the transaction after 60 trading days.

Bird et al. (2023b) extends their work to examine how emotions influence the movement in security valuations in the period after the earnings announcement. In many ways, this is the more interesting from an investment strategy perspective, as we want to predict future stock price movements. The success of the Emotions1 strategy depends on a correction to an initial underreaction, which should suggest that the level of emotions at the time of the earnings announcement, should play a key role in

explaining the future path taken by share prices. Specifically, this would suggest that a low positive (negative) emotion at the time of the release of a good (bad) earnings announcement would be associated with an upward (downward) drift in security valuations during the post-announcement period.

Bird et al. (2023b) explored how the trajectory of emotions following earnings announcements influences stock valuations. They discovered that it is this emotional trajectory during the post-announcement period rather than the emotional state at the time of the announcement, that provides the greater insights into future asset price movements. This insight is crucial as it challenges the profitability of our Emotions1 strategy and indicates that any effective strategy must consider future emotional trends. Predicting these trends is challenging, requiring understanding future emotional dynamics to forecast stock price behavior effectively. We will outline our approach to addressing this complexity as we refine our strategy.

4.1 Where does this leave us with the development of an investment strategy?

There are two major insights from the two studies discussed earlier:

- The *level* of emotion at the time of the earnings announcement affects how investors react to earnings news at the time of the announcement.
- The *change* in emotions over the post-announcement period influences the path taken by stock valuations during this period.

Armed with these insights, we commence the pursuit of devising a profitable investment strategy based on emotions by calculating the performance of an initial three investment strategies. Before proceeding further, it is important to explain the portfolio construction process applied in the case of all the strategies evaluated in this paper. In the case of each of the strategies evaluated (except for the Benchmark strategy), transactions are generated daily and are assumed to take place at the end of the trading day at which time the trades occur to ensure an equal investment in each stock held in the portfolio at the beginning of the next trading day. Hence the daily return for each portfolio is the average of the returns for the day realized by the stocks held at the beginning of the day.

In Table 1, we report the returns for each of our initial three strategies which are described below:

1. We start with what we refer to as our benchmark strategy (Benchmark) which is one that is not influenced by any information relating to either the nature of the earnings announcements nor details relating to the level of emotions. We hold two offsetting portfolios – one being an equally weighted portfolio including all stocks in the S&P500 universe and the other being a short

position also equally weighted of the same universe of stocks.[4] The net return will be zero as the return on the two portfolios will offset each other, resulting in the return on the long-short benchmark strategy being 0%. However, the returns on the two portfolios provide a useful benchmark when assessing the performance of each of our subsequent strategies[5]. In Table 1 we report the annualized returns for the long portfolios being 11.78%, and for the short portfolios being -11.78%.

<<INSERT TABLE 1>>

2. We then progress to the earnings strategy (Earnings), which incorporates information about the nature of the earnings announcements, but excludes any information about emotions. In this case we again construct both a long portfolio and short portfolio. Stocks enter the long portfolio at a time when they release good earnings news and are sold after being held for 60 trading days. Similarly, stocks enter the short portfolio when they release bad earnings news and are held for the duration of 60 trading days. The annualized returns for this strategy are also reported in Table 1. We observe that the returns for good news are much higher than the case for the equivalent benchmark portfolios, while for bad news, they are lower than for those for the benchmark strategy. Both findings are consistent with the post-earnings announcement literature that finds a continuing drift in stock valuations after the announcement (i.e., PEAD). A strategy of purchasing shares in companies with good earnings news and shorting stocks with bad earnings news (and then reversing the positions after 60 trading days[6]) realises a weighted annualized return of 17.01%.[7] However, an even more striking finding is that the annualized return increases to 20.90% if the strategy is restricted to only trading in stocks with "high" good and "high" bad earnings news.[8] By focusing our strategy exclusively on stocks that exhibit the most extreme earnings surprises, we enhance the annualized performance by nearly 4%. This finding offers crucial insights for developing a subsequent investment strategy that incorporates emotions.

[4] This is equivalent in taking a long position in the S&P 500 Equal Weight Total Return Index and a short position for the same index.

[5] There is no well accepted theory to determine the optimal holding period. Initially, we adopt a holding period of 60 trading days (or approximately 3 months in terms of trading days), which also aligns with the approximate interval between quarterly earnings announcements, as noted in Bird et al. (2023b). Later in the paper we consider alternative holding periods that are more aligned with evidence on the behavior of emotions during the post-announcement period.

[6] We first divide both the positive (good news) and negative (bad news) unexpected earnings into All, Above (high)- and Below (low)-median at the time of the announcement. We avoid the look-ahead bias by only using data from past announcements when specifying the medians.

[7] The long portfolio (Good News All) has annualized returns of 17.58% while the short portfolio (Bad News All) has annualized returns of -10.83%. Not reported in Table 1, we calculate the weighted return on the long-short portfolio as 17.01%. For an explanation of the calculation of weighted returns of a long-short portfolio, please refer to Peterson (2016).

[8] In this case, the annualized long portfolio return is 21.31% while the annualized short portfolio return is -10.21%. Not reported in Table 1, the calculate the weighted return for the long-short portfolio as 20.90%.

