Do Short Sellers Convey Information About Changes in Fundamentals or Risk?

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We examine whether unexpected levels of short interest are associated with subsequent downward revisions in fundamentals and/or subsequent upward revisions in risk. We use prediction errors from monthly models of short interest over 1992-2000 to proxy for unexpectedly high (and low) short interest positions, and we compare changes in fundamentals (as captured by analysts' earnings forecasts) and changes in risk factor loadings that occur subsequent to these unexpected positions. Relative to a sample of control firms with the lowest unexpected short interest, we find that analysts revise downward their earnings forecasts more severely for firms with high unexpected short interest; in addition, realized earnings for the high unexpected short interest firms are more likely to fall short of the consensus forecast. Tests examining shifts in three-factor risk loadings following high unexpected short interest show little evidence of significant risk changes. Overall, our evidence suggests that the information short sellers exploit mainly concerns the market's misperception of these firms' fundamentals.

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1. Introduction

This paper examines the information conveyed by short selling that is due to speculative trading.[1] Speculative short sellers sell overvalued stocks, hoping to reap gains when they reverse these positions (by buying the stock) when the stock price subsequently declines. There are at least three possible scenarios in which stocks are overvalued, and therefore are attractive to short sellers: (1) the market over-estimates the future earnings of the firm (the numerator effect in the valuation model); (2) the market under-estimates the firm's risk (the denominator effect in the valuation model); and/or (3) the market rationally and correctly assesses the firm's fundamentals and risk, but for some (irrational) reason, the stock price deviates from the intrinsic value that is supported by these fundamentals. An example of overvaluations arising in the third scenario is a fad or bubble.[2]

The objective of this paper is to investigate the extent to which the first and second scenarios are associated with short selling activity. That is, we investigate whether and to what extent short positions portend the market's misperception, and subsequent correction, of expectations of firms' fundamentals (as proxied by future earnings) and/or their risks. Our goal is to disentangle these two effects by providing evidence on whether high unexpected levels of short positions are associated with over-estimated earnings, under-estimated risks, or both. We also note that if short selling is largely driven by fads or bubbles (the third scenario), rather than misperceptions of fundamentals or risk, our tests are biased against finding changes in earnings expectations and/or changes in risk. This is because the end of a fad or the bursting of a bubble would not (necessarily) imply changes in the market's perceptions of the firm's underlying fundamentals or risk. Thus, if most short interest is due to bubble-speculation, we should not expect short positions to be related to predictable subsequent revisions in fundamentals or risk.

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[1] Short interest positions may also arise due to arbitrage, hedging or tax related reasons. Because these sources of short selling activity are not likely driven by mispricing, they are not the focus of our study. As we describe in more detail in section 4, our estimates of short selling activity associated with speculative positions control for these other motivations for short positions.

[2] For example, several studies show how speculative premia could arise from speculative trading driven by heterogeneous beliefs among investors (Miller, 1977; Harrison and Kreps, 1979; Morris, 1996).

Our research design to parse out the two sources of over-valuation is most closely related to the research designs used by Denis, McConnell, Ovtchinnikov and Yu (2003) and Grullon, Michaely and Swaminathan (2002). Denis et al. study the information content of additions to the S&P 500 Index, and Grullon et al. examine the information content of dividend changes. Grullon et al. attempt to separate the stock price effects of dividend changes due to shifts in fundamentals and shifts in perceived risk. We use a similar empirical design to analyze the information conveyed by unexpected changes in short interest. Like Denis et al., our primary interest is in explaining the subsequent returns to firms that experienced the event (i.e., firms that were added to the S&P 500 in Denis et al.'s study versus firms that experienced high unexpected short interest in our study).[3] In particular, we use analyst forecast revisions and forecast errors to proxy for the market's perception of future earnings and we use a three-factor model to estimate shifts in the market's perception of risk.

To identify the portion of short selling that is driven by speculation, we begin by constructing a model to estimate individual firms' monthly expected short interest positions between 1992 and 2000. Our model is successful in explaining over 90% of the variation in short interest levels. We use the residual from this model as our estimate of the firm's unexpected short interest position in a given month. We then relate such unexpected short interest to analyst forecast revisions and forecast errors. To control for over time patterns in analysts' forecast revisions, we use a sample of firms with low unexpected short interest levels as our control group. Our results show that, following the event month in which we measure unexpected high (or low) short interest positions, security analysts revise downward their earnings forecasts more severely for firms with high unexpected short interest than for firms with low unexpected short interest. We also find that realized earnings for firms with high unexpected short interest are more likely to fall short of the last consensus analyst forecast available prior to the unexpected increase in short interest. These findings indicate that short sellers appear to target firms where the

[3] In contrast, Grullon et al.'s focus is on explaining variation in the immediate market reaction to firms' announcements of dividend changes. Our setting does not lend itself to a clean test of immediate market reactions to unexpected short interest positions because our short interest data is observed at the monthly level, where changes in these values are not publicly announced (as are the information events studied by these other papers).

market has over-estimated the fundamentals, as reflected by the fact that subsequent forecast revisions and forecast errors are significantly more negative for high unexpected short interest positions.

To proxy for the extent to which the market misjudges firms' risks, we use three-factor asset pricing regressions (estimated at the firm level using 180 daily returns on each side of the event month) to determine the extent and magnitude of shifts in factor loadings surrounding unexpected changes in short interest. Similar to our tests of changes in analysts' forecasts, we use low unexpected short interest firms to control for changes in factor loadings that are due to macroeconomic shocks or other time-specific effects unrelated to changes in short interest. The results show that, in general, changes in most risk factor loadings for firms with high unexpected short interest are not different from changes in factor loadings for firms with low unexpected short interest; further, the few significant differences that we document are quite small in economic terms.

Taken together, our results suggest that the information short sellers exploit primarily concerns the market's misperception of firms' fundamentals (as measured by future profitability) rather than the market's misperception of risk. As such, we believe that our study contributes to the growing literature on short interest by identifying the type of information short sellers use or anticipate.

The rest of this paper is organized as follows. Section 2 motivates the paper and relates our study to the extant literature. We discuss our data and sample selection in section 3. Section 4 describes our model of unexpected short interest and provides summary statistics about the resulting estimates of unexpected short interest that we use in our tests. Section 5 presents our analysis of the relation between unexpected short interest positions and subsequent changes in fundamentals and changes in risk. We also present analyses to consider the link between changes in fundamentals and changes in risk and the subsequent returns earned by short sellers. Section 6 summarizes our findings and concludes.

2. Motivation and Related Research

Prior research has shown that short sale transactions are associated with immediate negative abnormal returns (Aitken, Frino, McCorry and Swan, 1998), and that firms with high levels of short interest subsequently experience negative abnormal returns (Asquith and Meulbroek, 1995; Desai, Ramesh, Thiagarajan and Balachandran, 2002; Asquith, Pathak and Ritter, 2004). Other research has investigated characteristics of firms that are targets of short selling activity. For example, Dechow, Hutton, Meulbroek and Sloan (1995) and Christophe, Ferri and Angel (2004) show that short sellers target firms with low ratios of fundamentals (such as earnings and book values) to market values. Jones and Lamont (2002) show that stocks that are expensive to short or which enter the borrowing market have high valuations and low subsequent returns. While these findings are consistent with short sellers identifying over-valued stocks, it does not speak to the specific pieces of information that short sellers exploit to determine this over-valuation.

