Uninformative Feedback and Risk Taking

Itzhak Ben-David

Fisher College of Business, The Ohio State University, and NBER

Justin Birru

Fisher College of Business, The Ohio State University

Viktor Prokopenya

SBS Swiss Business School and exp(Capital)

November 2014

Abstract

We document that retail day traders in the Forex market attribute random success to their own skill and, as a consequence, increase risk taking. Although past performance provides little information about future success for these traders, they increase leverage and active share with gains, but not with losses. Furthermore, there is a large discontinuity in risk taking around zero past week returns: traders increase leverage dramatically following weeks of small gains, relative to weeks of small losses. The effects are stronger for novice traders, consistent with more intense “learning” in early trading periods.

Keywords: Retail trading, futures, risk taking, overconfidence, self-attribution
JEL Classification: D12, D40, L51

We benefited from the comments of David Hirshleifer and Aner Sela. We thank exp(capital) for providing the data for the project. The authors appreciate comments received from participants in seminars at Notre Dame University, The Ohio State University, and the University of Washington, as well as participants at the Behavioral Finance Conference at Erasmus University (Rotterdam). Ben-David and Birru’s research was supported by the Dice Center at the Fisher College of Business.
1 Introduction

Feedback about outcomes from past actions can help improve future decision making (e.g., Seidenfeld 1985). Furthermore, feedback is considered one of the main remedies for overconfidence: the more instances that one can observe and learn from, the better future predictions become (e.g., Arkes, Christensen, Lai, and Blumer 1987, Thaler 2000). However, because people are often poor at interpreting it, feedback can be a double-edged sword. In particular, individuals tend to accredit observed successes to their own ingenuity and blame failures on bad luck. Langer and Roth (1975), for example, show that subjects attribute to themselves the skill of predicting the outcomes of coin tosses after a few correct guesses. The information in the feedback, therefore, can be misinterpreted and mistakenly enhance one’s perception of skill, even if the outcome is impossible or hard to predict. In such cases, self-attribution of successes can lead individuals to take greater risks, based on the false conclusion of having forecasting skill.

The idea that feedback may distort decision making due to self-attribution is a key component in several theoretical models. In Daniel, Hirshleifer, and Subrahmanyam (1998) and Gervais and Odean (2001), traders attribute successful investment outcomes to their skill and failures to bad luck. Over time, with some random successes, traders overestimate their ability to trade. This effect is expected to be stronger in traders’ early life. In the words of Gervais and Odean (2001): traders learn to become overconfident.

In a broader context, understanding the dynamics of overconfidence and trading is important, as previous research has suggested that the high volume in financial markets is a result of traders’ overconfidence. Statman, Thorley, and Vorkink (2006) find that trading volume at the market level is positively related to lagged market returns in the United States and argue that this pattern reflects investor overconfidence and biased self-attribution. Griffin, Nardari, and Stulz (2006) study 46 markets and find that this relationship holds for many of them. Barber and Odean (2000) document that retail traders trade too often: trader performance declines with the frequency of trading. Similarly, Grinblatt and Keloharju (2009) present evidence that Finnish traders who are more overconfident trade more often. Ben-David and Hirshleifer (2012) present evidence that the previously documented disposition effect for retail traders is a manifestation of overconfidence. Moreover, the importance of the role of feedback extends far beyond the trading
context to the corporate world. Gervais, Heaton, and Odean (2011) describe how overconfidence built through self-attribution makes executives less risk averse, and Gervais and Goldstein (2007) propose that overconfidence of some team members leads to an overall increase in productivity.

In this study, we test how past trading performance is interpreted and used by individuals. The usefulness of feedback for learning and risk taking is ultimately an empirical issue that boils down to the true ability of individuals to predict outcomes and the degree of self-attribution that they exhibit. With this in mind, we focus on a population of day traders in the Forex market: they trade intensively (median trade lasts 16 minutes) in an environment that is very noisy and leaves very little room for skill. At the same time, traders receive immediate feedback about outcomes following their actions. Our trading dataset allows us to measure risk taking (measured as leverage) and perceived skill (measured as active share) as a function of traders’ past performance. If overconfidence arises through the self-attribution mechanism, as proposed by Daniel, Hirshleifer, and Subrahmanyam (1998) and Gervais and Odean (2001), we should be able to detect it. Our results show that past performance plays an important role in the behavior of traders, supporting the “learning to be overconfident” mechanism.

We use a dataset of individual retail accounts in the Forex futures market provided by a large international broker. The broker lets traders leverage their equity up to 500 times, allowing ample room for risk taking. Most of the traders in our dataset are day traders who hold their positions open for only a short time. Retail trading in this market has seen large growth in recent years, perhaps because of its lottery-like nature (i.e., high leverage, short holding horizons, and quick feedback).

A key empirical challenge is to identify the effects of self-attribution, which is the mechanism that ties current trader behavior (e.g., risk taking) to past performance. Our identification strategy is based on two non-linearities predicted by the theory. First, traders’ responses to past gains and losses should be asymmetric. If traders exhibit self-attribution, then their behavior should be more sensitive to the magnitude of past profits in the gain domain than in the loss domain. Second, traders may perceive gains, irrespective of their magnitude, as a sign of success. Hence, we should see a discontinuity in trading behavior around the origin of past

---

1 In the words of Gervais and Odean (2001), “A trader who receives frequent, immediate, and clear feedback will, on average, peak in overconfidence early” (p. 13).
performance. In other words, traders may respond differently to small past gains versus small past losses.

In our main tests, we examine two measures of trader decision making. The first is the change in average leverage (within a week). This variable reflects the change in risk taking, as an increase in leverage suggests that the trader is increasing her bets. Our second measure of trader decision making is the change in the trader’s active share. The measure of active share utilized in this study is similar to that first introduced in Cremers and Petajisto (2009). It is a measure of the variability in trade sizes across the trader’s transactions, with high variability reflecting a greater amount of active portfolio management. An increase in active share is consistent with the trader making more elaborated decisions about which positions to bet on, which should ultimately be correlated with the trader’s perceived skill.

We find two novel results. First, we document that both the change in the current week’s leverage and the change in active share respond to past gains and losses in an asymmetric fashion. The past week’s gains are strongly associated with higher risk taking and higher perceived skill, measured as increased average leverage and change in active share, respectively. Conversely, the past week’s losses have only a minimal effect on these variables. For both variables, we find a difference in the response slope to past performance between the positive and negative domains that is statistically and economically significant, with a value of approximately 0.8.

Second, we document a discontinuity in average leverage and active share around zero past returns. When we compare small losses to small gains, we find that traders substantially increase their average leverage following small gains, but not following small losses. Similarly, active share increases greatly following weeks of small gains, relative to weeks of small losses. That is, we see a discontinuous jump in risk taking and perceived skill exactly around zero past returns. This result is consistent with self-attribution bias: traders behave as though they perceive any gain as a positive outcome, indicating their skill. Conversely, they attribute small losses to bad luck.

---

2 Since trading accounts are likely to be a relatively small fraction of traders’ wealth, the change in leverage that we observe cannot be driven by rebalancing.
The discontinuity in the changes in average leverage and active share is both statistically and economically significant in all specifications. In particular, the discontinuity around zero past performance accounts for about 13% to 17% of a standard deviation of the weekly changes in average leverage and active share.

We conduct further analyses and isolate the first weeks of trading for each trader. According to Gervais and Odean (2001), early trading experiences disproportionately shape traders’ perceptions of their own skill. Consistent with this prediction, we find that the effects we report are stronger for traders earlier in their trading life.

A necessary condition for our analysis to hold is to verify our identification assumption, i.e., that current performance carries little information about future performance and is smooth with respect to past performance. We test this assumption and, indeed, do not find a meaningful differential relation between current performance and past gains versus losses that can explain the observed relationship between trader behavior and past profits. Furthermore, there is no discontinuity in future performance with respect to past gains and losses.

Taken together, our results provide evidence consistent with the mechanism proposed by Daniel, Hirshleifer, and Subrahmanyam (1998) and Gervais and Odean (2001)—that traders attribute successes to their own skill and, thus, become overconfident over time. The mechanism is based on self-attribution: traders accredit successes to their own skill and blame losses on bad luck.

Our study joins previous research showing that individuals often modify their behavior based on feedback and signals that contain little information. Chiang, Hirshleifer, Qian, and Sherman (2011) and Kaustia and Knupfer (2008) find supporting evidence from the IPO (initial public offerings) market, documenting that investors increase their participation in IPOs following positive returns on their previous IPO investments. Similar evidence of learning from ones past actions is documented by Malmendier and Nagel (2011), finding that investors who have experienced low stock market returns throughout their lives are more risk averse. Choi, Laibson, Madrian, and Metrick (2009) show that individuals experiencing high returns to 401(k) accounts increase their savings rates. Our paper offers novel insights into the mechanism through which individuals interpret uninformative successes, and it provides new results regarding risk taking.
The evidence presented here complements the literature about rational learning in trading. Seru, Shumway, and Stoffman (2009) find that retail traders with worse trading experiences are more likely to exit the market. Linnainmaa (2011) presents a structural model in which traders rationally learn about ability through trading, and using Finnish data, he shows that investors increase trade size after successful trades and exit the market after unsuccessful trades.

2 Data

2.1 Sample

We utilize a dataset of individual retail accounts in the Forex futures market provided by a large international broker. The data contain trades for 3,103 traders who make a total of 1,118,632 trades between September 2010 and May 2012. We do not have information about the countries of residence of the traders; however, we observe their home currency: 28% use the US Dollar, 25% use the Euro, and 28% use the Polish Zloty. The remainder use Eastern European currencies.

Traders in this market do not pay fixed commissions but rather pay the bid-ask spread. The spread varies over time and across currencies; it is typically 1 basis point (pips), e.g., the Euro-U.S. Dollar contract (EURUSD) can be traded at a 1.2701/1.2702 spread. We have little information about the characteristics of the traders beyond when they started their trading activity. To provide greater comfort with the analysis, we include a specification with trader fixed effects in all analyses.