3. We introduced emotions into our investment strategy for the first time by modifying the Earnings strategy to incorporate information relating to emotions as we have previously described in the Emotions1 strategy. This adjustment leverages the observation that good earnings news often receives an underwhelming market response when released at a time when positive emotions are low. Specifically, we now only buy stocks that release positive earnings news if at the time their positive emotions are in the bottom quartile. Conversely, we only short stocks of companies that announce negative earnings when their negative emotions at the announcement are also in the bottom quartile. In both scenarios, we reverse the trades after 60 trading days. This strategy (Emotions1) produces a weighted annualized return from the long-short strategy of 20.06%[9], which is almost 1% less than the return achieved by the equivalent Earnings strategy that incorporates no information on emotions (20.90%). This finding is important, as it confirms that simply incorporating information on the level of emotions at the time of the earnings announcement adds nothing to the investment performance. This finding suggests that one cannot rely on the market necessarily correcting for any underreaction to an earnings announcement. As we continue to integrate data on emotions into our investment strategy in various ways, we will gain deeper insights into how emotions influence asset prices over time. In addition, this analysis will provide us with valuable insights into the nature of PEAD, highlighting that the path it takes at the individual stock level will be conditioned by the path taken by emotions.

The evidence suggests that we cannot simply rely on information on the level of emotions at the time of an earnings announcement as the basis for developing a profitable investment strategy. However, we have yet to incorporate into our strategies anything that flows from the finding that it is the path that emotions take during the post-announcement period that influences the path stock prices take during this period. This is a challenge as at the time of the announcement the future path that emotion will take is unknown and so it is not possible to incorporate them into any buy decision. However, we do gain from the important insight that emotions tend to spike and then quickly return to normal levels which suggests that the impact that emotions on pricing will be much shorter than the 60-day holding period included in our Emotions1 strategy. This suggest that we can benefit from a sell signal where we reverse the initial transaction after we have an indication that the spike in emotions has largely ran its course Hence, we incorporated a trigger as an extension of the Emotions1 strategy to capitalise on this behavior which reverses trades before the end of the 60-day holding period if the emotion score changes by more than a set threshold. This threshold is determined by a applying a specific percentage of the standard

[9] The return on the long portfolio (Good News High) is 20.74% while that on the short portfolio (Bad News High) is -7.31%. Not reported in Table 1, this results in a weighted return calculation for the long-short portfolio being 20.06%.

deviation in the emotion score's movement. The signal that we initially use to trigger the earlier reversal of the transaction is that a stock will be sold/bought back if the emotion score moves by an amount equal to 100% of the standard deviation of the emotions score.[10] We describe this as the Emotions2 strategy, which is detailed below:

The Emotions2 strategy for the long portfolio then becomes:

> *Buy a stock at the time of a positive unexpected earnings announcement if, at that time, its positive emotions score is in the bottom quartile. Reverse this trade either when the emotions score has moved up by an amount equal to the standard deviation of the positive emotion score, or after 60-trading days, whichever occurs first.*

The Emotions2 strategy for the short portfolio is similar:

> *Short stocks at the time of a negative unexpected earnings announcement if, at the time, their negative emotions score is in the bottom quartile. Reverse this trade either when the emotions score has moved down by an amount equal to the standard deviation of the negative emotion score, or after 60-trading days, whichever occurs first.*

The result for this strategy is reported in Table 2 (and compared to those already reported in Table 1, where there is no trigger for an early reversal of the initial transaction). We concentrate on the findings for the more extreme instances of good and bad unexpected earnings years as we have already identified that this is where the more profitable strategies will be found. The improvement in the performance because of this extension to the strategy is quite dramatic, with the annualized performance of the weighted long/short portfolio being 29.60%[11], which is about 50% higher than for the equivalent strategy without any trigger for an early reversal of both long and short positions. This finding is crucial as it shows that including information that draws upon the trajectory of emotions in the post-announcement period significantly enhances the performance of our investment strategy. It supports the conclusions drawn by Bird et al. (2023b) that it is the post-announcement behavior of emotions, rather than its level at the time of the announcement, that is vital in explaining the subsequent behavior of security prices. Importantly, this suggests that the extent to which the PEAD for a particular stock is conditioned by the path followed by the emotions after the announcement.

<<INSERT TABLE 2>>

[10] There are no insights from theory that leads us to the optimal level at which to set this trigger. We initially set it at one standard deviation but then subsequently adjust it after we obtain further insights into the relationship between emotions and stock price movements in the post-announcement period.

[11] The return on the long portfolio is 30.85% while that on the short portfolio is 5.10%. Not reported in Table 2, this results in the calculation for the weighted return on the long-short portfolio being 29.60%.

4.2 The question then arises: can investors do even better?

To address this, it is enlightening to reflect on the moving pieces in the investment strategy that we have developed to date:

1. What measure of emotions should be used?

Currently, we are using aggregate positive emotions for the long portfolio and aggregate negative emotions for the short portfolio.

2. What do we define as “high” and “low” emotions?

Currently, we are using the bottom quartile of emotions at the time of the news release to define low emotions.

3. What is “high” and “low” good and bad news?

Currently, we are using above and below-median unexpected earnings to define high and low.

4. What should be the holding period?

Currently, we are using 60 trading days.

5. What is the appropriate trigger?

Currently, we are using 100% applied to the standard deviation of the emotion score.

6. What is the optimal rebalancing strategy?

Currently, we are assuming that we will rebalance the portfolio holdings to equal weights at the end of each day.