Research which probes the types of information exploited by short sellers has yielded mixed results. Christophe, Ferri and Angel (2004) show that short selling activity appears to precede earnings announcements conveying negative news. Using a recent sample of short sale transactions occurring between April 1, 2004 and February 28, 2005, Daske, Richardson and Tuna (2005) question this finding. They find no evidence that short sale transactions are concentrated prior to bad news earnings announcements or bad news management forecasts. Desai, Krishnamurthy and Venkataraman (2004) and Richardson (2003) examine whether short sellers target firms with poor earnings quality. Desai et al. find increases in short positions in the 12-months prior to earnings restatements (their proxy for poor earnings quality), while Richardson finds no evidence that short sellers target firms with high accruals (his proxy for poor earnings quality).[4] Dechow, Sloan and Sweeney (1996) provide some evidence that short interest levels increase about two months prior to a sample of 27 SEC enforcement actions and remains high for about six months following the announcements. Finally, and perhaps most on point for our analysis of subsequent changes in fundamentals, Pownall and Simko (2005) find that firms targeted by

[4] Richardson (2003) examines raw short interest levels, while Desai et al. (2004) examine changes in short interest. The change in short interest is generally viewed as a more precise measure of speculative-based short interest positions, relative to the raw level of short interest, because other factors are known to influence short interest positions (arbitrage, hedging, and tax motivations). Under the view that these other explanations are roughly constant from one period to the next, the change in short interest will better isolate speculative short positions. As described in section 4, our model of expected short interest includes a lagged short interest term as well as explicit variables associated with these other motivations for short selling.

short sellers experience, in the year following these short positions, significant declines in earnings-based fundamentals such as earnings-to-price ratios and earnings growth.

Our study adds to this body of work in several ways. First, our study considers whether short seller anticipates a stock price decline due to either anticipated decreases in the numerator (corrections of over-estimated fundamentals) or anticipated increases in the denominator (corrections of under-estimated risk), or a combination of the two. To our knowledge, prior research has not investigated the possibility that short sellers take speculative positions for risk-related reasons, despite evidence in prior studies that short positions are larger and more concentrated in low book-to-market stocks (Dechow, Hutton, Meulbroek and Sloan, 1995; Christophe, Ferri and Angel, 2004). Together with Fama and French's (1993) evidence showing that the low book-to-market portfolio of stocks is not well-priced by the 3-factor asset pricing model,[5] these findings suggest that short sellers may target stocks whose risk is poorly captured by extant models of asset pricing, and therefore, perhaps poorly understood by investors.

Second, like Pownall and Simko, we develop a model of expected short interest levels which we estimate using a large sample of monthly short interest data covering the period 1992-2000. In contrast to Pownall and Simko's time-series model of short interest, we use a cross-sectional model which we estimate monthly. The main advantages of the cross-sectional approach are that we impose fewer data requirements (thus increasing sample size and sample composition)[6] and we allow the model parameters to change on a monthly basis. The latter allows us to capture tax-motivated short selling which has been shown by Brent, Morse and Stice (1990) to exhibit predictable patterns in December and January. The limitation of the cross-sectional model is that it imposes an assumption of a constant coefficient (on a given variable) across all firms, for a given month. We do not believe this limitation is terribly severe for our sample, as the average explained variation from the monthly models is over 93%. An important contribution of our study relative to Pownall and Simko's work is that we attempt to link the residual

[5] Specifically, Fama and French (1993, Table 9a) show that abnormal returns (as measured by the intercepts from 3-factor asset pricing regressions) are significant for both the smallest and the largest firms within the low book-to-market quintile.
[6] Our final sample contains 2,820 unique firms, compared to 1,333 unique firms in Pownall and Simko's sample of short interest over 1988-1999.

from the expected short interest model (that is, the unexpected short position) to explicit information events, occurring subsequent to the identification of the high unexpected short interest position, that reveal information about the firm's deteriorating fundamentals.

A third difference between our study and much of the prior research examining short sellers' anticipation of information events concerns the ordering of events in the research design. Most prior studies select an event (e.g., earnings announcement, management forecast, earnings restatement and SEC enforcement action) and then examine whether there are high levels of short interest preceding the event. In the case of earnings announcements and management forecasts (which might convey either good news or bad news), researchers further partition based on the sign of the event because their focus is (generally) on short selling prior to bad news earnings announcements or bad news management forecasts. In contrast, we begin with the identification of unusually high levels of short interest, and then focus on the magnitude and direction of information revealed by subsequent analysts' forecasts. Our approach of conditioning on the prior level of short interest rather than conditioning on the subsequent information event has at least two advantages. First, it allows us to speak to the implications of a broader cross-section of unexpected high short level positions than does prior research which, by construction, predicates its analysis on only short positions made prior to the information event being examined. There could, for example, be quite large short positions at other times, made in anticipation of information events not considered by the study (or any set of studies). Second, the information event-conditioning approach contains an implicit assumption that short sellers are able to predict both the timing and sign of the information event being examined, and that the information event is one that short sellers target. While it is reasonable to believe that short sellers are able to predict the timing of quarterly earnings announcements (either because announcement dates are known in advance or predictable based on prior year patterns), it is less reasonable to think short sellers can predict the timing of management forecasts, announcements of enforcement actions, or restatement announcements which are both less frequent in occurrence (so patterns are not able to be discerned from historical data) and have no required periodicity (i.e., they can occur at any time during the year). Further, while it is reasonable to believe that short sellers can predict the negative sign of the stock price consequences of restatements and enforcement actions (which are generally viewed as conveying bad news), there is much greater variation in the news content of earnings announcements and management forecasts. Thus, even if short sellers are able to predict *either* the timing *or* the sign of the information event, they would arguably have difficulty predicting both. These arguments may explain why prior studies' investigations of short interest positions near to information events have found mixed results.

Fourth, our study investigates a more timely and fluid information event than that examined in prior studies. In particular, security analysts continually update prior forecasts and issue new forecasts; importantly, there is no required timing or discrete periodicity to analysts' reporting as there is with quarterly earnings announcements. Because analysts can revise their forecasts at any time, it is more likely that short sellers take positions based on anticipated corrections in market expectations that are set by analysts, than based on corrections that are the result of firm-initiated disclosures which are rarer and, in some cases (such as earnings announcements) constrained-in-time. The reason is that short sellers hoping to profit from speculative positions would, all else equal, prefer that negative news about the shorted stock reach the market sooner rather than later, after they construct their short positions. This is because the short seller is exposed to the risk of the stock price increasing; the longer the short position remains open, the greater is the chance that the stock price will increase, thus exposing the short seller both to margin calls and an increased likelihood of an unprofitable return to his position. On this point, Reed (2003) suggest that the mean length of a loan for a short sale is about ten days. For hedge funds, Daske et al. argue that the average period that the short trade is open is likely to be longer, on the order of five to six months; for their sample, they estimate the mean (median) length to be 33 (42) trading days, or between one and two months.

A related advantage of examining analysts' forecast revisions is that it is not unreasonable to think that analysts' revisions are a *response* to the information conveyed by short positions. Alternatively, analysts' revisions may be a response to a more direct signal conveyed by the short seller to analysts: nothing precludes short sellers from directly communicating their negative views about a stock's fundamentals to analysts, in the hope that analysts might incorporate such views in their forecasts. In contrast, it is harder to see how the information in a firm's earnings announcement, management forecast or earnings restatement is a response to the short seller's position or to information conveyed by that short position. For example, in the case of short positions taken prior to earnings announcements, it seems that if the short position is successful, it must be because the short seller is able to predict the occurrence of negative earnings news; it is not because the negative earnings news is prompted by information conveyed by the short position. In fact, it is more likely that firms take deliberate actions to raise the level of short sale constraints rather than subsequently acquiesce to short sellers by disclosing bad news. On this point, Lamont (2004) suggests that shorted firms take actions (such as legal threats, investigations and lawsuits against the short seller) to impede short sellers from making a profit and thereby create a short squeeze.

Our focus on analysts' forecast revisions and forecast errors mitigates or avoids many of the above concerns because of several features of analysts' forecasts. As noted above, analysts generate forecasts frequently and have arguably weaker incentives (than firm management) to not attend to the information in short positions. Moreover, analysts' forecasts are based on a large set of information which encompasses the information events examined in prior studies; as such, analysts' forecasts represent a nice summary measure of the implications of many information events for expectations about the firm's fundamentals. For these reasons, tests based on revisions in analysts' forecasts are more likely to show a positive association between unexpected short positions and subsequent downward revisions in shorted firms' fundamentals – if, in fact, short positions anticipate (or cause) such changes.