Our analysis is performed at the trader-week level. We collapse our data at the weekly frequency and measure trader performance as well as trading patterns at this frequency. The choice of a week as a unit period is arbitrary. While it is possible that traders learn from their past performance, there is no reason to believe that there is a look-back unit that is common to all traders and that a week is that unit. In choosing the time unit, there is a trade-off. A short period (e.g., one hour) might be too short for updating a trader’s beliefs about his or her own skill. In contrast, a long period, say a year, might be too low a frequency, as traders might update their beliefs about their own skill a few times over this period. To ensure that our results are not unique to the weekly frequency, we report the main tests for the three-day (i.e., an approximation
for half a week) frequency (Appendix A) and two-week frequency (Appendix B); the main results remain the same.

2.2 Measuring Performance

In determining how to measure performance, we seek to best capture the signal the investor receives regarding her performance. Two possibilities emerge. First is to consider the weekly change in the trader’s account balance relative to the total amount invested over the week, which seems the most robust measure. This is equivalent to the average return per trade weighted by trade sizes (i.e., value-weighted average return per trade). Figure 1 presents the distribution of the lagged average trade returns. Trader-week observations are concentrated around zero past returns, with some bias toward very small negative average returns.

A second possibility is to examine the weekly change in the account balance relative to the beginning-of-week account balance. By construction, this option incorporates the endogenous leverage decision into the return variable, thereby failing to properly reflect the signal of performance that the trader receives. To clarify this concept, imagine the case of two traders, each with the same opening balance of, say, $100. Further assume that each trader makes a $100 profit trading in week $t$. Trader A uses no leverage, resulting in trade sizes of $100, but Trader B uses the maximum leverage of $\times 500$, resulting in trade sizes of $50,000$. That is, Trader A makes a return that is equal to 100% of her trade size, while Trader B makes a return that is equal to 0.2% of her trade size. Calculating returns as profit divided by balance leads us to conclude that both traders have equivalent 100% returns for the week. However, it seems quite clear that Trader A, who makes $100 profit on trades of $100, will interpret the profit as a more positive signal of skill than will Trader B, who makes a $100 profit by undertaking trades of $50,000. For this reason, we calculate returns relative to the size of the positions that the trader is taking rather than relative to the trader’s balance.
Bearing these considerations in mind, we calculate returns as total profit in a week relative to the aggregate value of all positions taken in the week. To eliminate erroneous observations, we remove observations where the return in the prior week is exactly zero (less than 1% of observations).

2.3 Measuring Risk Taking

We also face the question of how to best measure whether traders modified their risk taking. One possibility is to measure the change in risk taking by using the change in effective leverage (trade size divided by trader balance). Of course, balance is a function of the last period’s gain or loss, introducing a bias into our measure when using last week’s gain or loss as a predictive variable, as we do throughout our analysis. For example, for a trader with \( \times 500 \) leverage, a $1 profit in week \( t - 1 \) means that the trader must increase trade size by $500 in week \( t \) to simply maintain constant effective leverage. Continuing with the example, while a trader who increases trade size by $400 in response to a $1 profit would appear to be exhibiting a large increase in risk taking, this would actually show up as a decrease in risk taking according to effective leverage. On the other hand, a trader with \( \times 500 \) leverage who experiences a $1 loss in week \( t - 1 \) and maintains the same trade size in week \( t \) will be seen as increasing risk taking. In fact, a trader with a $1 loss in week \( t - 1 \) will need to decrease trade size by $500 to simply maintain constant leverage. A decrease in trade size by $400, for instance, would actually result in an increase in risk taking according to the effective leverage metric. Again, this measure does not appear to accurately capture the actual risk-taking behavior of the trader. As a result, the change in effective leverage measured in this way is not the appropriate benchmark to use.

To eliminate the bias introduced by using an updated balance, we simply use the beginning balance of week \( t - 1 \) to calculate both average leverage in week \( t - 1 \) and in week \( t \):

\[
\text{Average leverage}_t = \frac{\text{Average trade size}_t}{\text{Balance}_{t-1}}.
\]

We continue to measure leverage in week \( t - 1 \) as

\[
\text{Average leverage}_{t-1} = \frac{\text{Average trade size}_{t-1}}{\text{Balance}_{t-1}}.
\]
The change in average leverage is therefore measured as

$$\text{Change in average leverage}_{it} = \frac{\text{Average leverage}_t}{\text{Average leverage}_{t-1}} - 1$$

$$= \frac{\text{Average trade size}_t}{\text{Average trade size}_{t-1}} - 1,$$

where the change in average leverage is measured as a fraction. Thus, the change in average leverage reflects the growth in trade size. Traders who exit the sample have a change in average leverage of -100% in the week following the week of their last trade. (In Appendix C we verify that this assumption does not have a material effect on the main results.) After this, traders are removed from the sample.

A possible concern is that the measure of the change in the average leverage may be more precisely estimated for traders with a greater number of trades relative to those who trade relatively less frequently within the week. To alleviate this concern, we use two procedures. First, we form another measure of the change in the leverage based on the median leverage within a trader-week. Instead of using the average leverage in each week, we use the median. Second, we use a weighted least squares regression that gives greater weight to observations that are measured more precisely. We discuss this procedure in detail in Section 4.

### 2.4 Measuring Perceived Skill

We measure the perceived skill of traders as the change in active share. Active share captures the extent to which a trader actively manages trade positions. The interpretation of our measure is similar to that of Cremers and Petajisto (2009) in that it captures any deviation from passive management. In our setting, passive management refers to a trader who indiscriminately places the same amount of capital in every trade. On the other hand, a trader who is overconfident will take a more active role in differentially allocating capital to positions to reflect his private signals.

Active share for trader \(i\) at time \(t\) is equal to

$$\text{Active Share}_{it} = \sum_{j=1}^{N} |w_{ijt} - \tilde{w}_{it}|,$$
where $N$ is the total number of trades in a given week for trader $i$; $w_{ijt}$ is the portfolio weight for trade position $j$ for trader $i$ at week $t$ (where weight is equal to the value of the position divided by the aggregate value of all positions taken in the week); and $w_{jt}$ is the equal-weight portfolio share for trader $i$ in week $t$ (equal to $1/N$). We require at least two trades in a week to calculate active share.

Change in active share measures week-over-week changes in a trader’s perception of his or her skill. As the trader becomes more confident in his/her abilities, we expect to see active share increasing as the trader makes more active decisions about dollar allocation across trades. The change in active share is calculated as

$$Change_{it} = \frac{Active\ Share_{it}}{Active\ Share_{it-1}} - 1,$$

where the change in active share is measured as a fraction. Since the change in active share has a long right tail even after winsorizing at the 99% percentile, we winsorize it again at 200%, which corresponds to the 83rd percentile. In Appendix D we verify that this choice does not drive the results: we repeat the main tests with winsorization at 5 (88th percentile) and 10 (90th percentile).

### 2.5 Summary Statistics

Table 1 presents summary statistics for the sample. Panel A displays statistics at the trader level, Panel B at the trade level, and Panel C at the trader-week level. We exclude traders with fewer than 20 trades in the sample. The 3,103 active traders in the sample make a total of 1,118,632 trades. All regression variables are winsorized at 1% and 99%. The average trader is in the dataset for almost exactly six months (180 days). This is the amount of time between a trader’s first and last trade. About 25% of traders leave the sample within the first 46 days, while 50% of traders exit the sample within 155 days. Of the 180 days on average between open and close, traders are actively trading on an average of 50 of those days. The average trader has an equal-weighted return per trade of -0.035%, and very few traders quit while ahead. That traders have such small average returns per trade is not surprising given that the median trade is open for only 16 minutes, as can be seen from Panel B. Only 16.2% of traders are profitable upon exiting the sample.
The traders in the sample are very active. Despite the relatively short trading lives of the traders in the sample, the average trader engages in just over 341 trades. Panel B shows that traders, on average, keep trades open for very short periods of time. The average trade is open for 291 minutes, but this is heavily skewed by the right tail of trades. About 25% of trades are open for only four minutes or less, and the median trade is open for only 16 minutes. The average absolute trade size is $14,230.

Panel C displays trader-week–level summary statistics. Again demonstrating the active nature of the traders in the sample, the average trader makes 23 trades per week. Traders are on average not profitable. Only 44% of weeks are profitable, and only 24% of weeks close with a trader having an aggregate running profit. This stands in contrast to the fact that 62.8% of trades are winning trades, as shown in Panel B. Traders exhibit the disposition effect, quickly realizing winning trades while only slowly realizing losing trades. The result is that the magnitude of the gain on winning trades is much smaller than the magnitude of the loss on losing trades. In unreported statistics, we find that losing trades are on average open for more than twice as long as winning trades and that the average loss on a losing trade is more than twice the absolute magnitude of the average gain on a winning trade.

3 Identification and Empirical Approach

The goal of the study is to test whether traders adjust their future risk taking and perceptions about their own skill in response to past performance. The tested claim is causal in the sense that there is an explicit proposed economic mechanism that generates the effect. Specifically, traders adjust their behavior based on past performance in an asymmetric manner: they attribute successes to their own skill but ascribe failures to bad luck. We expect this behavior to generate an asymmetric pattern with respect to past performance.

We propose two testable predictions. First, the week-on-week changes in risk taking and perceived skill may have greater sensitivity to past performance in the domain of past gains than in the domain of past losses. In other words, higher returns in the domain of past gains should encourage traders to increase their risk taking and enhance their perceptions of their own skill. In

---

3 Returns always use both realized and unrealized profits.
contrast, an increase in losses is expected not to have a large effect on risk taking or perceived risk, as losses are attributed to bad luck, and hence traders do not see a need to adjust their trading parameters.

To test this hypothesis, we use a piece-wise linear specification (positive versus negative) in which we measure the average slope (sensitivity) of trading behavior (risk taking or perceived risk) as a function of past performance. We predict that the slope in the positive domain will be steeper than that in the negative domain.

Our second prediction is about the discontinuity in trading behavior around the origin of past returns, as traders may simply use the binary categories of “gain” or “loss” to summarize their performance. Because traders attribute gains to their own skill and losses to bad luck, even a very small gain could trigger an increase in risk taking and enhanced perceptions of their skill. Thus, we expect to see a discontinuity in behavior around the origin of past performance.