For now, we will continue to use aggregate positive and aggregate negative emotions in our analysis, maintain our current definitions of high and low emotions, and continue to rebalance at the end of each day to equal weights. Further, analysis we have undertaken suggests that using the median is appropriate when splitting up good and bad earnings news into high and low. However, we believe it could be beneficial to introduce varied settings for the triggers and holding periods. The evidence supporting this extension is shown in Exhibit 2, which displays the cumulative abnormal returns from our applying our existing strategies (without triggers) over holding periods of up to 60 days. The long portfolio data indicate that most outperformance occurs within a relatively short time frame, with minimal additional returns accrued throughout the remainder of the 60 days. In contrast, the results for the short portfolio are less predictable; there is a significant initial gain, followed by a reversal, and then another increase in value towards the end of the holding period.

<<INSERT EXHIBIT 2>>

There are two implications that we take from this information as to how we close out portfolio positions:

(i) A holding period of 60 days might be far too long, and

(ii) A finer trigger than 100% may be better for maximising the profits generated over the first few days after the announcement given the short-term nature of the price hikes.

Therefore, we also evaluate a holding period of 15 days (c.f. 60 days) and a trigger of 25% (c.f. 100%) of the standard deviation of the emotion score. Our findings for the different combinations of triggers and holding periods reported in Table 3 highlight that the performance of the long/short portfolio improve when both the holding period and the triggers are decreased. The most effective strategy, with a 15-day holding period and a 25% trigger, yields a 60.20% annualized return. This performance is twice the yearly return of our original strategy which had a 60-day holding period, and a 100% trigger. This significant increase in performance by reducing the period that stocks are held is consistent with the findings reported in Figure 2, which suggest that the bulk of the returns due to the correction of an underreaction caused by emotions occurs within a few days of the earnings announcement.

<<INSERT TABLE 3>>

In Table 4, we report several characteristics of our Emotions2 portfolios that differ in terms of holding periods and the trigger for early reversals of transactions. The information confirms that these are aggressive portfolios, but one would not expect otherwise, given the magnitude of the generated returns. We note that the volatility of returns in the long portfolio increases as the holding period shortens. However, the rising Sharpe ratios indicate that this increased volatility does not outweigh the benefits of the higher returns. The situation is somewhat different for the short portfolio; as the holding period and trigger threshold decrease, performance improves (becomes more negative), while volatility remains relatively stable, as evidenced by the increasing Sharpe ratios.

<<INSERT TABLE 4>>

An unsurprising feature of both the long and short portfolios is that they are highly concentrated[12]. Indeed, the best performing of the portfolios holds on average, only 3.36 stocks each day in the long portfolio and only 1.66 stocks in the short portfolio.[13] This strongly suggests that it is not a strategy in which to invest a large portion of one's wealth, both for risk and liquidity reasons. However, only small amounts of investment will quickly grow to large amounts of funds over a relatively short period of time. A $1,000 investment in the best strategy would accumulate to over $1.2M. over the 15-year

[12] It is crucial to emphasise that our concentrated portfolios are a direct outcome of a strategic focus on the role emotions play in the mispricing associated with a specific corporate event: earnings announcements. This approach underscores the significant impact and efficacy of an emotion-based investment strategy. We argue that emotions likely influence investor reactions to various corporate announcements similarly. Consequently, a professional fund manager aiming to leverage an emotion-based strategy would adopt a portfolio selection approach incorporating diverse company announcements. This method would naturally lead to a broader portfolio holding at any given time.

[13] There are days when there are zero holding in the long and/or short portfolio. We assume that these days, the funds are "invested in 30-day T-Bills.

period. Furthermore, it is essential to note that the primary aim of this paper is not merely to identify highly profitable investment strategies but to demonstrate the extent to which individuals' emotions contribute to market mispricing.

The average holding period for the best-performing strategies (15 days and a trigger of 25%) is seven days for both the long and short portfolios. This is consistent with the evidence presented in Exhibit 2, which suggests that the daily added value of the strategy will peak around five to seven days. The information provided on the unexpected earnings (UE) confirms that we are dealing with the more extreme versions of earnings surprise. Finally, the difference between the average emotions scores at the time of the investment (E_0) and that at the time of reversing the position (E_n) indicates that the strategy successfully includes stocks that experience a relatively large subsequent movement in emotions.

One might assume that a strategy generating such exceptional returns would generate wildly volatile returns over our 15-year sample period. In Figure 3, we report the weighted annualized returns for the best of the Emotions2 strategies for each of the 15 years over which we form portfolios and compare this to the weighted annual return for our Earnings strategy, which simply purchases stock on the earnings signal and sells them at the end of the holding period. Hence, our earnings strategy that incorporates no information from the emotion signals, so the difference between the two returns reflects any value-added/subtracted due to incorporating information on emotions into the strategy.

<<INSERT EXHIBIT 3>>

Perhaps the most critical insight provided by Exhibit 3 is that our investment strategy incorporating emotions (Emotions2) did not produce a negative return in any of the 15 calendar years covered in our analysis, and this includes the years that incorporate the Global Financial Crisis of 2008-09. Further, the impact of including information on emotions in the strategy as measured by the difference in the performance of the Emotions2 strategy and the Earnings portfolio was positive in nine of the 15 years. The extent of the annualized outperformance in the nine positive years ranged between 25% and 125%. Conversely, the underperformance observed in the remaining six years was relatively minor, with three of those years seeing a reduction of less than 5%.