3. Data and Sample

Our sample consists of NYSE and NASDAQ stocks with monthly short positions during the period January 1992 – December 2000. While both NYSE and NASDAQ firms report short positions on the day of settlement (which occurs on the 15^{th} of each month), the data are compiled differently by the two exchanges. For NYSE stocks, the data are complied four days after the settlement date (so on or about the 19th of each month); for NASDAQ firms, the data are compiled eight business days after the reporting of the settlement data (so on or about the 23rd of each month). We measure the short interest in a stock using the ratio of the number of shares shorted to the total number of shares outstanding on that particular day. This normalization controls for the effects that events such as stock splits and stock dividends have on short positions. In total, our sample consists of 93,045 firm-months with data on short positions. This sample represents short interest positions of 2,820 distinct firms.

Other data required by our tests include: analyst forecast data, which are taken from the Institutional Brokers Estimate System (I/B/E/S); earnings and other financial data, which are collected from COMPUSTAT; stock return data, taken from CRSP; option listing data, obtained from OptionMetrics database.

4. Estimating Unexpected Short Interest Positions

Short selling can occur for several reasons other than speculation. Notably, short selling in a firm's stock may arise due to arbitrage opportunities, hedging strategies and tax motivations (Brent, Morse and Stice, 1990). Consequently, for purposes of our tests it is important that we purge short sale activity attributable to non-speculative reasons from our measure of short selling activity. We do this by constructing an expectations model to predict the amount of short positions in a stock that is driven by factors other than speculation. We use the residual from this model as our proxy for the unexpected short interest in a firm's stock, which we interpret as a measure of the firm's speculative short interest.

Our model of short interest builds on Brent et al.'s model which includes variables capturing arbitrage, hedging and tax motivations for investors' short interest positions. We briefly summarize the variables included in their model (and therefore in ours). First, firms with significant inherent risks, both systematic and unsystematic, are more likely to be candidates for hedging and arbitrage strategies through offsetting short positions. To capture these sources of risk, our model includes estimates of the firm's market model beta and residual (idiosyncratic) variance. Second, we note that investors may consider short interest and option securities as substitutes in achieving arbitrage positions; at the same time, arbitrageurs may use short selling as complements to option strategies. To capture these effects, we include the presence of option trading to capture the potential complementary (or substitutive) nature of options trading with respect to short selling. Third, we consider the possibility that investors who own convertible securities hedge their exposure to common stock fluctuations by short selling the stock and locking in a stock price. Therefore, we include a dummy variable that captures the presence of convertible debt in the firm's capital structure.

In addition to the above factors, we include three variables which we expect to affect the level of short interest. First, we control for the stock's return over the preceding three months to control for speculative short selling that is motivated by recent price changes. Second, Dechow et al. (2001) document that short sellers position themselves in stocks with significantly low book-to-market ratios, because such stocks are known to have systematically lower future stock returns. Their research suggest that we include the book-to-market ratio as an additional explanatory variable. Similar arguments suggest that we include size as an additional explanatory variable, since size has also been shown to be related to subsequent returns. In particular, while small firms have, on average, outperformed large firms over long periods (1927-2003), this size effect reversed over our sample period (1992-2000) where we observe a negative average daily value of the *SMB* factor of -0.012%. If short sellers anticipate that small stocks under-perform large stocks, we expect them to position themselves in stocks of smaller firms. Lastly, we include the firm's short interest position in the prior month to control for omitted variables that may determine short interest but which are not explicitly identified by or included in our model.

We estimate the following empirical specification using the variables discussed above:

$$\begin{aligned} Short_{i,t} = {} & \lambda_0 + \lambda_1 Beta_{i,t} + \lambda_2 Retvar_{i,t} + \lambda_3 Convdebt_{i,t} + \lambda_4 Option_{i,t} + \lambda_5 Return_{i,t-3} \\ & + \lambda_6 Size_{i,t} + \lambda_7 B/M_{i,t} + \lambda_8 Short_{i,t-1} + \varepsilon_{i,t} \end{aligned} \tag{1}$$

where $Short_{i,t}$ = firm i's short interest in month t scaled by number of shares outstanding in month t; $Beta_{i,t}$ = firm i's market model beta estimated from three years of daily data up through the last fiscal quarter; $Retvar_{i,t}$ = residual variance from market model estimated using three years of daily data up through the last fiscal quarter; $Convdebt_{i,t}$ = a dummy variable that takes the value of 1 if firm i has outstanding convertible debt at the end of the prior fiscal year and zero otherwise; $Option_{i,t}$ = a dummy variable that takes a value of 1 if firm i has options trading at the beginning of month t and zero otherwise;[7] $Return_{i,t-3}$ = firm i's cumulative return over the three months preceding month t; $Size_{i,t}$ = firm i's market value at the beginning of month t; $B/M_{i,t}$ = firm i's book to market ratio calculated as the book value of equity at the end of the prior fiscal quarter scaled by the market value of equity at the beginning of month t.

We estimate equation (1) in cross section for each of the 106 months in our sample period, March 1992 through December 2000.[8] We use each firm's residual from the regression for month t, $\hat{\varepsilon}_{i,t}$, as our measure of firm i's unexpected short interest in month t. Estimating monthly cross-sectional regressions has two advantages over a pooled sample estimation. First, it controls for serial correlation in error terms that plagues pooled estimations. Second, Brent et al. document that short interest positions are significantly larger in December and significantly smaller in January, consistent with tax motivations for short interest activity. Our monthly estimations allow the intercept, λ_0, to capture any time-specific effects on short interest levels, such as tax motivated short selling in December and January.

Table 1 summarizes the coefficients obtained from estimations of equation (1). For completeness, we report summary statistics from both a pooled estimation and monthly estimations; the monthly estimations use the Fama-MacBeth (1973) approach in that we report average coefficient estimates and use the time-series of the standard errors of the 106 monthly estimates to calculate t-statistics. We focus

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[7] The OptionMetrics database contains option prices beginning in 1996. For the period prior to 1996, we treat a firm as having options trading if that firm had traded options on the first trading day of 1996 for which data is available in OptionMetrics. This identification procedure induces measurement error in our estimation of the unexpected short interest for firm-months in our sample prior to 1996 (i.e., 1992-1995). We address this problem in two ways. One, we eliminate observations prior to 1996 and repeat our empirical analyses on this reduced sample. Two, we re-estimate equation (1) after eliminating the option dummy variable, and then use the resulting residuals as the measure of unexpected short interest in all of the empirical tests. Results (not tabled) from conducting these additional analyses do not alter any inferences.

[8] Our estimations begin in March 1992 rather than January 1992 (the first month for which we have short position data) for two reasons: 1) our model of short interest includes a lag term, $Short_{i,t-1}$; and 2) there are too few observations for February 1992 to reliably estimate the model.

our discussion on the results from the monthly estimations. Consistent with the results documented in Brent et al., the average coefficient estimates on convertible securities and market beta are positive and statistically significant (t-statistics are 5.71 for $Beta_{i,t}$ and 4.28 for $Convdebt_{i,t}$). The average coefficient on size is significantly negative (t-statistic = -8.95), consistent with the view that short sellers target smaller stocks which, over our sample period, underperformed relative to larger firms. Similar to Dechow et al. (2001), we also find that short sellers assume positions in firms with low book-to-market ratios (average coefficient on $B/M_{i,t}$ is -0.502, t-statistic = -7.29), consistent with short sellers believing that such stocks have lower future returns. None of option trading, idiosyncratic returns variability, and prior stock return is associated with short interest positions (as indicated by insignificant average coefficient estimates from the monthly estimations).[9]

By far the most significant variable in our model is the prior month's short interest which we find is positively associated with the current month's short interest, with a t-statistic of 203.67. The explanatory power of the short interest model is quite high: 93.11% on average for the monthly estimations. A significant portion of this explained variability is due to the influence of prior short interest; in unreported tests we find that a model which includes only $Short_{i,t-1}$ (and excludes all other variables) explains 92.9% of the variation in current month short interest, $Short_{i,t}$. We note, however, that there is substantial shared variation between prior short interest and the other explanatory variables, as evidenced by the fact that these other variables explain about 12% of the variation in $Short_{i,t}$ if lagged short interest is excluded from the regression (results not reported).