This prediction can be tested by examining the average response of the trading behavior measures (risk taking and perceived skill) around zero for small gains and for small losses. We predict that small gains will generate a statistically larger response than will small losses. Figure 2 presents an illustration of the patterns predicted by our two hypotheses.

Another dimension in which we expect to observe differential effects is traders’ experience. According to Gervais and Odean (2001), traders adjust their behavior more when they are novices. Hence, the effects (differential slopes, discontinuity) should be stronger for early-life traders.

A necessary component in the identification proposal is that the relation between current performance and past performance does not correspond with the patterns of trading behavior that traders exhibit. While current performance can vary with past performance (e.g., if some skill exists in trading), the identification exercise will not be valid if there is a slope differential in the direction predicted (steeper slope for positive performance than for negative performance, or a discontinuity around zero past returns). We can test the relation between current and past performance using the same set of empirical specifications as in the predictions discussed above: a test for slope differences and a test for discontinuity around zero past returns.
4 Risk Taking and Perceived Skill: Effect of Past Performance

In Table 2, we examine how past performance affects risk taking and perceived skill. Panel A tests whether changes in risk taking and perceived skill exhibit differential responses in the positive and negative domains of past returns. Self-attribution bias suggests that traders will display increasing risk taking and perceived skill in the domain of gains, while exhibiting far less sensitivity to past returns in the domain of losses. We examine this hypothesis by testing for a difference in slope in the positive and negative domain of past returns.

Panel A displays results from OLS regressions of the change in average leverage and the change in active share on returns in week $t - 1$, a binary variable capturing whether the return in week $t - 1$ was positive, and returns in week $t - 1$ interacted with this binary variable. The interaction term coefficients in the second row capture any differences in slope in the positive and negative domains of past week returns. In addition to the main variables, we also control for week fixed effects (with respect to the trader’s first week of trading) and for calendar week fixed effects in all regressions and for trader fixed effects in Columns (2), (4), and (6). Standard errors are clustered two-ways in all regressions, by week and trader.

Consistent with traders exhibiting self-attribution bias, the results indicate that the change in average leverage and the change in active share exhibit a substantially higher sensitivity to returns in the positive domain of returns than in the negative domain of gains. In the negative domain, the slope is -0.31 (i.e., leverage increases as losses increase). In the positive domain, the slope is 0.53 (0.84 – 0.31), reflecting a difference of 0.84 between the positive and negative domains (Column (2)). The results remain robust when we use the alternative measure for the change in leverage based on medians (Columns (3) and (4)). Similarly, the slope in the positive domain for the change in active share (0.72 – 0.17 = 0.55) is substantially greater than the slope in the negative domain (-0.17), reflecting a difference in slopes of 0.72 (Column (6)).

Interestingly, the slope in the negative domain of past returns is negative but small, indicating that within the domain of losses the average trade size is increasing in the size of the loss from the previous week. While we do not document an overly strong effect, increased risk taking in response to larger losses is consistent with prospect theory preferences. Specifically, it is consistent with the convexity of the value function in the domain of losses, as this suggests that investors become increasingly risk seeking within the domain of losses. Coval and Shumway (2005) document consistent evidence among professional traders on the Chicago Board of Trade (CBOT), finding that within the domain of losses, the smaller the morning loss the smaller the afternoon increase in risk taking. That is, within the domain of losses, CBOT traders become increasingly risk seeking as losses become larger.
The regressions in Table 2, Panel A, also provide evidence that the behavior that we observe is not driven by margin calls. In particular, the negative slope in the domain of losses suggests that traders with losses actually increase their leverage in the following week, in contrast to a margin call explanation in which traders reduce their positions. Panel B employs a regression discontinuity design (RDD) to test for a jump in risk taking and perceived skill at zero. We fit separate third-degree polynomials to the positive and negative domains of past returns and test for a discontinuity at zero by including an indicator variable to capture positive past returns. The regressions display the coefficient on the indicator variable that tests for the existence of a jump.\footnote{Ben-David and Hirshleifer (2012) used a similar methodology to identify jumps around the origin of past returns.} We face a trade-off in choosing the appropriate degree of polynomial to use. A low-degree polynomial may not be flexible enough to capture the functional form. In contrast, a high-degree polynomial may be attenuated by extreme observations and therefore may not measure the discontinuity around zero well. See Ben-David and Hirshleifer (2012) for a discussion of this technique. In Appendix E, we provide additional analyses that measure the discontinuity with fourth- and fifth-degree polynomials. The results from these tests are consistent with those using the third-degree polynomial.

The coefficients in the trader fixed effect specifications (Columns (2), (4), and (6)) imply that traders increase their average leverage by 0.12 and their active share by 0.17 in weeks that follow very small positive returns, relative to weeks with very small negative returns. The results for leverage are insensitive to whether we use the change in the average leverage or the change in the median leverage (Columns (1) and (2) versus Columns (3) and (4)). These effects are very large, given that one standard deviation changes in average leverage and active share are 0.926 and 0.997, respectively. Thus, the economic effect is 13% and 17% of a standard deviation of the weekly changes in average leverage and active share. These results again support the hypothesis that traders suffer from self-attribution bias: small gains lead to large increases in risk taking and perceived skill while the same is not true for small losses.

We plot the relation between the change in the average leverage and past returns in Figure 3. To produce the figure, we split the trader-week sample into bins of 0.02% by their value-weighted average returns per trade in week $t - 1$ in the region around the origin. We limit the range of the sample to $+/− 0.15\%$ (capturing about 86% of sample observations). For each
group, we calculate the change in average leverage and plot the error bounds for $+/-$ two standard errors around the mean. We overlay on the chart the third-degree polynomial that is produced in Panel B of Table 2 (estimated on the entire sample). Figure 3 demonstrates that the slopes in the positive and negative domains are different, and it also shows a clear discontinuity around zero past returns.

In Figure 4, we use the same methodology to chart the change in active share with respect to previous week performance. The figure shows that active share is practically flat in the negative domain of past performance but is increasing in the positive domain. Furthermore, we see a clear discontinuity around zero past returns.

One possible concern is that the dependent variables are statistics based on individual trades within the week. When few trades are made in a week, then the calculated statistics are measured with noise. The usual econometric treatment for this heteroskedasticity problem is to use weighted least squares (WLS) regressions in which the weight of each observation is the square root of the inverse of its precision. We implement this approach in Appendix F, where we replicate the regressions from Table 2 using WLS. In the case of the change in average leverage and change in active share regressions, the weight of each observation is the square root of the average number of trades in weeks $t$ and $t-1$. In the case of the return regressions, the weight of each observation is the square root of the number of trades in week $t$. The results in Appendix F are almost identical to those in the main table.

To mitigate the concern that our discontinuity test is misspecified by focusing on zero returns as the focal point, we employ falsification tests to examine the robustness of our results in Panel B. The falsification test is presented in Appendix G. We test whether the effects we have documented around zero past returns are present at other random non-zero values. If traders do attribute successes to their own skill and failures to bad luck, then we would not expect to see effects as large around other randomly chosen values.\(^6\)

The falsification tests examine increments of $+/- 0.5$ standard deviations of the past week return out to $+/- 2$ standard deviations from the origin. The results support the hypothesis that the change in slope and discontinuity is specific to the origin. Panel A of Appendix G tests for a

---

\(^6\) Note that the predicted theoretical relationship documented in Figure 2 suggests that the slope should be higher to the right of any randomly chosen point relative to the left of that point. However, the effect should be strongest at the origin.
change in slope for the change in average leverage, and finds that only three of the eight falsification tests are significant at the 5% level. The same is true for four of the eight tests for the change in active share, as displayed in Panel B. The results in Panels C and D are similar for the falsification tests of a discontinuity. Only two of the eight falsification tests exhibits significance at the 5% level in the predicted direction for the change in average leverage. For the change in active share, none of the eight tests is significant at the 5% level in the predicted direction. The falsification tests support the hypothesis that the change in slope and discontinuity is specific to zero past week returns.

5 Risk Taking and Perceived Skill: Effects of Past Performance along Traders’ Lives

According to Gervais and Odean (2001), experiences early in a trader’s life have a disproportionately large effect on trader overconfidence. Table 3 tests this hypothesis by examining whether the effects that we document in Table 2 are strongest early in a trader’s life. To do so, we restrict the sample to traders who survive at least 15 weeks in our sample. This conditioning allows us to avoid a survival bias and ensures that the composition of the sample is constant vis-à-vis weeks of traders’ experience. Then, we limit the sample to only trader-week observations taking place in the first five weeks of the trader’s life. We repeat with limitations of 10 weeks and 15 weeks. We repeat the analysis from Table 2 (slopes and discontinuities) for these samples limited by traders’ trading experience.

Consistent with Gervais and Odean (2001), the results clearly suggest that the effect of past returns on risk taking and perceived skill is strongest early in a trader’s life. Panel A shows that both average leverage and active share exhibit the strongest response to past returns in the early weeks of trading. As the trader becomes more experienced, the average response becomes smaller: the coefficient decreases in size moving from Column (1) to (4), and from Column (5) to (8). We find a similar pattern in Panel B. The magnitude of the discontinuity decreases as traders become more experienced.
6 Current Performance and Past Performance

Lastly, we examine whether traders’ performance shares the same patterns exhibited by growth in average leverage and change in active share with respect to past returns. As noted before, this is a crucial test since it validates the identification of the effect of overconfidence. If the relation between current and past returns is similar to the relation between past returns and the change in average leverage or active share, then traders could have potentially interpreted the signals from past performance correctly, and we cannot conclude that they self-attribute positive signals and discard negative ones.

In Tables 4 and 5, we follow an empirical specification similar to that of Tables 2 and 3. The only difference is that the dependent variable is the trader’s performance in week \( t \). The explanatory variables are the same as before. Table 4 shows that in contrast to volume and active share, trader returns show no discontinuity at zero with respect to past returns. Furthermore, the relation between past and future returns does not exhibit an increased slope in the domain of gains relative to the domain of losses.