To shed more light on the relative performance of the Emotions2 strategy and the Earnings strategy, we next present in Exhibit 4 the frequency distribution of the monthly returns for the best performing Emotions2 strategy and the Earnings strategy. The Earnings strategy monthly returns mostly fall between -5% and +15%. The Emotions2 strategy that includes emotions deviates from this range in only ten months. Interestingly, eight of these ten deviations are positive. While the distribution of the

return on our Earnings strategy is approximately normal (skewness=0.0152), that of the Emotions2 strategy incorporating emotions has the desirable property of being positively skewed (skewness=0.447).

<<INSERT EXHIBIT 4>>

4.3 Cost and turnover

With daily rebalancing back to equal weights and the average holding period for the Emotions2 strategy being around a week (for the most profitable implementation), one would expect the investment strategy to have a high turnover. Indeed, we find that the two-way annualized turnover of the strategy with a 15-day holding period, and a 25% trigger, is 971% per annum. We adopted an alternative approach to reducing turnover by not transacting the portfolio to rebalance the portfolio. Instead, we strategically utilise cash flows to attempt to as effectively as possible maintain equal weights in both the long and short portfolios.[14].

Table 5 provides details of the turnover for the Emotions2 strategy and the Earnings Strategy portfolios with and without daily rebalancing by transacting. The second column details the turnover for each strategy, indicating that not rebalancing daily leads to a reduction in turnover by just over 20%. Columns three to six of Table 5 (i.e. 0% to 1.50%) report the net returns on the four strategies for various levels of transaction costs. It shows that while avoiding rebalancing can lead to a reduction of turnover volume, it also leads to a more significant drop in returns. This result suggests that it is more advantageous to maintain a strategy with higher turnover. In the final column of Table 5, we report the level of transaction costs required to reduce the net return of each strategy to zero. It establishes that the two-way transaction costs must be more than 6% to negate any added value from incorporating emotions into our investment strategy. The available evidence suggests that two-way transaction costs is less than 1% at which level the incorporation of information on emotions into the strategy is clearly adding significant value.

<<INSERT TABLE 5>>

4.4 Emotions and factors

There is ample evidence of the existence of several factors which have being found to be correlated with investment returns (e.g., Ali et al., 2003; Detzel and Strauss, 2018). Many would argue that the performance of any investment strategy should be adjusted for any contributions due to exposure to

[14] See the Appendix for details on our trading strategy with no rebalancing.

these factors to ensure that the strategy is not rewarded for any already known price inefficiencies and/or the risks associated with exposure to the factors. In this section, we report this added performance of the Emotions2 strategy in the context of the one factor model (CAPM), the Fama-French three-factor and five-factor models (Fama and French, 1993, 2015). The results for our four implementations of this strategy are reported in Table 6.

<<INSERT TABLE 6>>

The two strategies with shorter time horizons (T15) that generate the greatest added value only display exposure to the market factor and generate an alpha in the range of 1.3% to 1.4% per month which is equivalent to an annualized return of around 18%. The two strategies with the longer holding period (T60) generate slightly lower added value and display exposure not only to the market but also to growth and the more conservative stocks. The T60 strategy combined with a 100% trigger returned an annualized alpha of approximately 12%, while that combined with a 25% trigger returned an annualized alpha of slightly less than 10%. The fact that the alphas for all four strategies are highly significant confirms the added performance potential from incorporation information on emotions into an investment strategy.

4. Concluding Comments

Research into the impact of emotions on asset pricing is in its early stages and has largely been restricted to applying regression analysis to seek out the association between proxies for investor emotions and stock returns. The results to date support the proposition that their emotions influence investors' decision-making and impact asset pricing. In this paper we extend the existing analysis to investigate whether knowledge of investor emotions can be used within an investment strategy to generate outperformance. Drawing on the findings of two papers that investigated how emotions influence investors react to information signals; we have developed a series of decision rules that incorporate information to guide the timing for buying/short-selling stocks and the reversal of these transactions. For the long portfolio, our strategy involves buying stocks that announce positive earnings when emotions toward the company are subdued and selling them once emotions pick up to a more typical level. Similarly, the strategy involves short-selling stocks that announce negative earnings at a time when negative emotions are low and repurchasing them when negative emotions intensify to a more normal level. The underlying rationale is that muted emotional responses at the time of the announcement can lead to an underreaction, presenting an opportunity to profit when emotions revert to more normal levels.

Our strategy realises significant investment returns, even after consideration is given to both risk and transaction costs. The fact that available information on emotions can be used as the basis for a profitable investment strategy strengthens the existing evidence that emotions influence investor decision-making and the determination of asset pricing. A much-studied phenomenon associated with earnings announcements is the PEAD which suggests an initial underreaction to an earnings release is followed by a subsequent price correction, presumably due to investors realising the mistake they made and correcting it. The findings in this paper are at variance with the proposition that investors recognise their past mistakes and correct them. Instead, we find that security prices are always influenced by emotions and so the direction they take in the post-announcement period is driven by the direction taken by emotions during that period rather than by investors consciously correcting past mistakes.

This finding has important implications for the efficiency of markets as it suggests one cannot assume that any variation from fundamental value is temporary as future stock prices remain at the whim of future movement in emotions (and, of course, several other factors). Hence, it throws into question the idea that markets are efficient most of the time, and the proposition that the current market valuation provides an unbiased estimate of the firm's fundamental value. Finally, the findings in the paper provide valuable insight for practitioners as to how to incorporate emotions into an investment strategy.