Descriptive statistics for our measure of firms' unexpected short interest positions (i.e., the residuals from equation (1), $\hat{\varepsilon}_{i,t}$) are presented in Panel A of Table 2. For reporting purposes, we partition the sample into five quintiles based on the magnitude of the unexpected short interest: quintile 1

[9] We note that the pooled estimation shows that both option trading and return variability are positively associated with short interest (t-statistic = 4.64 for *Option*, and 1.91 for *Retvar*). The positive coefficient on *Option* is consistent with Brent et al.'s findings, but the positive coefficient on *Retvar* is not (they find a significant negative coefficient relating residual stock volatility to short positions).

(Q1) contains stocks with the smallest unexpected short interest, and quintile 5 (Q5) contains stock with the largest unexpected short interest. The ranking of residuals is performed each month (not over the entire sample period). By construction, the magnitudes of the unexpected short interest increase monotonically from Q1 (mean of -0.767%) to Q5 (mean of 0.876%). In contrast, we note that while the raw short interest position of Q5 is markedly higher than that of Q1 (4.223% versus 2.387%), the increase in the magnitude of the (raw) short interest is not monotonic across the intermediate quintiles. In fact, the data in Table 2 shows that the *highest* levels of (raw) short interest are observed for *both* stocks with the *highest* level of unexpected short interest (raw short interest level is 4.223 for Q5) *and* stocks with the *lowest* level of unexpected short interest (raw short interest level is 2.387 for Q1). Stocks in the intermediate quintiles have mean raw short interest positions of between 0.784% and 1.296%, well below the mean values for either of the two extreme quintiles. This pattern suggests that extreme high (low) levels of raw short interest do not necessarily imply high (low) levels of unexpected short interest. This finding may explain why prior research based on raw short interest levels (such as Richardson, 2003) reports weak evidence concerning the relation between short positions and selected information (i.e., high accruals in Richardson, 2003). Specifically, if high levels of (raw) short interest are associated with *both* high *and* low unexpected short interest, tests which use raw short interest to identify unusual levels of short selling activity could easily yield null results.

Information about the over time pattern in unexpected short interest and raw short interest is presented in Panel B of Table 2 and illustrated in Figure 1. Month t=0 is the month in which we group observations into quintiles based on the magnitude of unexpected short interest (hereinafter the “event month”). On average, there are about 176 distinct firms represented in each monthly quintile (i.e., 93,405 firm-months in the sample implies an average of 18,681 firm-months per quintile, which divided by 106 months yields an average of 176 firms). We then track both raw and unexpected short interest positions for Quintiles 1 and 5 (i.e., high vs. low unexpected short interest quintile) for the preceding and succeeding six months relative to the event month (months -6 to + 6). Note that the average unexpected short interest for Q1 in month 0 of -0.767% and for Q5 of 0.876% correspond to the mean values of unexpected short interest reported in Panel A. The levels of raw short interest and unexpected short interest for stocks in Q1 and Q5 are in close proximity to each other prior to month 0 (i.e., over months -6 to -1). During month 0, however, we observe a marked shift: firms in Q1 (Q5) experience a significant decrease (increase) in short interest. These increases (decreases) are illustrated in Figure 1, Panel A (for raw short interest) and Panel B (for unexpected short interest). Subsequent to the event month, unexpected short interest levels revert to normal levels within one month. In contrast, inspection of the Panel A graph shows that while raw levels of short interest in Q1 (Q5) increase (decrease) slightly over subsequent months, they do not mean revert to the levels observed during months -6 to -1. The conclusion we draw from these patterns is that our identification of high and low unexpected short interest positions appears to capture a marked change in short interest activity which is relatively short lived.

5. Unexpected Short Interest and Changes in Fundamentals and Changes in Risk

This section contains our main empirical tests, of the association between unexpected short interest and changes in fundamentals (section 5.1) and changes in risk (5.2). We begin by presenting univariate comparisons of these changes, showing the relative difference in each effect for the test sample versus the control sample. Next, we present a multivariate analysis which considers the joint effect of unexpected short interest on changes in fundamentals and changes in risk (section 5.3). We conclude by presenting the links between subsequent returns and changes in fundaments and changes in risk (section 5.4) and discussing sensitivity tests (section 5.5).

5.1. Changes in fundamentals following unexpected short interest

We begin by examining whether an unexpected increase in firm i's short interest in the event month is associated with a subsequent decrease in investors' expectations about firm i's future operating performance. These tests are predicated on the view that if short sellers (through their high unexpected short positions) convey information about potential over-estimation of firm fundamentals, then we expect to observe subsequent decreases in these fundamentals. To the extent that investors attend to the information in short sellers' positions we would, in turn, expect stock prices to fall (as a consequence of the downward revision of fundamentals) – thus benefiting short sellers who buy the stock back at the lower prices.

We use analysts' earnings forecasts obtained from the I/B/E/S database to proxy for investors' expectations of future operating performance. We examine the change in analysts' forecasts measured over the period just before the increase in short interest, to the period just after the increase in short interest. In comparing changes in analysts' forecasts before and after the event month, we require a benchmark for the magnitude of any such over-time change because prior research documents that analysts are overly optimistic early in the forecast period and tend to lower their forecasts as the announcement date nears (e.g., Richardson, Teoh and Wysocki, 2004). This pattern inherently biases towards a finding that analysts decrease their earnings forecasts following an unexpectedly high short interest position, because we compare forecasts issued before versus after the month of the unexpected increase. To control for this bias, we compare changes in analysts' forecasts for firms with significant *increases* in short interest positions (the *test sample*) to firms with significant *decreases* in short interest (the *control sample*). In other words, we compare changes in analysts' forecasts for firms in Q5 (the test sample) with changes in analysts' forecasts for firms in Q1 (the control sample).

We consider both current year and one-year-ahead consensus earnings forecasts as proxies for analysts' expectations of the firm's fundamentals. Using current year earnings forecasts presents two challenges. First, for unexpected short interest positions that occur late in the fiscal year (i.e., in the fourth quarter), it may be difficult to detect a change in the current year forecast because much of the information about a firm's annual earnings (i.e., changes due to realizations of earnings known from the first, second and third fiscal quarters) will already be incorporated in analysts' forecasts. Second, because annual earnings are not announced (usually) until a couple of months after the end of the fiscal year, some months in the subsequent fiscal year will have forecasts pertaining to the previous fiscal year, which will appear as current year forecasts in the I/B/E/S database. For example, a firm with fiscal year ending December 1994 will have analysts' forecasts for fiscal year 1994 earnings appearing in January and February of 1995 as current year forecasts. Following Denis et al., we resolve these issues as follows.

For unexpected short interest positions measured in the last three months of a firm's fiscal year, we use forecasts made for the subsequent fiscal year as our proxy for the current year forecast. Using the example above, this means that we use earnings forecasts for 1995 (1996) earnings made in October, November and December of 1994 (for a firm with a fiscal year ending December 1994) as our proxy for the current year (one-year ahead) earnings forecast.