Table 5 repeats the same test but limits the sample to the first weeks in each trader’s life. We see no discernable patterns in the relation between future and past performance as a function of trader experience. The findings in Tables 4 and 5 confirm that the earlier results documenting changes in risk taking and perceived skill are not driven by the relation between current performance and past performance.

The relation between current returns and past returns is graphed in Figure 5. For all values of past returns, traders—on average—lose money in their current trades. In addition, current returns are lower for traders who experienced extreme returns—either very high or very low—in the previous week, likely because these traders enter into volatile trades, which result in extreme returns but with very low expected returns.

Figure 5 also shows that past returns have some predictability for current returns. In the positive domain, the returns are, on average, somewhat higher than those in the negative domain. However, the slopes are opposite of those we document in regard to traders’ behavior. In the positive domain, higher past returns are associated with worse current returns. In contrast, the results from the regressions of the change in average leverage and change in active share show the opposite: better past performance induces traders to increase leverage and active share. We
observe similar divergence in the negative domain: worse past performance in the negative domain predicts worse current performance. Conversely, within the negative domain, trading behavior appears to be more aggressive (e.g., leverage increases) following worse negative performance.

While there are differences in the average levels between positive and negative past performance, there is no discontinuity around zero. Very small losses and very small gains predict the same current performance. Nevertheless, traders attribute much importance to whether they are in the domain of positive or negative performance, as Table 2, Panel B, shows: both average leverage and active share increase following small gains, relative to small losses.

In several settings, we perform robustness tests of our main results that the slope of current performance on past performance does not match the pattern of trader behavior (Panel A) and that there is no discontinuity around zero returns (Panel B). In Appendix E, we measure the discontinuity in current value-weighted average returns around the origin using fourth- and fifth-degree polynomial specifications. The regressions report a small discontinuity, in the opposite direction than what we found in trader behavior (Table 2, Panel B). In Appendix F, we repeat the main tests using WLS regressions and find that after adjusting for heteroskedasticity, the results remain similar to the main results.

Overall, Figure 5 shows that the relation between current and past performance does not explain the strong patterns we observe in trading behavior with respect to past performance. In particular, we note in line with the results in the regressions in Table 4, Panel B, that there is no discontinuity around the origin. In fact, the relation between current returns and past returns around the origin is flat, meaning that small gains or losses have no predictive power over future returns at all.

7 Regression Discontinuity Design without High-Order Polynomials

The RDD method that we used above is widely used in economics. In a recent paper, Gelman and Imbens (2014) criticize this approach that uses high-order polynomials for estimating discontinuities. They argue that this method is arbitrary in the degree of polynomials
used (i.e., different polynomial degrees can lead to different results) and that the standard errors of the discontinuities estimated using this method may be understated.

Gelman and Imbens (2014) instead propose using a linear specification and limiting the sample to the close neighborhood of the discontinuity. We use this approach in Table 6. We limit the sample to +/-0.5 standard deviations (+/-0.07%) around the origin and use a simple piecewise linear specification that estimates the discontinuity.

The regressions in Table 6 confirm the prior estimation of the discontinuity as in Table 2, Panel B. The regressions estimating the discontinuity at zero average returns for the change in the average leverage (Columns (1) and (2)) present estimates that are slightly larger than those in Table 2, Panel B, Columns (1) and (2): 0.11 and 0.14, respectively, here relative to 0.09 and 0.12 in Table 2, Panel B. The estimates of the discontinuity for the change in active share (Columns (3) and (4)) are similar to those estimated in Table 2, Panel B: 0.16 and 0.17 here relative to 0.15 and 0.17 in Table 2, Panel B. The estimates for the discontinuity in current average returns (Columns (5) and (6)) are closer to zero and statistically insignificantly different from zero (although still negative), relative to those in Table 4, Panel B. Overall, our RDD results in the previous sections are robust to the estimation technique.

The table also allows us to estimate the slopes of the variables around the origin. The slopes of the change in the average leverage are similar to those estimated in Table 2, Panel A: the slope is negative in the negative domain and positive domain. The difference in the slopes is higher than estimated earlier, 2.4, from Column (2). The change in active share regressions (Columns (3) and (4)) do not exhibit a significant difference in slopes between the positive and negative domains.

8 Conclusion

Feedback in the form of past performance is important in forming one’s beliefs about skill. However, in certain situations, it may lead irrational individuals to develop overconfidence in their own skill. Specifically, when individuals attribute successes to their own skill and failures to luck, they become overconfident (Daniel, Hirshleifer, and Subrahmanyam 1998, and
Gervais and Odean 2001). Ultimately, overconfidence leads to excess risk taking as the individual discounts the true volatility of the outcome of the action taken.

Our study presents evidence for this mechanism in data of Forex day traders. We document that traders increase the amount that they trade (increased risk taking) and increase active share in their portfolio (increased perceived skill) following periods of successful trading. Our identification comes from contrasting the response of trader behavior in the positive and negative domains of past performance, as well as identifying the presence of a discontinuity around the origin of past performance. Furthermore, by focusing on a specific subset of investors—extremely active Forex traders who are arguably possess very little actual skill—we are able to estimate an upper bound on the economic importance of the effect in real markets.

The findings in this paper expand the academic discussion about the quality of feedback. In our study, there is ample feedback, but traders misinterpret it due to self-attribution. One wonders whether the same applies to other professions or domains, e.g., corporate executives, professional forecasters, weather forecasters, or medical doctors. If the usefulness of feedback differs across domains, it remains an open question what the determinants of this distinction are. Finally, one wonders to what extent our findings of retail trader overconfidence shed light on the behavior of professional traders. Professional traders are certainly not immune to overconfidence, and we therefore expect that our results also provide insight into the behavior of this important group of market participants. We leave these important questions for future research.
References


Appendix A. Main Tests with Three-Day Frequency

This table reports results from regressions in which the dependent variable measures the change in average leverage or change in active share for trader $i$ in the two-week period $t$ relative to the three-day period $t - 1$. $\text{Avg Trade Ret}(t - 1)$ (%) is a continuous variable equal to the return of trader $i$ in the two-week period $t - 1$, represented as percentage points. $I(\text{Avg Trade Ret}(t - 1) > 0)$ is an indicator variable taking a value of 1 when past value-weighted average returns are positive. The change in average leverage and the change in active share are represented as fractions. The regressions in Panel B include a third-degree polynomial of returns for the positive and for the negative domains, the coefficients of which are not reported. All regressions include week fixed effects. Trader fixed effects are included where noted. All regressions are OLS regressions. Standard errors are clustered at the trader and week level. $t$-statistics are in parentheses. *, **, *** denote significance at the 10%, 5%, and 1% level, respectively.

Panel A: The Slopes of the Change in Average Leverage and Change in Active Share with Respect to Past Returns, around Zero Past Returns (Three-Day Frequency)

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>Change in Average Leverage (t)</th>
<th>Change in Active Share (t)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Avg Trade Ret (t-1) (%)</td>
<td>-0.22***</td>
<td>-0.32***</td>
</tr>
<tr>
<td></td>
<td>(-5.06)</td>
<td>(-6.78)</td>
</tr>
<tr>
<td>$\times I(\text{Avg Trade Ret (t-1) &gt; 0})$</td>
<td>0.51***</td>
<td>0.70***</td>
</tr>
<tr>
<td></td>
<td>(7.98)</td>
<td>(9.64)</td>
</tr>
<tr>
<td>$I(\text{Avg Trade Ret (t-1) &gt; 0})$</td>
<td>0.07***</td>
<td>0.09***</td>
</tr>
<tr>
<td></td>
<td>(6.65)</td>
<td>(7.80)</td>
</tr>
<tr>
<td>Calendar FE</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Week FE</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Trader FE</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Obs</td>
<td>78,161</td>
<td>78,161</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.011</td>
<td>0.013</td>
</tr>
</tbody>
</table>

Panel B: The Discontinuity in the Change in Average Leverage and the Change in Active Share with Respect to Past Returns, around Zero Past Returns (Three-Day Frequency)

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>Change in Average Leverage (t)</th>
<th>Change in Active Share (t)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>$I(\text{Avg Trade Ret (t-1) &gt; 0})$</td>
<td>0.09***</td>
<td>0.10***</td>
</tr>
<tr>
<td></td>
<td>(5.71)</td>
<td>(6.94)</td>
</tr>
<tr>
<td>3rd degree polynomial</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>$\times I(\text{Avg Trade Ret (t-1) &gt; 0})$</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Calendar FE</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Week FE</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Trader FE</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Obs</td>
<td>78,161</td>
<td>78,161</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.011</td>
<td>0.013</td>
</tr>
</tbody>
</table>
Appendix B. Main Tests with Two-Week Frequency

This table reports results from regressions in which the dependent variable measures change in average leverage or change in active share for trader \(i\) in the two-week period \(t\) relative to the two-week period \(t-1\). \(\text{Avg Trade Ret}(t - 1)\) (%) is a continuous variable equal to the return of trader \(i\) in the two-week period \(t - 1\), represented as percentage points. \(I(\text{Avg Trade Ret}(t - 1) > 0)\) is an indicator variable taking a value of 1 when past value-weighted average returns are positive. The change in average leverage and the change in active share are represented as fractions. The regressions in Panel B include a third-degree polynomial of returns for the positive and for the negative domains, the coefficients of which are not reported. All regressions include week fixed effects. Trader fixed effects are included where noted. All regressions are OLS regressions. Standard errors are clustered at the trader and week level. *-statistics are in parentheses. * *, **, *** denote significance at the 10%, 5%, and 1% level, respectively.