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Table 1: Returns Where We Reverse the Transactions at the End of T60.

Aggregate Positive Emotions		Benchmark	Earnings	Emotions1
		% pa	% pa	% pa
Good News	All	11.78	17.58	17.10
	High		**21.31**	**20.74**
	Low		12.46	12.32
Bad News	All	-11.78	-10.53	-10.38
	High		-9.91	-8.30
	Low		-10.73	-14.05

Aggregate Negative Emotions		Benchmark	Earnings	Emotions1
		% pa	% pa	% pa
Good News	All	11.78	17.85	19.06
	High		**21.27**	**20.73**
	Low		13.01	15.85
Bad News	All	-11.78	-10.83	-10.71
	High		**-10.21**	**-7.31**
	Low		-10.86	-12.64

We first created six portfolios based on unexpected earnings. We divide both the positive (good news) and negative (bad news) unexpected earnings into all, above(high)- and below(low)-median at the time of the announcement. We avoid the look-ahead bias by only using data from past announcements when specifying the median. Although we have data from January 1998, we do not start forming portfolios until January 2003 and so we have five years of data to calculate the initial medians with subsequent medians being determined using an expanding window. For **Benchmark strategy**, we hold two offsetting portfolios – one being an equally weighted portfolio including all stocks in the $&P500 universe and the other being short position also equally weighted of the same universe of stocks. We find the annualized returns using the following formula:

$$APR_{i,t} = (((IV_t / IV_{t-1}) \wedge (12 / n)) - 1) * 100) \ldots (Eq.1)$$

where $APR_{i,t}$ is the annualized portfolio return for the portfolio "i" at the time "t". IV_t is the index value at the end of 2017, whereas IV_{t-1}here is the index value at the beginning of 2003. n is the number of months from the beginning of 2003 to the end of 2017.

For each portfolio "i" of the **Earnings strategy**, we hold the stock based on the unexpected earnings, however, the stocks do not incorporate any information related to emotions. We buy the stock if the earnings announcement is positive and short sell if the earnings announcement is negative with transactions reversed after 60 trading days. We calculate the daily stock return of each stock held in the portfolio "i" using the following formula.

$$SR_{i,t} = \frac{P_{t1} - P_{t0}}{P_{t0}} \ldots (Eq.2)$$

where SRi,t are stock returns at the time 't', for the company 'i', P_{t0} is the adjusted closing price of the previous trading day, and P_{t1} is the adjusted closing price of the current trading day. Next, for each portfolio "i" of the benchmark, we create an index that starts at 100 on the first trading day of January 2003. Then each subsequent trading day, the value of the index either increases or decreases based on the stock returns held in the portfolio "i" using Eq. 3. For example, if the return on the portfolio "i" at time "t" is 10% (-10%) then the index will increase(decrease) to 110(90).

$$PR_{i,t} = 1 + \frac{\sum_{t=t_0}^{t1} SR_{i,t}}{\text{number of stocks at time "t"}} \ldots (Eq.3)$$

where $PR_{i,t}$ are portfolio returns at the time 't', for portfolio 'i'. For the short portfolio, we multiply SRi,t with -1. We then annualise the Earnings strategy returns using Eq 1.

We follow the same process as benchmark for the **Emotions1 strategy**, however, in addition to the filters based on the unexpected earnings, we purchase companies that announce good earnings news if, at time 4 pm t-1, their aggregate positive emotions are in the bottom quartile. Similarly, we only sell short stock in companies that announce bad earnings news if, at time 4 pm t-1, their aggregate negative emotions score is in the bottom quartile. As we restrict our investments to stocks whose emotion scores fall into the bottom quartile. So, we need to know the breakpoint for the bottom quartile by emotion in order to implement the strategy. Again, we avoid the look-ahead bias by using the holdout period of five years to calculate the initial break point which we then update using an expanding window.

Table 2: Results Using 100% of SD as the Trigger for T60

Aggregate Positive Emotions		Benchmark	Earnings	Emotions2
		% pa	% pa	% pa
Good News	All	11.78	17.58	21.21
	High		**21.31**	**30.85**
	Low		12.46	12.78
Bad News	All	-11.78	-10.53	2.72
	High		-9.91	13.83
	Low		-10.73	-9.29

Aggregate Negative Emotions		Benchmark	Earnings	Emotions2
		% pa	% pa	% pa
Good News	All	11.78	17.85	20.99
	High		21.27	25.35
	Low		13.01	13.88
Bad News	All	-11.78	-10.83	2.55
	High		**-10.21**	**5.10**
	Low		-11.00	-10.32

For the Benchmark and Earnings strategies, please see the annotation of Table 1. For the **Emotions2 strategy** incorporating emotions, we buy the stock if earnings announcement is positive and emotion is in the bottom quartile at 4 pm t-1, and short sell if earnings announcement is negative and emotion is in the bottom quartile at 4 pm t-1. However, instead of reversing all the transactions after 60-trading days, we reverse the transaction before the end of the 60-trading day holding period once the emotion score moves by more than a pre-specified amount. For the above results, this pre-specified amount is based on a 100% of the standard deviation (SD) of the movement of the emotion score. We use this 100% of the SD as trigger for buying/selling stocks. Again, we need past data to determine this standard deviation which is another potential source of look-ahead bias. Having a five-year holding period from 1998 to 2002 provides the data to calculate the initial standard deviations which are updated using an expanding window. If the emotion score of a particular company does not move by this trigger value, we reverse the transaction at the end of 60th trading day.