We use the mean consensus earnings forecast for each fiscal year reported by I/B/E/S in the month before, and the month after, the event month. In unreported tests, we confirm that the results are qualitatively similar if we use median rather than mean consensus forecasts. If no consensus forecast is available for firm i in months -1 and +1 (or if a consensus forecast is available but is based on a single analyst forecast), we determine the next most proximate month in which there is a consensus forecast (or a consensus forecast that is based on two or more analyst forecasts). Our proximate period includes up to three months before and three months after the event month. We delete firms from both the test sample and the control sample where we are unable to obtain a consensus forecast for both the pre-event period and the post-event period. The vast majority of the pre-consensus forecasts come from month -1 and the vast majority of post-consensus forecasts come from month +1. The average number of analysts covering our sample firms is 8.5, median analyst coverage is 6 and maximum coverage is 51.

To determine the change in analysts' earnings expectations, we consider both raw and standardized analysts forecasts. The raw change in firm i's consensus earnings forecast for year k$\in${current year, one-year ahead}, $\Delta FCST_{i,t}^{k}$, is computed as the difference between the consensus estimate measured prior to the event month (the pre-consensus forecast) and the consensus estimate measured after the event month (the post-consensus forecast):[10] $\Delta FCST_{i,t}^{k} = FCST_{i,Post}^{k} - FCST_{i,Pre}^{k}$

[10] Note that the inclusion of stale forecasts in forming the consensus will, if anything, bias against a finding that analysts revise downward their forecasts following high unexpected short positions. The reason is that staleness will induce an appearance of stickiness in consensus forecasts, causing any change in consensus forecasts to understate the true change (i.e., the change that would be observed absent the inclusion of stale forecasts). Understatement rather than overstatement results because of the known greater optimism in earlier-in-the-year forecasts.

where $FCST_{i,Pre}^{k}$ = the pre-consensus forecast for firm i's earnings for period k (k= current year or one-year ahead) made just before the event month; $FCST_{i,Post}^{k}$ = the post-consensus forecast for firm i's earnings for year k made just after the event month. Because raw changes in earnings forecasts are likely to be influenced by firm size (i.e., larger firms are likely to have larger changes), we also consider two standardized measures of the forecast revision. First, we standardize the change in consensus forecasts by firm i's stock price at the beginning of the event month: $\frac{\Delta FCST_{i,t}^{k}}{P_{i,t-1}} = \frac{FCST_{i,Post}^{k} - FCST_{i,Pre}^{k}}{P_{i,t-1}}$. Second, we standardize the change in consensus forecasts by the absolute value of the consensus forecast for year k in the pre-period: $\Delta FCST_{i,t}^{k}\% = \frac{FCST_{i,Post}^{k} - FCST_{i,Pre}^{k}}{\left|FCST_{i,Pre}^{k}\right|}$.

Results for all three forecast change measures are presented in Table 3, Panel A (for current year forecasts) and Panel B (for one-year-ahead forecasts). These findings show that firms with the largest unexpected short interest (Q5 firms) experience a *downward* forecast revision of -4.9 cents per share in current year EPS forecasts, which is substantially more negative than the -3.7 cents per share change in current year EPS forecasts found for firms with the smallest unexpected short interest (Q1 firms). The t-statistic for the difference in the current year forecast revision is -3.37 (based on the Fama-MacBeth test). Similar results are found in the one-year-ahead forecasts where we find mean forecast revisions of -4.0 cents for the test sample versus -2.6 cents for the control sample; the difference is also significant at the 0.10 level or better. Although not discussed, results based on the pooled sample of observations show a similar pattern, with higher statistical significance.

Our inferences are largely unchanged if we examine changes in standardized EPS forecasts. For example, when we standardize EPS forecast change by stock price prior to the event month, firms in the highest quintile of unexpected short interest experience a significantly more negative forecast revision in current year (one-year-ahead) forecast than firms in the lowest quintile. The mean difference is -0.06% of price for current year forecast revisions (-0.05% for one year ahead forecast revisions), and the Fama-

MacBeth t-statistic testing whether this value is reliably different from zero is -2.78 (-1.48). Similarly, for EPS forecast revisions standardized by the absolute value of the EPS forecast in the pre-period, we find that firms in the highest quintile have a more negative current year (one-year-ahead) forecast change relative to the lowest quintile, of -1.12% (-0.74) with Fama-MacBeth t-statistics of -2.93 (-2.07).

We extend the findings from Table 3, Panel A concerning analysts' earnings forecast revisions to consider future changes in a firm's *realized* profitability. Thus, in contrast to the forecast revision tests, these analyses assume a rational expectations framework where future earnings realizations are expected to, on average, approximate investor expectations. Stated differently, examination of forecast errors allows us to comment on whether the observed forecast revisions were directionally consistent with the actual reported earnings. To perform this analysis, we use firm i's realized earnings for the current year (or one year ahead). Our tests examine whether the forecast errors for firms in the test sample (i.e., firms with the highest unexpected short interest) differ from the forecast errors for control firms (i.e., firms with the smallest unexpected short interest). The forecast error for firm i's year k earnings ($FE_{i,t}^{k}$) is measured as the difference between firm i's reported EPS for year k and the consensus analyst forecast for year k earnings made immediately prior to the event month: $FE_{i,t}^{k} = EPS_{i}^{k} - FCST_{i,Pre}^{k}$ where EPS_{i}^{k} = firm i's reported earnings for year k; other variables are as previously defined. Similar to the analysis of earnings forecast revisions, we examine both raw forecast errors and forecast errors standardized by beginning of month stock price ($\frac{FE_{i,t}^{k}}{P_{i,t-1}} = \frac{EPS_{i}^{k} - FCST_{i,Pre}^{k}}{P_{i,t-1}}$) and by the absolute value of the prior forecast ($FE_{i,t}^{k}\% = \frac{EPS_{i}^{k} - FCST_{i,Pre}^{k}}{\left|FCST_{i,Pre}^{k}\right|}$).

Results of the analysis of realized future profitability, as proxied by analysts' forecast errors, are presented in Table 4. As with the forecast revision results, we present forecast errors separately for current year forecasts (Panel A) and for one-year-ahead forecasts (Panel B). The results indicate that both the test sample and the control sample evidence significantly negative forecast errors. In particular, the mean current year forecast error for the test firms is -26.7 cents versus -20.1 cents for the control firms. The finding of negative forecast errors is consistent with prior findings on analyst optimism, which show that, on average, analysts' forecasts are significantly higher than realized earnings (especially when those forecasts are made early in the year). What is noteworthy for our setting is that the current year forecast errors for the test firms are significantly *more* negative than are the forecast errors for the control firms – by about 7 cents per share on average (Fama-MacBeth t-statistic is -3.48). Similar results are observed for analyses based on one-year ahead forecasts, where we find that the average forecast error for the test sample is -59.0 cents per share, compared to -47.6 cents per share for the control sample (the t-statistic for the mean difference of -11.4 cents per share is -2.74). Finally, we note that similar inferences obtain from comparisons of price-scaled, or absolute forecast scaled, forecast errors.

In sum, the findings in Table 4 indicate that firms with unexpectedly high short interest positions have poorer subsequent operating performance. The results in Table 3 further suggest that some portion of this poorer performance is anticipated by analysts, insofar as we document that in periods following the unexpected short interest positions, we observe more negative forecast revisions for high unexpected short interest positions than for low unexpected short positions. While these results are consistent with short sellers anticipating (or causing) revisions in the market's expectations about shorted firms' fundamentals, they do not preclude the possibility that short sellers (also) target firms whose stock prices are inflated due to the market under-estimating risk. The analysis in the next section probes the latter explanation by examining changes in risk in months surrounding the one in which we identify unexpectedly high levels of short interest.