Panel A: The Slopes of the Change in Average Leverage and the Change in Active Share with Respect to Past Returns, around Zero Past Returns (Two-Week Frequency)

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>Change in Average Leverage (t)</th>
<th>Change in Active Share (t)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Avg Trade Ret (t-1) (%)</td>
<td>-0.27*</td>
<td>-0.54***</td>
</tr>
<tr>
<td></td>
<td>(-1.95)</td>
<td>(-5.06)</td>
</tr>
<tr>
<td>(\times I(\text{Avg Trade Ret (t-1) &gt; 0}))</td>
<td>0.77***</td>
<td>1.29***</td>
</tr>
<tr>
<td></td>
<td>(2.74)</td>
<td>(5.08)</td>
</tr>
<tr>
<td>I(Avg Trade Ret (t-1) &gt; 0)</td>
<td>0.14***</td>
<td>0.19***</td>
</tr>
<tr>
<td></td>
<td>(6.29)</td>
<td>(9.11)</td>
</tr>
<tr>
<td>Calendar FE</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Week FE</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Trader FE</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Obs</td>
<td>24,815</td>
<td>24,815</td>
</tr>
<tr>
<td>(R^2)</td>
<td>0.011</td>
<td>0.034</td>
</tr>
</tbody>
</table>

Panel B: The Discontinuity in the Change in Average Leverage and the Change in Active Share with Respect to Past Returns, around Zero Past Returns (Two-Week Frequency)

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>Change in Average Leverage (t)</th>
<th>Change in Active Share (t)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>I(Avg Trade Ret (t-1) &gt; 0)</td>
<td>0.10***</td>
<td>0.15***</td>
</tr>
<tr>
<td></td>
<td>(3.59)</td>
<td>(5.84)</td>
</tr>
<tr>
<td>3rd degree polynomial &amp; (\times I(\text{Avg Trade Ret (t-1) &gt; 0}))</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Calendar FE</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Week FE</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Trader FE</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Obs</td>
<td>24,815</td>
<td>24,815</td>
</tr>
<tr>
<td>(R^2)</td>
<td>0.013</td>
<td>0.036</td>
</tr>
</tbody>
</table>
Appendix C. Main Tests without Accounting for Trader Exit

This table reports results from regressions in which the dependent variable measures change in average leverage or change in active share for trader $i$ from one week to another. In these tests, trader-weeks who exit the sample are simply dropped. $\text{Avg Trade Ret}(t - 1)$ (%) is a continuous variable equal to the return of trader $i$ in the two-week period $t - 1$, represented as percentage points. $I(\text{Avg Trade Ret}(t - 1) > 0)$ is an indicator variable taking a value of 1 when past value-weighted average returns are positive. The change in average leverage and the change in active share are represented as fractions. The regressions in Panel B include a third-degree polynomial of returns for the positive and for the negative domains, the coefficients of which are not reported. All regressions include week fixed effects. Trader fixed effects are included where noted. All regressions are OLS regressions. Standard errors are clustered at the trader and week level. $t$-statistics are in parentheses. *, **, *** denote significance at the 10%, 5%, and 1% level, respectively.

Panel A: The Slopes of the Change in Average Leverage with Respect to Past Returns, around Zero Past Returns (Exiting Trader-Weeks Are Dropped)

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>Change in Avg Leverage (t)</th>
<th>Change in Median Leverage (t)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Avg Trade Ret (t-1) (%)</td>
<td>-0.37**</td>
<td>-0.55***</td>
</tr>
<tr>
<td></td>
<td>(-5.96)</td>
<td>(-8.32)</td>
</tr>
<tr>
<td>$\times I(\text{Avg Trade Ret (t-1) &gt; 0})$</td>
<td>0.86***</td>
<td>1.26***</td>
</tr>
<tr>
<td></td>
<td>(7.09)</td>
<td>(9.30)</td>
</tr>
<tr>
<td>$I(\text{Avg Trade Ret (t-1) &gt; 0})$</td>
<td>0.09***</td>
<td>0.12***</td>
</tr>
<tr>
<td></td>
<td>(4.74)</td>
<td>(8.10)</td>
</tr>
<tr>
<td>Calendar FE</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Week FE</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Trader FE</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Obs</td>
<td>41,480</td>
<td>41,480</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.011</td>
<td>0.013</td>
</tr>
</tbody>
</table>

Panel B: The Discontinuity in the Change in Average Leverage with Respect to Past Returns, around Zero Past Returns (Exiting Trader-Weeks Are Dropped)

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>Change in Avg Leverage (t)</th>
<th>Change in Median Leverage (t)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>$I(\text{Avg Trade Ret (t-1) &gt; 0})$</td>
<td>0.09***</td>
<td>0.13***</td>
</tr>
<tr>
<td></td>
<td>(3.87)</td>
<td>(6.69)</td>
</tr>
<tr>
<td>3rd degree polynomial</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>$\times I(\text{Avg Trade Ret (t-1) &gt; 0})$</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Calendar FE</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Week FE</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Trader FE</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Obs</td>
<td>41,480</td>
<td>41,480</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.011</td>
<td>0.015</td>
</tr>
</tbody>
</table>
Appendix D. Winsorizing the Change in Active Share

This table reports results from regressions in which the dependent variable measures change in active share for trader $i$ in week $t$ relative to week $t-1$. $Avg \text{ Trade Ret}(t-1)\%$ is a continuous variable equal to the return of trader $i$ in week $t-1$, represented as percentage points. $I(Avg \text{ Trade Ret}(t-1) > 0)$ is an indicator variable taking a value of 1 when returns in week $t-1$ are positive. The change in active share is represented as a fraction. The dependent variable (change in active share) is winsorized at 5 in Columns (1) to (3), and at 10 in Columns (4) to (6). The regressions in Panel B include a third-degree polynomial of returns for the positive and for the negative domains, the coefficients of which are not reported. All regressions include week fixed effects. Trader fixed effects are included where noted. All regressions are OLS regressions. Standard errors are clustered at the trader and week level. $t$-statistics are in parentheses. *, **, *** denote significance at the 10%, 5%, and 1% level, respectively.

Panel A: The Slopes of the Change in Average Leverage and the Change in Active Share with Respect to Past Returns, around Zero Past Returns

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>Change in Active Share (t) (winsorized at 5)</th>
<th>Change in Active Share (t) (winsorized at 10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weeks:</td>
<td>$\leq 5$</td>
<td>$\leq 10$</td>
</tr>
<tr>
<td>Avg Trade Ret (t-1) (%)</td>
<td>-1.23*</td>
<td>-0.91***</td>
</tr>
<tr>
<td>$\times I(Avg \text{ Trade Ret}(t-1) &gt; 0)$</td>
<td>(1.92)</td>
<td>(2.72)</td>
</tr>
<tr>
<td>I(Avg Trade Ret (t-1) &gt; 0)</td>
<td>4.29***</td>
<td>3.44***</td>
</tr>
<tr>
<td>Calendar FE</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Week FE</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Trader FE</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Obs</td>
<td>4,247</td>
<td>9,378</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.055</td>
<td>0.036</td>
</tr>
</tbody>
</table>

Panel B: The Discontinuity in the Change in Average Leverage and the Change in Active Share with Respect to Past Returns, around Zero Past Returns

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>Change in Active Share (t) (winsorized at 5)</th>
<th>Change in Active Share (t) (winsorized at 10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weeks:</td>
<td>$\leq 5$</td>
<td>$\leq 10$</td>
</tr>
<tr>
<td>I(Avg Trade Ret (t-1) &gt; 0)</td>
<td>0.39***</td>
<td>0.38***</td>
</tr>
<tr>
<td>3rd degree polynomial $\times I(Avg \text{ Trade Ret}(t-1) &gt; 0)$</td>
<td>(3.83)</td>
<td>(3.92)</td>
</tr>
<tr>
<td>Calendar FE</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Week FE</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Trader FE</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Obs</td>
<td>4,247</td>
<td>9,378</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.056</td>
<td>0.037</td>
</tr>
</tbody>
</table>
Appendix E. Measuring the Discontinuity Using Higher Degree Polynomials

This table reports results from regressions in which the dependent variable measures the change in average leverage or the change in active share for trader \( i \) in week \( t \) relative to week \( t - 1 \), or the average trade return in week \( t \). \( \text{Avg Trade Ret}(t - 1) \text{ (%)} \) is a continuous variable equal to the return of trader \( i \) in week \( t - 1 \), represented as percentage points. \( I(\text{Avg Trade Ret}(t - 1) > 0) \) is an indicator variable taking a value of 1 when returns in week \( t - 1 \) are greater than 0. The change in average leverage and the change in active share are represented as fractions. The regressions include a fourth- or fifth-degree polynomial of returns for the positive and for the negative domains, the coefficients of which are not reported. All regressions include week fixed effects and trader fixed effects. All regressions are OLS regressions. Standard errors are clustered at the trader and week level. \( t \)-statistics are in parentheses. *, **, *** denote significance at the 10%, 5%, and 1% level, respectively.

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>Change in Average Leverage (t)</th>
<th>Change in Active Share (t)</th>
<th>Average Trade Return (t) (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polynomial degree:</td>
<td>4th</td>
<td>5th</td>
<td>4th</td>
</tr>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>( I(\text{Avg Trade Ret}(t-1) &gt; 0) )</td>
<td>0.14***</td>
<td>0.15***</td>
<td>0.15***</td>
</tr>
<tr>
<td></td>
<td>(6.47)</td>
<td>(5.96)</td>
<td>(7.16)</td>
</tr>
<tr>
<td>( \times I(\text{Avg Trade Ret}(t-1) &gt; 0) )</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Calendar FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Week FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Trader FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Obs</td>
<td>42,880</td>
<td>42,880</td>
<td>34,785</td>
</tr>
<tr>
<td>( R^2 )</td>
<td>0.015</td>
<td>0.016</td>
<td>0.026</td>
</tr>
</tbody>
</table>
Appendix F. Estimation Using WLS

This table reports results from regressions in which the dependent variable measures the change in average leverage, the change in active share for trader \( i \) in week \( t \) relative to week \( t - 1 \), or the average trade return in week \( t \). \( \text{Avg Trade Ret}(t - 1) \) (%) is a continuous variable equal to the return of trader \( i \) in week \( t - 1 \), represented as percentage points. \( I(\text{Avg Trade Ret}(t - 1) > 0) \) is an indicator variable taking a value of 1 when returns in week \( t - 1 \) are greater than 0. The change in average leverage and the change in active share are represented as fractions. The regressions in Panel B include a third-degree polynomial of returns for the positive and for the negative domains, the coefficients of which are not reported. All regressions include week fixed effects, and trader fixed effects are included where noted. All regressions are weighted least squares (WLS) regressions. Standard errors are clustered at the trader and week level. \( t \)-statistics are in parentheses. *, **, *** denote significance at the 10%, 5%, and 1% level, respectively.