Table 3: Returns (%pa) for the Long Portfolio. Short Portfolio and the Weighted Long/Short Portfolio under the Emotions2 Strategy with Various Implementations

Holding period (Days)	Trigger (%)	Long (%pa)	Short (%pa)	Weighted Long/Short (%pa)
60	100	30.85	5.10	29.60
	25	49.41	30.42	47.63
15	100	50.81	32.31	48.75
	25	62.95	53.64	60.20

Please see the annotation of Tables 1 and 2 for trigger and the returns on long and short portfolio. Following Peterson (2016) we calculate the weighted returns on the Long and the Short portfolios to calculate our return on the long/short portfolio. For every year, first, we calculate the weight of our long portfolio (Eq. 4) and our short portfolio (Eq. 5). Then we simply multiply them to get the return on the long/short portfolio (Eq. 6). By decomposing the long/short returns, we can identify the contribution of both the long and short portfolios in the overall returns.

Calculating Weights for Long = Value of Long / (Value of Long + Value of Short) … (Eq. 4)

Calculating Weights for Short = Value of Short / (Value of Long + Value of Short) … (Eq. 5)

Long/short return = (Weight of Long * Return of Long) + (Weight of Short * Return of Short) … (Eq. 6)

Table 4 Statistics for the Different Combinations of Triggers and Holding Periods

	Holding Period: 60 Days				Holding Period: 15 Days			
	Trigger 100%		Trigger 25%		Trigger 100%		Trigger 25%	
	Long	Short	Long	Short	Long	Short	Long	Short
Return (%pa)	30.85	5.10	49.41	30.42	50.81	32.31	62.95	53.64
S.D.	0.211	0.100	0.302	0.113	0.296	0.088	0.323	0.103
Sharpe	1.24	0.257	1.351	0.792	1.427	1.006	1.539	1.304
Ave. Stocks	14.07	6.09	4.75	1.85	6.75	7.73	3.36	1.66
Ave. Days Stock held	30	33	10	10	14	15	7	7
Days with no stocks	1	37	197	1012	244	372	739	1082
UE	0.280	-0.651	0.280	-0.651	0.281	-0.651	.0281	-0.651
E_0	0.002	0.012	0.002	0.012	0.002	0.012	0.002	0.012
E_n	0.090	0.077	0.050	0.044	0.056	0.052	0.041	0.039

For the calculation of returns, please see the annotation for Tables 1 and 2.

Table 5: Turnover and the Net Returns for the Earnings Strategy and the Emotions2 Strategy for Different Levels of Transactions Costs: Daily Rebalancing and No Rebalancing

Weighted Long-Short portfolios	Turnover (%pa)	Net Return with Two-way Cost @ x% of Turnover				Net return = 0 %
		0%	0.50%	1.00%	1.50%	
Emotions2 Strategy for T15 @25% trigger with Daily Rebalancing	971	60.2	55.35	50.49	45.64	6.2
Earnings Strategy for T15 (%pa) with daily Rebalancing	530	35.61	32.96	30.31	27.67	6.7
Emotions2 Strategy for T15 @25% with No Rebalancing	768	50.81	46.97	43.13	39.29	6.6
Earnings Strategy for T15 with No Rebalancing	443	28.16	25.95	23.73	21.52	6.4

For calculation of long/short returns, please see annotation of Table 3. For more information on the calculation of turnover, please see the Appendix.

Table 6: Results from applying 1-factor, 3-factor, and 5-factor models to monthly returns of weighted long/short portfolio for each of four strategies.

	T15@25%			T15@100%			T60@25%			T60@100%		
Vars.	1-Factor	3-Factor	5-Factor	1-Factor	3-Factor	5-Factor	1-Factor	3-Factor	5-Factor	1-Factor	3-Factor	5-Factor
Alpha	0.0136***	0.0137***	0.0130***	0.0139***	0.0140***	0.0129***	0.00788***	0.00777***	0.00739***	0.00993***	0.00978***	0.00948***
Market	0.0949*	0.119**	0.155**	0.261***	0.233***	0.286***	0.182***	0.203***	0.226***	0.297***	0.310***	0.338***
SMB		-0.136	-0.118		-0.0113	0.0381		-4.58e-06	-0.00667		0.0659	0.0118
HML		0.0342	-0.0104		0.177	0.149		-0.120**	-0.179**		-0.155*	-0.248***
RMW			0.148			0.295			0.0614			0.0194
CMA			0.202			0.109			0.205*			0.348**
R-Sq.	0.020	0.032	0.045	0.075	0.087	0.100	0.128	0.148	0.165	0.172	0.191	0.210

To assess the added performance of our strategy, we run regressions of our long/short monthly return against 1-Factor (CAPM), Fama and French 3-Factor (FF3), and Fama and French 5-Factor (FF5) models. The monthly data for the factors is downloaded from Ken French's website. We run the following regressions:

$$R_{it} - R_{ft} = \alpha + \beta_1(R_{mt} - R_{ft}) + \varepsilon$$

$$R_{it} - R_{ft} = \alpha + \beta_1(R_{mt} - R_{ft}) + \beta_2 SMB_t + \beta_3 HML_t + \varepsilon$$

$$R_{it} - R_{ft} = \alpha + \beta_1(R_{mt} - R_{ft}) + \beta_2 SMB_t + \beta_3 HML_t + \beta_4 RMW_t + \beta_5 CMA_t + \varepsilon$$