5.2. Changes in risk following unexpected short interest

Our tests of whether firms with unexpected high levels of short interest experience subsequent increases in risk are predicated on the view that if short sellers (through their high unexpected short positions) convey information about potential under-estimation of firm risk, then we expect to observe subsequent increases in their systematic risk factor loadings. To the extent that investors attend to the information in short sellers' positions we would, in turn, expect stock prices to fall – thus benefiting short sellers who buy the stock back at the lower prices. We measure changes in the systematic risk of equity using the Fama and French (1993) three-factor model. In particular, we look for changes in factor loadings that occur after the month in which we identify the unexpected increase in short interest. Our tests are similar to those used by Grullon et al. (2002) and Chen, Shevlin and Tong (2005) to study the effect of dividend changes on changes in the market's perception of risk.

Similar to our analysis of changes in fundamentals (sections 5.1), we compare firms in the highest and lowest quintiles of unexpected short interest to see if firms in the highest quintile (i.e., firms with the highest unexpected short interest positions) exhibit increases in risk that are significantly larger than the risk changes observed for firms in the lowest quintile (i.e., firms with the lowest unexpected short interest positions). To estimate shifts in risk factor loadings, we estimate equation (2) for each firm, using a 360 day estimation interval consisting of 180 trading days prior to the event month and 180 trading days after the event month.[11] We exclude all trading days in the event month from the estimation interval because the data about short interest positions is not specific as to when during the month the short interest positions are taken.

$$\begin{aligned} R_{i,t} - R_{f,t} = {} & \alpha_{0,i} + \beta_{m,i}(R_{m,t} - R_{f,t}) + \beta_{s,i} SMB_t + \beta_{h,i} HML_t \\ & + \alpha_{\Delta 0,i} D_{i,t} + \beta_{\Delta m,i}(R_{m,t} - R_{f,t}) * D_{i,t} + \beta_{\Delta s,i} SMB_t * D_{i,t} + \beta_{\Delta h,i} HML_t * D_{i,t} + \eta_{i,t} \end{aligned} \quad (2)$$

where $R_{i,t}$ = firm i's raw return on day t; $R_{f,t}$ = daily return on a 1-month Treasury bill rate; $R_{m,t}$ = the daily return on the value-weighted market portfolio comprising NYSE, AMEX, and NASDAQ firms; SMB_t = size factor return on day t, equal to the difference between the return on a portfolio of small stocks and a portfolio of large stocks; HML_t = book-to-market factor return on day t, equal to the difference between the return on a portfolio of high book-to-market stocks and a portfolio of low book-to-market stocks; $D_{i,t}$ = a dummy variable that equals one when the time period relates to the 180 trading days subsequent to the end of firm i's event month, zero otherwise. All returns variables (including *SMB* and *HML*) are obtained from the WRDS database.

[11] In unreported tests, we verify that we obtain similar inference is we use other estimation windows, such as 90 days or 270 days.

$\beta_{m,i}$, $\beta_{s,i}$, and $\beta_{h,i}$ denote the factor loadings for firm i with respect to market beta, size and book-to-market factors in the 180 days prior to the increase in unexpected short interest. Our primary focus is on the coefficient estimates $\beta_{\Delta m,i}$, $\beta_{\Delta s,i}$, and $\beta_{\Delta h,i}$ which capture the shifts in firm i's factor loadings that occur after the change in their unexpected short interest position. $\alpha_{0,i}$ is Jensen's alpha, i.e., it represents the daily risk-adjusted abnormal return for firm i prior to the change in short interest; $\alpha_{\Delta 0,i}$ captures the change in abnormal returns after the unexpected change in short interest.

We estimate equation (2) for each firm-month in which there is an unexpected increase (or decrease) in short interest. In other words, we estimate firm-specific coefficients for the test sample (firms in Q5) and the control sample (firms in Q1) for each of the 106 months from March 1992 to December 2000. We report the average of the resulting coefficient estimates in Table 5. In testing for statistical significance, we report t-statistics that use the average factor loading based on all firm-month observations as well as Fama and Macbeth t-statistics which use the average factor loadings for each of the 106 event months (the Fama-MacBeth t-statistics are reported in parentheses in Table 5).

The average value of the intercept, $\alpha_{0,i}$, capturing the risk-adjusted abnormal return, is about 0.05% for firms in both quintiles and is reliably different from zero. This result suggests that both the test firms and the control firms earned significant positive abnormal returns prior to the unexpected change in short interest. What is interesting is the change in abnormal returns that occurs subsequent to the unexpected change in short interest, as captured by $\alpha_{\Delta 0,i}$. While both the test and control firms experience a decline in risk-adjusted abnormal returns (-0.024% and -0.009%, respectively) following the event month, the test sample firms have more negative post-event abnormal returns. Specifically, the difference between -0.024% and -0.009% is reliably different from zero (t-statistic for the pooled difference is -3.99, and -2.40 for Fama-MacBeth based t-statistic)). This finding is consistent with Asquith and Muelbruck (1995), Desai et al (2002) and others who find that higher levels of short interest are associated with lower future abnormal returns.

The average market beta ($\beta_{m,i}$) for the test and control firms is above one (1.237 for firms with high unexpected short interest; 1.271 for firms with low unexpected short interest), indicating that both sets of firms are riskier than the market portfolio. The average loading on the *SMB* factor, $\beta_{s,i}$, for both samples is positive (around 0.85 to 0.88 in magnitude) and is statistically significant. The average *HML* loading, $\beta_{h,i}$, for firms with high unexpected short interest is -0.025, compared to -0.038 for firms with low unexpected short interest; both are reliably different from zero. While the negative loadings on *HML* suggest that both the test firms and the control firms behave like glamour stocks, we note that the coefficient estimates for both samples are small in economic terms.

In terms of changes in the risk characteristics of the test versus control firms, we focus on $\beta_{\Delta m,i}$, $\beta_{\Delta s,i}$, and $\beta_{\Delta h,i}$. We begin by examining changes observed for the test firms, i.e., firms with the highest unexpected short interest. The results suggest that the average market beta and average *SMB* factor loading decline ($\beta_{\Delta m,i}$ = -0.032, t-statistic = -5.15; $\beta_{\Delta s,i}$ = -0.049, t-statistic = -6.53), while the *HML* factor loading increases ($\beta_{\Delta h,i}$ = 0.042, t-statistic = 4.16). The control firms (i.e., firms with the smallest unexpected short interest) experience similar directional changes in factor loadings. Specifically, control firms' market beta and SMB loading decline by 0.059 and 0.055, respectively, whereas their HML loading increases by 0.067; all changes are significant at the 0.01 level. To examine whether the magnitude of the shifts in factor loadings are greater for the test firms than the control firms, we examine the difference in the mean values of $\beta_{\Delta m,i}$, $\beta_{\Delta s,i}$, and $\beta_{\Delta h,i}$ for the two samples. The only consistent result that emerges from this comparison is that the change in the factor loading for market beta is significantly less negative for the test firms than for the control firms (-0.032 versus -0.059, Fama-MacBeth t-statistic of 1.68). Neither of the other two factor loadings shows a significant difference between the test and control samples.

Given the mixture of changes in factor loadings (i.e., some loadings increase, while others decrease) as well as differences across loadings in the sign and magnitude of the factor return, it is not possible to infer, solely from $\beta_{\Delta m,i}$, $\beta_{\Delta s,i}$, and $\beta_{\Delta h,i}$, whether the test firm's overall risk increased or decreased following the unexpected short interest. To compute the overall impact of risk changes on the test firms' risk premia, we multiply the changes in the factor loadings with the average daily factor returns over our sample period. The average daily returns on the market, SMB, and HML factors over March 1992 to December 2000, are 0.042%, -0.012% and 0.016%, respectively. Using these values as proxies for the unconditional risk premia associated with the three factors, we compute the net effect on the average test firm's risk premium as -0.00002% (-0.032*0.042 + (-0.049)*(-0.012) + 0.042*0.016). This economically small average effect provides little evidence that the test firms experienced any meaningful shift in risk following unexpectedly high short interest positions. For the control firms, the net change in risk is a decline of -0.0007%; again this average effect is quite small in economic terms, as is the incremental difference in risk implied by the difference between -0.00002 and -0.0007. On the whole, we conclude there is no evidence that unexpectedly high levels of short interest are associated with subsequent increases (or decreases) in risk.