**Panel A: The Slopes of the Change in Average Leverage, the Change in Active Share, and Average Trade Return with Respect to Past Returns, around Zero Past Returns**

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>Change in Average Leverage (t)</th>
<th>Change in Active Share (t)</th>
<th>Average Trade Return (t)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>Avg Trade Ret (t-1) (%)</td>
<td>-0.95***</td>
<td>-0.62***</td>
<td>-0.29*</td>
</tr>
<tr>
<td></td>
<td>(-5.07)</td>
<td>(-4.03)</td>
<td>(-1.76)</td>
</tr>
<tr>
<td>× I(Avg Trade Ret (t-1) &gt; 0)</td>
<td>1.76***</td>
<td>1.07***</td>
<td>0.99***</td>
</tr>
<tr>
<td></td>
<td>(5.22)</td>
<td>(4.39)</td>
<td>(3.28)</td>
</tr>
<tr>
<td>I(Avg Trade Ret (t-1) &gt; 0)</td>
<td>0.19***</td>
<td>0.15***</td>
<td>0.23***</td>
</tr>
<tr>
<td></td>
<td>(10.66)</td>
<td>(6.92)</td>
<td>(11.19)</td>
</tr>
<tr>
<td>Calendar FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Week FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Trader FE</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Obs</td>
<td>42,880</td>
<td>42,880</td>
<td>34,785</td>
</tr>
<tr>
<td>( R^2 )</td>
<td>0.027</td>
<td>0.042</td>
<td>0.034</td>
</tr>
</tbody>
</table>

**Panel B: The Discontinuity in the Change in Average Leverage, the Change in Active Share, and Average Trade Return with Respect to Past Returns, around Zero Past Returns**

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>Change in Average Leverage (t)</th>
<th>Change in Active Share (t)</th>
<th>Average Trade Return (t)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>I(Avg Trade Ret (t-1) &gt; 0)</td>
<td>0.1830***</td>
<td>0.1540***</td>
<td>0.1720***</td>
</tr>
<tr>
<td></td>
<td>(7.62)</td>
<td>(4.45)</td>
<td>(5.87)</td>
</tr>
<tr>
<td>3rd degree polynomial</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>× I(Avg Trade Ret (t-1) &gt; 0)</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Calendar FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Week FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Trader FE</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Obs</td>
<td>42,880</td>
<td>42,880</td>
<td>34,785</td>
</tr>
<tr>
<td>( R^2 )</td>
<td>0.030</td>
<td>0.044</td>
<td>0.035</td>
</tr>
</tbody>
</table>
Appendix G. Falsification Tests: Testing Slope and Discontinuity at Other Values

This table reports results from regressions in which the dependent variable measures the change in average leverage or the change in active share for trader $i$ in the week $t$ relative to week $t-1$. $Avg\ Trade\ Ret (t-1)\ (%)$ is a continuous variable equal to the return of trader $i$ in week $t-1$, represented as percentage points. $I(Avg\ Trade\ Ret (t-1) > x)$ is an indicator variable taking a value of 1 when returns in week $t-1$ are greater than $0 +/-$ the specified number of standard deviations. The change in active share is represented as a fraction. The regressions in Panel B include a third-degree polynomial of returns for the positive and for the negative domains, the coefficients of which are not reported. All regressions include week fixed effects, and trader fixed effects are included where noted. All regressions are OLS regressions. Standard errors are clustered at the trader and week level. $t$-statistics are in parentheses. *, **, *** denote significance at the 10%, 5%, and 1% level, respectively.

Panel A: Slopes of the Change in Average Leverage around Non-Zero Returns

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>Change in Average Leverage (t)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-2 std</td>
</tr>
<tr>
<td>Avg Trade Ret (t-1) (%)</td>
<td>(1)</td>
</tr>
<tr>
<td>0.08</td>
<td>0.06</td>
</tr>
<tr>
<td>(0.38)</td>
<td>(0.44)</td>
</tr>
<tr>
<td>$I(Avg\ Trade\ Ret (t-1) &gt; x)$</td>
<td>0.39*</td>
</tr>
<tr>
<td>(1.86)</td>
<td>(3.73)</td>
</tr>
<tr>
<td>$I(Avg\ Trade\ Ret (t-1) &gt; x)$</td>
<td>-0.04</td>
</tr>
<tr>
<td>(-0.40)</td>
<td>(-0.77)</td>
</tr>
</tbody>
</table>

Calendar FE Yes Yes Yes Yes Yes Yes Yes Yes Yes
Week FE Yes Yes Yes Yes Yes Yes Yes Yes Yes
Trader FE Yes Yes Yes Yes Yes Yes Yes Yes Yes
Obs 42,880 42,880 42,880 42,880 42,880 42,880 42,880 42,880 42,880 42,880
R$^2$ 0.010 0.010 0.011 0.012 0.014 0.010 0.009 0.009 0.009

Panel B: Slopes of the Change in Active Share around Non-Zero Returns

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>Change in Active Share (t)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-2 std</td>
</tr>
<tr>
<td>Avg Trade Ret (t-1) (%)</td>
<td>(1)</td>
</tr>
<tr>
<td>-0.01</td>
<td>-0.23</td>
</tr>
<tr>
<td>(-0.04)</td>
<td>(-0.91)</td>
</tr>
<tr>
<td>$I(Avg\ Trade\ Ret (t-1) &gt; x)$</td>
<td>1.05***</td>
</tr>
<tr>
<td>(3.11)</td>
<td>(4.99)</td>
</tr>
<tr>
<td>$I(Avg\ Trade\ Ret (t-1) &gt; x)$</td>
<td>0.01</td>
</tr>
<tr>
<td>(0.10)</td>
<td>(1.33)</td>
</tr>
</tbody>
</table>

Calendar FE Yes Yes Yes Yes Yes Yes Yes Yes Yes
Week FE Yes Yes Yes Yes Yes Yes Yes Yes Yes
Trader FE Yes Yes Yes Yes Yes Yes Yes Yes Yes
Obs 34,785 34,785 34,785 34,785 34,785 34,785 34,785 34,785 34,785 34,785
R$^2$ 0.020 0.020 0.021 0.021 0.025 0.018 0.017 0.017 0.017 0.017
### Appendix G: Falsification Tests: Testing Slope and Discontinuity at Other Values (Cont.)

#### Panel C: Discontinuity in the Change in Average Leverage around Non-Zero Returns

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>Change in Average Leverage (t)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-2 std</td>
</tr>
<tr>
<td>------------------------------</td>
<td>--------</td>
</tr>
<tr>
<td>I(Avg Trade Ret (t-1) &gt; x)</td>
<td>-9.41*</td>
</tr>
<tr>
<td></td>
<td>(-5.04)</td>
</tr>
<tr>
<td>3rd degree polynomial</td>
<td>Yes</td>
</tr>
<tr>
<td>× I(Avg Trade Ret (t-1) &gt; x)</td>
<td>Yes</td>
</tr>
</tbody>
</table>

### Panel D: Discontinuity in the Change in Active Share around Non-Zero Returns

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>Change in Active Share (t)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-2 std</td>
</tr>
<tr>
<td>------------------------------</td>
<td>--------</td>
</tr>
<tr>
<td>I(Avg Trade Ret (t-1) &gt; x)</td>
<td>3.40</td>
</tr>
<tr>
<td></td>
<td>(1.16)</td>
</tr>
<tr>
<td>3rd degree polynomial</td>
<td>Yes</td>
</tr>
<tr>
<td>× I(Avg Trade Ret (t-1) &gt; x)</td>
<td>Yes</td>
</tr>
</tbody>
</table>

R² values:

- Panel C: 0.0126, 0.0119, 0.0117, 0.013, 0.015, 0.0126, 0.0128, 0.0116, 0.0109
- Panel D: 0.022, 0.022, 0.022, 0.023, 0.025, 0.023, 0.022, 0.021, 0.020

Obs values:

- Panel C: 42,880, 42,880, 42,880, 42,880, 42,880, 42,880, 42,880, 42,880, 42,880
- Panel D: 34,785, 34,785, 34,785, 34,785, 34,785, 34,785, 34,785, 34,785, 34,785
Table 1. Summary Statistics

Table 1 presents summary statistics for the sample. Panel A displays statistics at the trader level; Panel B displays statistics at the trade level; and Panel C displays statistics at the trader-week level.