R_{it} is the monthly return on a long/short portfolio "i" at time "t". R_{ft} is the monthly risk-free rate. MktRF (Market), SMB, HML, RMW and CMA are the proposed factors by (Fama & French, 1993, 2015). *** p<0.01, ** p<0.05, * p<0.1

Exhibit 1: Proposed impact of emotions and new information on investors' expectations

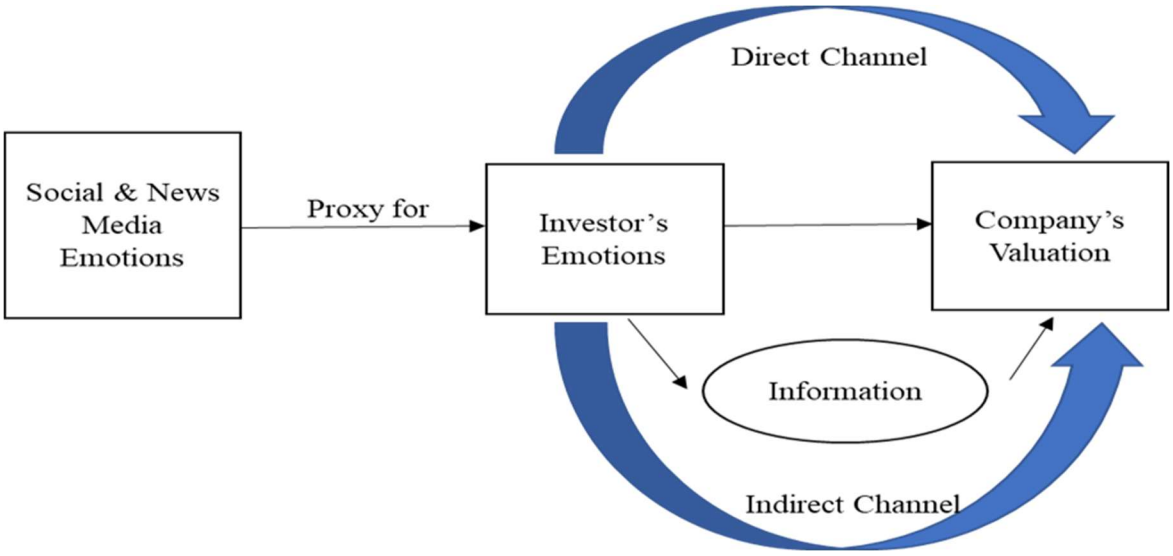
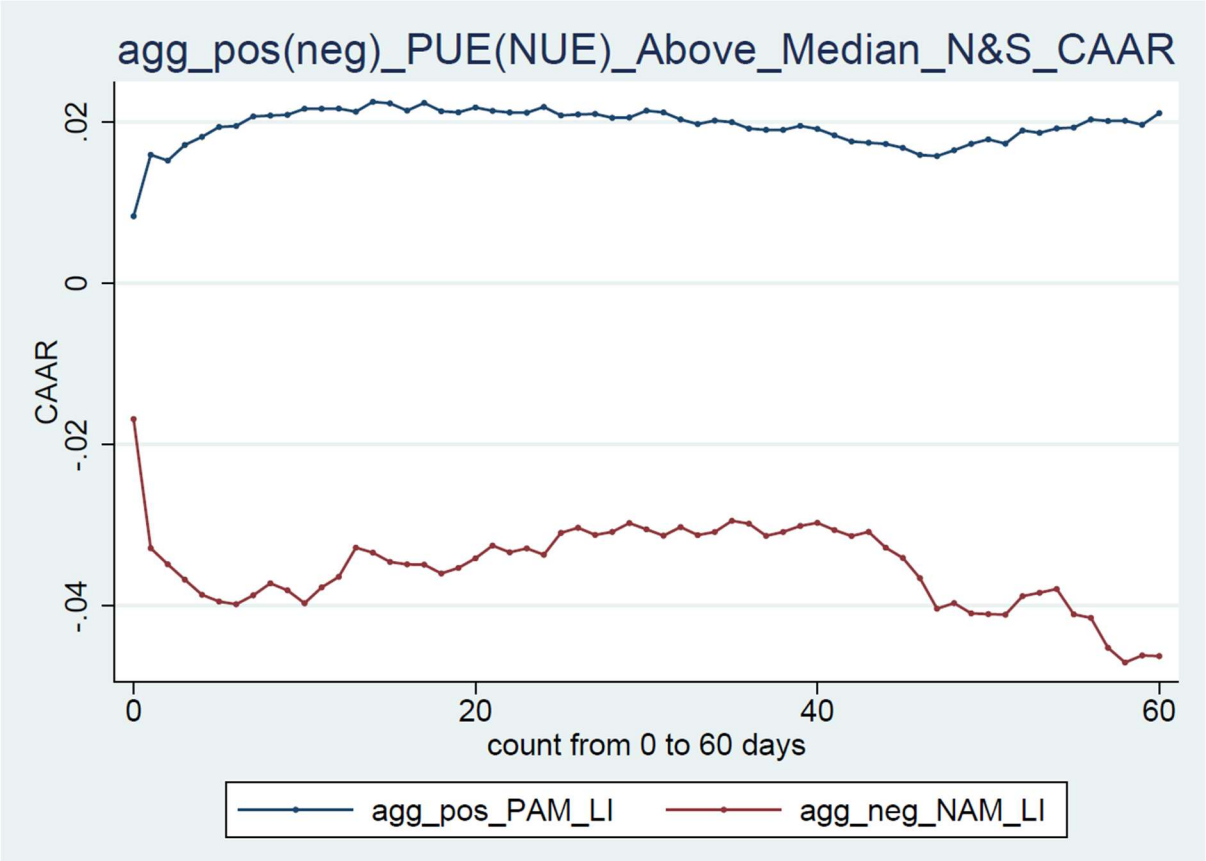