5.3. Multivariate analysis of changes in fundamentals and risk following unexpected short interest

Our analyses thus far have focused on univariate associations between unexpected short interest and analyst forecast revisions (or forecast errors) or changes in risk characteristics. In this section we consider the relation between unexpected short interest and both changes in fundamentals and changes in risk. The multivariate analysis, given by expression (3), extends our previous analyses (which compared properties of the Q5 and Q1 portfolios) to considering variation in the magnitude of unexpected short interest positions; it also facilitates controls for other factors known to be associated with revisions in analysts' earnings forecasts (such as the stock return in the event month). We restrict the estimation of equation (3) to firms in the test sample (Q5) and the control sample (Q1) for consistency with the univariate analysis. However, we note that our inferences are unchanged if we use the entire distribution of monthly unexpected short interest positions.

$$UE\_SHORT_{i,t} = \gamma_0 + \gamma_1(\Delta FUND^k_{i,t}) + \gamma_2 Return_{i,t} + \gamma_3\beta_{\Delta m,i} + \gamma_4\beta_{\Delta s,i} + \gamma_5\beta_{\Delta h,i} + \psi_{i,t} \qquad (3)$$

where $UE\_SHORT_{i,t}$ = firm i's unexpected short interest in month t, proxied by the residual $\hat{\varepsilon}_{i,t}$ from equation (1); $\Delta FUND_{i,t}^{k} \in \{\frac{\Delta FCST_{i,t}^{k}}{P_{i,t-1}}, \frac{FE_{i,t}^{k}}{P_{i,t-1}}\}$; $Return_{i,t}$ = firm i's stock return in the event month; all other variables are as previously defined. We include $Return_{i,t}$ as an independent variable because prior research shows that the change in fundamentals ($\Delta FUND_{i,t}^{k}$) is a function of the event month return ($Return_{i,t}$) and other information ($\Pi_{i,t}$), i.e., $\Delta FUND_{i,t}^{k} = f(Return_{i,t}, \Pi_{i,t})$. Consequently, absent the inclusion of $Return_{i,t}$ as an explanatory variable, observing a positive relation between $UE\_SHORT_{i,t}$ and $\Delta FUND_{i,t}^{k}$ could be due to either a change in $\Pi_{i,t}$ or $Return_{i,t}$. By including $Return_{i,t}$, we control for the fact that $\Delta FUND_{i,t}^{k}$ measures $\Pi_{i,t}$ with error; that is, $Return_{i,t}$ helps purge the measurement error in $\Delta FUND_{i,t}^{k}$. This purging of measurement error leads to the prediction that the coefficient on $Return_{i,t}$ should be opposite in sign to the coefficient on $\Delta FUND_{i,t}^{k}$ (Greene, 1993, p.281)

We predict that the coefficient on the change in fundamentals, γ_1, is negative, consistent with higher unexpected short interest being associated with subsequent lower (that is, or more negative) forecast revisions and forecast errors. Based on the preceding measurement error discussion, we predict a positive value of γ_2, the coefficient on $Return_{i,t}$. In terms of the coefficients on changes in systematic risk factors (γ_3, γ_4, and γ_5), we expect these variables to be positively related to unexpected short interest, consistent with the prediction that short sellers target firms with positive changes in risk characteristics.

Results of estimating equation (3) are presented in Table 6. Consistent with the univariate results, we find that changes in current year forecast revisions and current year forecast errors are negatively related to unexpected short interest. That is, the coefficient on each of these variables is negative and statistically significant in each specification: γ_1 = -0.015, t-statistic = -2.50 for the forecast revision specification, and γ_1 = -0.007, t-statistic = -4.47 for the forecast error specification. Results are similar if we examine specifications based on one-year ahead forecast revisions and one-year ahead forecast errors.

Also as predicted, we find that the coefficient on the event month return, γ_2, is positive and reliably different from zero (t-statistics range between 4.93 and 5.97). Turning to the results concerning risk shifts, there is no evidence in support of increases in risk following unexpected high levels of short interest. If anything the evidence is consistent with a reduction in the average factor loading on the book-to-market risk factor (*HML*), and no change in the loadings on the market premium or size factor.

In summary, the results of the multivariate analysis are very similar to results documented from the univariate comparisons. Taken together, the findings indicate that short sellers do not appear to increase their short positions in anticipation of upward shifts in risk loadings for such firms. Rather, we find that short sellers appear to increase their short interest positions in anticipation of future downward revisions in fundamentals, as measured by analysts' expectations of firm profitability. An alternative characterization of the same finding is that analysts are more likely to revise downward their forecasts following increases in short interest. Our tests, however, do not allow us to discern the direction of any causal relation between short interest positions and subsequent changes in fundamentals: short sellers may anticipate future downward revisions and take positions accordingly (i.e., causality runs from the anticipated change in fundamentals to the short seller) or analysts may respond to the information conveyed by unexpectedly high short positions and revise their earnings forecasts downward for such firms (i.e., causality runs from the short position to the change in fundamentals predicted by the analyst).

5.4. Subsequent Returns and Changes in Fundamentals and Changes in Risk

Our final analysis links our findings concerning changes in fundamentals observed following unexpected short interest positions to the subsequent returns earned by short sellers on their positions. Prior research documents that firms with high raw levels of short interest, and high changes in short interest, earn significant negative abnormal returns up to six months following the short interest. Our tests in this section provide evidence on whether our test sample, which is identified by high *unexpected* levels of short interest, also experience significant negative returns, and whether these negative returns are associated with subsequent downward revisions in fundamentals that we documented in section 5.3.

We begin by documenting the raw returns and the market-adjusted returns to our portfolios of test firms and control firms,[12] as well as the difference in returns between the two samples; results are reported in Panel A of Table 7. We report returns for months +1 through +3, relative to event month 0; we also report the average cumulative return over months +1 through +3, as well as months +1 through +6. The results show that the test sample firms earned lower returns than the control sample firms in each of the three months following the event month. The cumulative return over months (+1,+3) is 1.53% lower for test firms than for control firms, with a t-statistic of -4.54. The cumulative 6-month return is lower by 2.53%, t-statistic of -4.66. These results confirm prior findings showing significant negative abnormal returns following short interest positions.

We next examine whether the cross-sectional variation in these subsequent returns can be explained by the changes in fundamentals (or the changes in risk) shown in sections 5.1-5.3. Prior studies find that, in broad samples, forecast revisions and forecast errors are positively associated with contemporaneous stock returns (e.g., Lys and Sohn, 1990). This, in turn, suggests that we will observe a positive association between the changes in fundamentals and the returns earned by the short sellers. Our tests here are, therefore, not intended to provide evidence on this general phenomenon, but rather to show that this link exists for our sample.

Our tests relate cumulative future returns with both changes in fundamentals and changes in risk. For consistency with specification (3), we include the stock return in the event month as an explanatory variable and estimate the following equation:[13]

$$Fut\_Return_{i,t} = \delta_0 + \delta_1(\Delta FUND_{i,t}^{k}) + \delta_2 Return_{i,t} + \delta_3\beta_{\Delta m,i} + \delta_4\beta_{\Delta s,i} + \delta_5\beta_{\Delta h,i} + \psi_{i,t} \quad (4)$$

where $Fut\_Return_{i,t}$ = the 3-month or 6-month cumulative return, measured from the end of the event month; all other variables are as defined previously. As before, we consider both current year forecasts and one-year-ahead forecasts separately.

[12] The market-adjusted return is the firm's return less the return on the value-weighted market portfolio for all NYSE, AMEX and NASDAQ stocks.
[13] In additional tests, we also include the cumulative return on the market portfolio as an independent variable. Results are qualitatively similar, and are not reported.