**Panel A: Trader-Level Summary Statistics**

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>St Dev</th>
<th>Min</th>
<th>P25</th>
<th>P50</th>
<th>P75</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td># Days in Sample</td>
<td>3,103</td>
<td>180.67</td>
<td>149.38</td>
<td>1</td>
<td>46</td>
<td>155</td>
<td>279</td>
<td>563</td>
</tr>
<tr>
<td># Days Active (Days with Trades)</td>
<td>3,103</td>
<td>50.34</td>
<td>53.22</td>
<td>1</td>
<td>11</td>
<td>32</td>
<td>70</td>
<td>254</td>
</tr>
<tr>
<td>% Profitable at End</td>
<td>3,103</td>
<td>16.21</td>
<td>36.86</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Avg Trade Ret/Trade (%)</td>
<td>3,103</td>
<td>-0.035</td>
<td>0.089</td>
<td>-0.570</td>
<td>-0.039</td>
<td>-0.016</td>
<td>-0.004</td>
<td>0.164</td>
</tr>
<tr>
<td>Avg Abs Trade Size/Trade ($)</td>
<td>3,103</td>
<td>21293.31</td>
<td>40368.51</td>
<td>1224.71</td>
<td>2224.19</td>
<td>5759.83</td>
<td>17578.94</td>
<td>235645.83</td>
</tr>
<tr>
<td># Trades</td>
<td>3,103</td>
<td>341.75</td>
<td>514.81</td>
<td>2</td>
<td>42</td>
<td>150</td>
<td>399</td>
<td>2975</td>
</tr>
</tbody>
</table>

**Panel B: Trade-Level Summary Statistics**

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>St Dev</th>
<th>Min</th>
<th>P25</th>
<th>P50</th>
<th>P75</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td># Minutes Trade Open</td>
<td>1,118,632</td>
<td>291.63</td>
<td>1065.64</td>
<td>0</td>
<td>4</td>
<td>16</td>
<td>83</td>
<td>7929</td>
</tr>
<tr>
<td>Trades Long (%)</td>
<td>1,118,632</td>
<td>47.28</td>
<td>49.93</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Average Trade Return (%)</td>
<td>1,118,632</td>
<td>-0.009</td>
<td>0.204</td>
<td>-1.120</td>
<td>-0.038</td>
<td>0.015</td>
<td>0.056</td>
<td>0.578</td>
</tr>
<tr>
<td>Trades Profitable (%)</td>
<td>1,118,632</td>
<td>62.76</td>
<td>48.34</td>
<td>0</td>
<td>0</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Trade Size ($)</td>
<td>1,118,632</td>
<td>-841.16</td>
<td>30383.46</td>
<td>-139805.00</td>
<td>-4026.59</td>
<td>-1300.26</td>
<td>2872.53</td>
<td>137286.00</td>
</tr>
<tr>
<td>Abs Trade Size ($)</td>
<td>1,118,632</td>
<td>14230.60</td>
<td>29162.89</td>
<td>1000.00</td>
<td>1414.55</td>
<td>3203.78</td>
<td>13500.77</td>
<td>173101.80</td>
</tr>
<tr>
<td>Leverage</td>
<td>1,118,632</td>
<td>53.24</td>
<td>80.61</td>
<td>0.2</td>
<td>5.6</td>
<td>20.9</td>
<td>64.1</td>
<td>416.4</td>
</tr>
</tbody>
</table>

**Panel C: Trader-Week-Level Summary Statistics**

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>St Dev</th>
<th>Min</th>
<th>P25</th>
<th>P50</th>
<th>P75</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td># Trades/Week</td>
<td>41,480</td>
<td>23.10</td>
<td>34.45</td>
<td>1</td>
<td>4</td>
<td>10</td>
<td>27</td>
<td>214</td>
</tr>
<tr>
<td>Weeks Profitable (%)</td>
<td>41,480</td>
<td>44.07</td>
<td>49.65</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Weeks w Running Profit at Close (%)</td>
<td>41,480</td>
<td>24.07</td>
<td>42.75</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Average Trade Return (t) (%)</td>
<td>41,480</td>
<td>-0.023</td>
<td>0.151</td>
<td>-0.726</td>
<td>-0.051</td>
<td>-0.007</td>
<td>0.030</td>
<td>0.488</td>
</tr>
<tr>
<td>Average Trade Return (t-1) (%)</td>
<td>42,880</td>
<td>-0.021</td>
<td>0.145</td>
<td>-0.726</td>
<td>-0.049</td>
<td>-0.007</td>
<td>0.030</td>
<td>0.488</td>
</tr>
<tr>
<td>Change in Average Leverage</td>
<td>42,880</td>
<td>0.124</td>
<td>0.926</td>
<td>-1.000</td>
<td>-0.190</td>
<td>-0.004</td>
<td>0.136</td>
<td>6.130</td>
</tr>
<tr>
<td>Change in Active Share</td>
<td>34,785</td>
<td>0.241</td>
<td>0.997</td>
<td>-0.999</td>
<td>-0.511</td>
<td>-0.020</td>
<td>0.808</td>
<td>2.000</td>
</tr>
</tbody>
</table>
Table 2. Change in Average Leverage and Change in Active Share, and Past Performance

This table reports results from regressions in which the dependent variable measures the change in average leverage or the change in active share for trader $i$ in week $t$ relative to week $t - 1$. $Avg\ Trade\ Ret(t - 1)\ (\%)$ is a continuous variable equal to the return of trader $i$ in week $t - 1$, represented as percentage points. $I(Avg\ Trade\ Ret(t - 1) > 0)$ is an indicator variable taking a value of 1 when returns in week $t - 1$ are positive. The change in average leverage and the change in active share are represented as fractions. The regressions in Panel B include a third-degree polynomial of returns for the positive and for the negative domains, the coefficients of which are not reported. All regressions include week fixed effects. Trader fixed effects are included where noted. All regressions are OLS regressions. Standard errors are clustered at the trader and week level. $t$-statistics are in parentheses. *, **, *** denote significance at the 10%, 5%, and 1% level, respectively.

Panel A: The Slopes of the Change in Average Leverage and the Change in Active Share with Respect to Past Returns, around Zero Past Returns

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>Change in Avg Leverage (t)</th>
<th>Change in Median Leverage (t)</th>
<th>Change in Active Share (t)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>Avg Trade Ret (t-1) (%)</td>
<td>-0.14***</td>
<td>-0.31***</td>
<td>-0.99***</td>
</tr>
<tr>
<td></td>
<td>(-2.24)</td>
<td>(-5.18)</td>
<td>(-3.13)</td>
</tr>
<tr>
<td>$\times I(Avg\ Trade\ Ret(t-1) &gt; 0)$</td>
<td>0.51***</td>
<td>0.84***</td>
<td>1.23***</td>
</tr>
<tr>
<td></td>
<td>(4.44)</td>
<td>(6.55)</td>
<td>(3.08)</td>
</tr>
<tr>
<td>$I(Avg\ Trade\ Ret(t-1) &gt; 0)$</td>
<td>0.11***</td>
<td>0.13***</td>
<td>0.02</td>
</tr>
<tr>
<td></td>
<td>(5.85)</td>
<td>(9.10)</td>
<td>(0.46)</td>
</tr>
<tr>
<td>Calendar FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Week FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Trader FE</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Obs</td>
<td>42,880</td>
<td>42,880</td>
<td>42,880</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.010</td>
<td>0.014</td>
<td>0.004</td>
</tr>
</tbody>
</table>

Panel B: The Discontinuity in the Change in Average Leverage and the Change in Active Share with Respect to Past Returns, around Zero Past Returns

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>Change in Avg Leverage (t)</th>
<th>Change in Median Leverage (t)</th>
<th>Change in Active Share (t)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>$I(Avg\ Trade\ Ret(t-1) &gt; 0)$</td>
<td>0.09***</td>
<td>0.12***</td>
<td>0.09*</td>
</tr>
<tr>
<td></td>
<td>(3.72)</td>
<td>(6.48)</td>
<td>(1.86)</td>
</tr>
<tr>
<td>3rd degree polynomial</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\times I(Avg\ Trade\ Ret(t-1) &gt; 0)$</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Calendar FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Week FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Trader FE</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Obs</td>
<td>42,880</td>
<td>42,880</td>
<td>42,880</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.011</td>
<td>0.015</td>
<td>0.004</td>
</tr>
</tbody>
</table>
Table 3. Change in Average Leverage and Change in Active Share, with Respect to Past Returns, by Period

This table reports results from regressions in which the dependent variable measures the change in average leverage or the change in active share for trader \(i\) in week \(t\) relative to week \(t - 1\). \(\text{Avg Trade Ret}(t - 1)\) (%) is a continuous variable equal to the return of trader \(i\) in week \(t - 1\), represented as percentage points. \(I(\text{Avg Trade Ret}(t - 1) > 0)\) is an indicator variable taking a value of 1 when returns in week \(t - 1\) are positive. The change in average leverage and the change in active share are represented as fractions. The sample is limited to the first five weeks of trading for each trader (Columns (1), and (5)), the first 10 weeks of trading for each trader (Columns (2) and (6)), the first 15 weeks of trading for each trader (Columns (3) and (7)), or all trader-weeks (Columns (4) and (8)). To enter the sample, a trader needs to survive at least 15 weeks. The regressions in Panel B include a third-degree polynomial of returns for the positive and for the negative domains, the coefficients of which are not reported. All regressions include week fixed effects. Trader fixed effects are included where noted. All regressions are OLS regressions. Standard errors are clustered at the trader and week level. t-statistics are in parentheses. *, **, *** denote significance at the 10%, 5%, and 1% level, respectively.

Panel A: The Slopes of the Change in Average Leverage and the Change in Active Share with Respect to Past Returns, around Zero Past Returns, by Period

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>Change in Average Leverage (t)</th>
<th>Change in Active Share (t)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(\leq 5)</td>
<td>(\leq 10)</td>
</tr>
<tr>
<td>Avg Trade Ret (t-1) (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(-0.92***)</td>
<td>(-0.83***)</td>
<td>(-0.71***)</td>
</tr>
<tr>
<td>((-4.90))</td>
<td>((-9.43))</td>
<td>((-9.31))</td>
</tr>
<tr>
<td>(\times I(\text{Avg Trade Ret}(t-1) &gt; 0))</td>
<td>(1.93***)</td>
<td>(1.80***)</td>
</tr>
<tr>
<td>((4.10))</td>
<td>((6.88))</td>
<td>((8.71))</td>
</tr>
<tr>
<td>(I(\text{Avg Trade Ret}(t-1) &gt; 0))</td>
<td>(0.18***)</td>
<td>(0.15***)</td>
</tr>
<tr>
<td>((3.25))</td>
<td>((8.43))</td>
<td>((5.90))</td>
</tr>
<tr>
<td>Calendar FE</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Week FE</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Trader FE</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Obs</td>
<td>4,833</td>
<td>10,859</td>
</tr>
<tr>
<td>(R^2)</td>
<td>0.038</td>
<td>0.026</td>
</tr>
</tbody>
</table>
Table 3. Change in Average Leverage and Change in Active Share, with Respect to Past Returns, by Period (Cont.)