Exhibit 2: Cumulative Average Abnormal Returns (CAAR) Generated by Our Existing Strategies (Without Triggers) for Holding Periods up to 60 Days.



The blue line in the graph shows the CAARs for long portfolio where we have above-median Good News and aggregate positive emotions start in the bottom quartile (at 4pm t-1) and they increase over time. The red line is the CAAR for the short portfolio where we have above-median Bad news, and aggregate negative emotions start in the bottom quartile (at 4pm t-1) and they increase overtime.

Exhibit 3: Annual Long-Short Return Comparison Between the Earnings Strategy and Emotions2 Strategy for T15 @ 25% Trigger

The blue bars in the figure show the annualized returns on a long/short portfolio of strategy where the investment period is 15days and trigger is 25% of the standard deviation. The orange bars in the figure show the annualized returns on the long/short portfolio of the earnings strategy.

Exhibit 4: Long-Short Monthly Return Frequency Distribution for Emotions2 Strategy for T15 @ 25% Trigger and Earnings Strategy.

The above figure shows the monthly frequency distribution of returns on a long/short portfolio on both the earnings strategy which does not include any information on the emotions and the emotions strategy where the trigger for trading is 25% of the standard deviation of the emotions. The monthly returns are from 2003 to 2017.

Appendix

Trading Strategy where Holdings were not rebalanced:

There are 4 possible scenarios in this trading strategy which are explained below.

1) **No purchase and no sale:** On a particular day, where we do not have any old stock leaving the portfolio or new stock entering our portfolio, we do not rebalance anything. Hence, we do not transact at all.
2) **Sale but no purchase:** distribute the total value of the sales equally across the stocks that we continue to hold in our portfolio.
3) **Purchases but no sale:** sell of Q/N of the value of each stock still owned and distribute the amount raised equally over the new stocks purchased (where Q is the number of new stocks purchased, and N is the total number of stocks including the new ones purchased)
4) **Buy some stocks and sell some stocks:** This is a much more complicated scenario, and we take the following steps to complete it.

Step 1) We work out the value of the portfolio at the end of the day before any transacting (e.g., $500)

Step 2) We divide this value by the number of stocks in the portfolio after we have bought and sold (say we start with 4 stocks, sell 2 and buy 3 and hence end up with 5 stocks in the new portfolio. We divide the value of the portfolio which is $500 by the number of stocks after trading, which is five, and we get $100. This tells us that we must invest $100 in each of the new stocks that we are buying.

Step 3) We multiply the amount we calculate in Step 2 by the number of stocks we are buying, and we then have the amount of funds we need to raise to purchase the new stocks (in our example, we must raise $300 in order to invest $100 in each of the three new stocks)

The formula for the above calculations is:

Amount to be raised = $P\ (V/\ (N+P-S))$

Where:

V= Value of portfolio at end of the day before any transactions

N= number of stocks in existing portfolio

P= number of stocks to be purchased

S= number of stocks to be sold

Step 4) We calculate the amount of additional funds that has to be raised – this is the difference between the amount of fund needed to invest in the new stocks and the amount raised from the sale of stocks (in our example we sell two stocks and assume that this raises $220, then we have to raise an additional $80 in order to be able to invest $300 in the stocks to be purchased.)

Step 5a) This $80 is raised by selling an equal amount (in $) from the sale of the existing stocks which are not being sold (in our example, we started with 4 stocks, are selling 2 so there are two stocks remaining. Hence, we must sell $40 worth of each of the remaining stocks. The formula for calculating the amount that we must sell of the existing stocks = $((P(V/\ (N+P-S))) – M)/(N-S)$

Where M is the amount raised by the sale of existing stocks. Our holdings in each of the stocks in our portfolio immediately after trading will be (i) for the existing stocks retained it will be their value at the end of the day less $40, while for the new stock purchased

it will be $100. This amount must add up to $500 which was the value of the portfolio at the end of the day before any transacting took place.

Step 5b) The calculations in 5A are based on the presumption that the amount raised by the sale of stocks in not sufficient to fund the purchase of the new stocks. This will quite frequently not be the case, especially on those days when we are selling more stocks than we are purchasing. For example, assume that the sale of stocks in our example raises $350 which is $50 more than we need to acquire the new stocks. After transacting we have 5 stocks (N+P-S) and so each stock is allocated an additional $10. In our example, the value of the existing stocks which are not sold will be increased by $10 while the holding in each of the stocks that are purchased will be $110. Again, this holding will add up to $500.