Panel B: The Discontinuity in the Change in Average Leverage and the Change in Active Share with Respect to Past Returns, around Zero Past Returns, by Period

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>Change in Average Leverage (t)</th>
<th>Change in Active Share (t)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weeks:</td>
<td>≤ 5</td>
<td>≤ 10</td>
</tr>
<tr>
<td>I(Avg Trade Ret (t-1) &gt; 0)</td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td></td>
<td>0.27*** (4.41)</td>
<td>0.19*** (4.94)</td>
</tr>
<tr>
<td>3rd degree polynomial</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>× I(Avg Trade Ret (t-1) &gt; 0)</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Calendar FE</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Week FE</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Trader FE</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Obs</td>
<td>4,833</td>
<td>10,859</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.041</td>
<td>0.028</td>
</tr>
</tbody>
</table>
Table 4. Current Performance and Past Performance

This table reports results from regressions of returns in week $t$ as predicted by returns in week $t-1$. The dependent variable is the return of trader $i$ in week $t$. $Avg\ Trade\ Ret(t-1)\ (%)$ is a continuous variable equal to the return of trader $i$ in week $t-1$, represented as percentage points. $I(Avg\ Trade\ Ret(t-1) > 0)$ is an indicator variable taking a value of 1 when returns in week $t-1$ are positive. The regressions in Panel B include a third-degree polynomial of returns for the positive and for the negative domains, the coefficients of which are not reported. All regressions include week fixed effects. Trader fixed effects are included where noted. All regressions are OLS regressions. Standard errors are clustered at the trader and week level. $t$-statistics are in parentheses. *, **, *** denote significance at the 10%, 5%, and 1% level, respectively.

Panel A: The Slopes of Current Performance with Respect to Past Performance

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>Average Trade Return (t) (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
</tr>
<tr>
<td>Avg Trade Ret (t-1) (%)</td>
<td>0.07***</td>
</tr>
<tr>
<td></td>
<td>(6.00)</td>
</tr>
<tr>
<td>$\times I(Avg\ Trade\ Ret (t-1) &gt; 0)$</td>
<td>-0.13***</td>
</tr>
<tr>
<td></td>
<td>(-4.94)</td>
</tr>
<tr>
<td>$I(Avg\ Trade\ Ret (t-1) &gt; 0)$</td>
<td>0.01***</td>
</tr>
<tr>
<td></td>
<td>(3.18)</td>
</tr>
<tr>
<td>Calendar FE</td>
<td>Yes</td>
</tr>
<tr>
<td>Week FE</td>
<td>Yes</td>
</tr>
<tr>
<td>Trader FE</td>
<td>No</td>
</tr>
<tr>
<td>Obs</td>
<td>41,480</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.011</td>
</tr>
</tbody>
</table>

Panel B: Is There a Discontinuity around Zero for Current Performance with Respect to Past Performance?

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>Average Trade Return (t) (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
</tr>
<tr>
<td>$I(Avg\ Trade\ Ret (t-1) &gt; 0)$</td>
<td>-0.0027</td>
</tr>
<tr>
<td></td>
<td>(-0.91)</td>
</tr>
<tr>
<td>3rd degree polynomial</td>
<td>Yes</td>
</tr>
<tr>
<td>$\times I(Avg\ Trade\ Ret (t-1) &gt; 0)$</td>
<td>Yes</td>
</tr>
<tr>
<td>Calendar FE</td>
<td>Yes</td>
</tr>
<tr>
<td>Week FE</td>
<td>Yes</td>
</tr>
<tr>
<td>Trader FE</td>
<td>No</td>
</tr>
<tr>
<td>Obs</td>
<td>41,480</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.012</td>
</tr>
</tbody>
</table>
Table 5. Current Performance and Past Performance, by Period

This table reports results from regressions of the average trade return in week $t$ as predicted by the return in week $t - 1$. The dependent variable is the return of trader $i$ in week $t$. $Avg\ Trade\ Ret(t - 1)\ (%)$ is a continuous variable equal to the return of trader $i$ in week $t - 1$, represented as percentage points. $I(Avg\ Trade\ Ret(t - 1) > 0)$ is an indicator variable taking a value of 1 when returns in week $t - 1$ are positive. The change in average leverage and the change in active share are represented as fractions. The regressions in Panel B include a third-degree polynomial of returns for the positive and for the negative domains, the coefficients of which are not reported. All regressions include week fixed effects. Trader fixed effects are included where noted. All regressions are OLS regressions. Standard errors are clustered at the trader and week level. $t$-statistics are in parentheses. *, **, *** denote significance at the 10%, 5%, and 1% level, respectively.

Panel A: The Slopes of Current Performance with Respect to Past Performance, by Period

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>Week:</th>
<th>Average Trade Return (t) (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>≤ 5</td>
<td>≤ 10</td>
</tr>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Avg Trade Ret (t-1) (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-0.24***</td>
<td>-0.11***</td>
</tr>
<tr>
<td></td>
<td>(-4.16)</td>
<td>(-6.04)</td>
</tr>
<tr>
<td>× I(Avg Trade Ret (t-1) &gt; 0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-0.06</td>
<td>-0.08</td>
</tr>
<tr>
<td></td>
<td>(-0.63)</td>
<td>(-1.45)</td>
</tr>
<tr>
<td>I(Avg Trade Ret (t-1) &gt; 0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>(0.03)</td>
<td>(1.15)</td>
</tr>
<tr>
<td>Calendar FE</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Week FE</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Trader FE</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Obs</td>
<td>4,833</td>
<td>10,859</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.084</td>
<td>0.034</td>
</tr>
</tbody>
</table>
### Table 5. Current Performance and Past Performance, by Period (Cont.)

Panel B: Is There a Discontinuity around Zero for Current Performance with Respect to Past Performance, by Period?

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>Average Trade Return (t) (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>≤ 5</td>
</tr>
<tr>
<td></td>
<td>(1)</td>
</tr>
<tr>
<td>I(Avg Trade Ret (t-1) &gt; 0)</td>
<td>-0.0080</td>
</tr>
<tr>
<td></td>
<td>(-0.97)</td>
</tr>
<tr>
<td>3rd degree polynomial</td>
<td>Yes</td>
</tr>
<tr>
<td>× I(Avg Trade Ret (t-1) &gt; 0)</td>
<td>Yes</td>
</tr>
<tr>
<td>Calendar FE</td>
<td>Yes</td>
</tr>
<tr>
<td>Week FE</td>
<td>Yes</td>
</tr>
<tr>
<td>Trader FE</td>
<td>Yes</td>
</tr>
<tr>
<td>Obs</td>
<td>4,833</td>
</tr>
<tr>
<td>R²</td>
<td>0.092</td>
</tr>
</tbody>
</table>
Table 6. Regression Discontinuity Design without High-Order Polynomials

This table reports results from regressions in which the dependent variable measures the change in average leverage, the change in active share for trader $i$ in week $t$ relative to week $t-1$, or the average trade return in week $t$. $\text{Avg Trade Ret}(t - 1) \%$ is a continuous variable equal to the return of trader $i$ in week $t-1$, represented as percentage points. $I(\text{Avg Trade Ret}(t - 1) > 0)$ is an indicator variable taking a value of 1 when returns in week $t-1$ are greater than 0. The change in average leverage and the change in active share are represented as fractions. The sample in this regression is limited to +/-0.5 standard deviations (+/-0.07%) around the origin. All regressions include week fixed effects, and trader fixed effects are included where noted. All regressions are OLS regressions. Standard errors are clustered at the trader and week level. $t$-statistics are in parentheses. *, **, *** denote significance at the 10%, 5%, and 1% level, respectively.

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>Change in Avg Leverage ($t$)</th>
<th>Change in Active Share ($t$)</th>
<th>Average Trade Return ($t$) (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>Avg Trade Ret ($t-1$) (%)</td>
<td>-0.92***</td>
<td>-1.28***</td>
<td>0.99*</td>
</tr>
<tr>
<td></td>
<td>(-1.99)</td>
<td>(-2.34)</td>
<td>(1.91)</td>
</tr>
<tr>
<td>$\times I(\text{Avg Trade Ret} (t-1) &gt; 0)$</td>
<td>1.93***</td>
<td>2.41***</td>
<td>-0.95</td>
</tr>
<tr>
<td></td>
<td>(3.13)</td>
<td>(3.35)</td>
<td>(-1.27)</td>
</tr>
<tr>
<td>I(Avg Trade Ret ($t-1$) &gt; 0)</td>
<td>0.11***</td>
<td>0.14***</td>
<td>0.16***</td>
</tr>
<tr>
<td></td>
<td>(4.56)</td>
<td>(6.20)</td>
<td>(7.32)</td>
</tr>
<tr>
<td>Calendar FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Week FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Trader FE</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Obs</td>
<td>29,497</td>
<td>29,497</td>
<td>25,525</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.011</td>
<td>0.013</td>
<td>0.022</td>
</tr>
</tbody>
</table>
The figure shows the distribution of trader-week observations by their lagged average trade return. Bin size is 0.02%.
Figure 2. Hypothesis: Risk Taking and Perceived Skill Have Differential Slopes and Discontinuity around Zero Past Performance

The figure presents an illustration of the hypotheses that individuals respond to past performance in an asymmetric manner (different slope) with respect to gains and losses and that they may exhibit a discontinuity around the origin of past performance.
The figure shows the weekly change in the average leverage of traders as a function of the lagged average trade return. The change in average leverage is computed as the change in the average amount invested in each trade as a fraction of the initial balance at week \( t - 1 \). Observations (trader-week) are sorted into bins of 0.02%. In each bin, the diamond marker indicates the average, and the small x’s represent two standard errors from the mean. The solid line represents a third-degree polynomial fit (separate fit for positive and negative domains).
The figure shows the weekly change in the active share of traders as a function of the lagged average trade return. The change in active share is a measure of the change in the variability in trade sizes within a week (at least two trades are required). Observations (trader-week) are sorted into bins of 0.02%. In each bin, the diamond marker indicates the average, and the small x’s represent two standard errors from the mean. The solid line represents a third-degree polynomial fit (separate fit for positive and negative domains).
The figure shows the weekly average trade return of traders as a function of the lagged average trade return. Observations (trader-week) are sorted into bins of 0.02%. In each bin, the diamond marker indicates the average, and the small x’s represent two standard errors from the mean. The solid line represents a third-degree polynomial fit (separate fit for positive and negative domains).