For the reasons stated above, we expect the coefficient on the change in fundamentals, δ_1, to be positive (i.e., firms with more negative forecast revisions have lower returns). The expected signs of the coefficients on the risk change variables are not obvious. On the one hand, increases in systematic risk should result in lower stock prices, leading to an immediate negative return in the stock. On the other hand, increases in risk should, in equilibrium, be associated with higher expected returns. Ex ante, it is unclear which of these effects dominates.

Results of estimating equation (4) are presented in Table 7: Panel B shows results for 3-month cumulative returns, and Panel C shows results for 6-month cumulative returns. Because of the similarity in results, we discuss only the results pertaining to 3-month cumulative returns (Panel A). Consistent with our predictions (and with prior research), we find that the coefficients on current year forecast revisions and current year forecast errors are significantly positive (δ_1 = 0.451, t-statistic = 3.01 for forecast revisions; δ_1 = 1.187, t-statistic = 30.33 for forecast errors). Similar results are found for one-year ahead forecast revisions and forecast errors (also reported in Table 7).

Our results on the relation between changes in factor loadings and future returns are mixed. While we find a significant positive relation between changes in market beta loadings and future returns (the average value of δ_3, the coefficient on $\beta_{\Delta m,i}$, in Panel B is 0.048), we find a significant negative relation between changes in book-to-market factor loadings and future returns (the average value of δ_5, the coefficient on $\beta_{\Delta h,i}$, in Panel B is -0.023). The effect of the change in size factor is close to zero (i.e., the average value of δ_4, the coefficient on $\beta_{\Delta s,i}$, is -0.0008). The net effect of the significant changes (to the market and book-to-market factors), when multiplied by the relevant factor return, is an average *increase* in future returns of about 0.00165% per month, equal to 0.048 x 0.042% (the average monthly market risk premium over our sample period) plus -0.023 x 0.016% (the average monthly *HML* factor return over our sample period). Thus, on net, the increase in the market beta loading, although economically marginal, has a larger effect on subsequent returns than does the decrease in the *HML* loading. The net increase in returns is consistent with the argument that subsequent increases in risk (following unexpected short interest positions) are associated with, on average, higher future returns.[14]

Overall, we interpret the results in Table 7 as confirming and extending prior evidence concerning the returns consequences of short interest positions. Specifically, our results show that firms with high unexpected short interest positions earn significantly more negative abnormal returns than firms with low unexpected short interest positions. These return differences are apparent over as little as one month following the measurement of the unexpected short interest position, and extend to at least six months following this measurement date. Moreover, we find that the subsequent downward revision in fundamentals documented for high unexpected short positions is strongly positively correlated with their subsequent cumulative returns.

While our tests do not speak to the causal relations among short interest positions, changes in fundamentals and subsequent returns, our findings do suggest a consistent pattern among these three variables. More precisely, we cannot rule out (or in) either of the following causal relations: 1) Short sellers target stocks where they believe the market has over-valued the fundamentals; analysts subsequently revise downward their forecasts (either because they interpret short positions as a signal of over-valuation or because they arrive at this decision independent of any information conveyed by the short position), causing stock prices to decline; or 2) Short sellers target stocks where they expect price declines (for some reason other than over-valued fundamentals); analysts subsequently revise downward their earnings forecasts, after observing the price declines.[15] We note, however, that the latter relation would not imply a positive association between the magnitude of unexpected short interest positions and the magnitude of subsequent forecast revisions (which we document in Tables 3, 4 and 6). Moreover,

[14] In unreported tests, we conducted a more complete test of the effect of net risk shifts on subsequent returns, where we combined the product of each factor loading with its average factor return over our sample period. This procedure gave us an expected change in risk premium for each sample firm. When we substitute this variable in equation (4) (replacing the separate variables capturing changes in risk loadings), we find that the change in the expected risk premium is positively associated with future returns.

[15] Our design does allow us to rule out the possibility that analysts' downward forecast revisions prompt short sellers to take unexpectedly high short positions in these stocks. Specifically, because we measure analysts' forecast revisions after the unexpected short interest month, it cannot be the case (at least for our samples) that the direction of causality runs from the analyst to the short seller.

because the multivariate tests include the return on the stock up to the time of the analyst forecast ($Return_{i,t}$), our tests control for the information effect that such price changes have on analysts' forecast revisions.

5.5. Sensitivity Tests

We conducted a variety of additional sensitivity tests. First, we examine the influence of outliers on our results by repeating all tests after excluding observations with variables in the extreme top and bottom 1% of the distribution. Results (not tabled) are similar in all respects to those reported. Second, for all multivariate analyses (i.e., those involving equations 3 and 4), we repeat our tests using all firm-months, not just firm-months in the extreme high and extreme low unexpected short interest quintiles. Results, not reported, are similar in all respects to those reported; if anything, significance levels increase when all observations are included. Third, given some prior evidence that short sellers anticipate the news conveyed in earnings announcements, we repeat our tests after excluding all observations where the firm announced quarterly earnings in month +1. Results (not reported) are similar in all respects to the full sample, and suggest that short seller anticipation of earnings announcements is not the primary force driving our results.

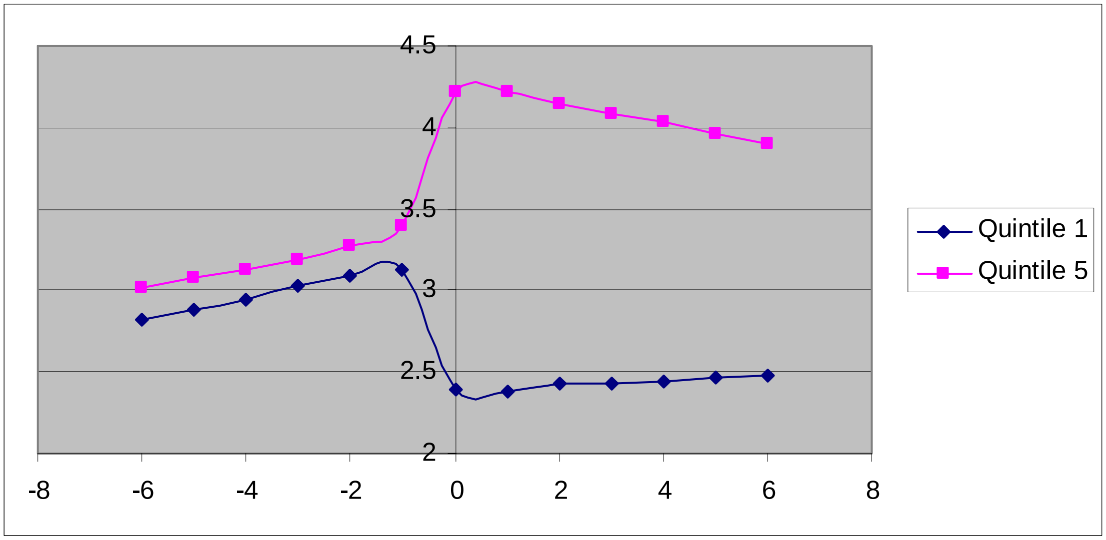
Finally, we consider the possibility that the inclusion of risk factors in the model of short interest (notably, proxy variables capturing beta, book-to-market and firm size) may "over-control" for the risk effects that we predict may follow high unexpected short interest positions. To address this concern, we re-estimate the model of expected short interest excluding these three risk factors; we then use the new residuals ($\hat{\varepsilon}_{i,t}^{Without\ Risk}$) as our measure of the firm's unexpected short interest in month t. We then repeat the tests in Tables 2-7 forming quintiles based on $\hat{\varepsilon}_{i,t}^{Without\ Risk}$ rather than on $\hat{\varepsilon}_{i,t}$. Results (not reported) are similar in all respects to those we table. We conclude from this analysis that the inclusion of risk factors in the model of expected short interest does not bias our results towards our finding of no meaningful change in risk factors following high unexpected short interest positions.

6. Summary and Conclusions

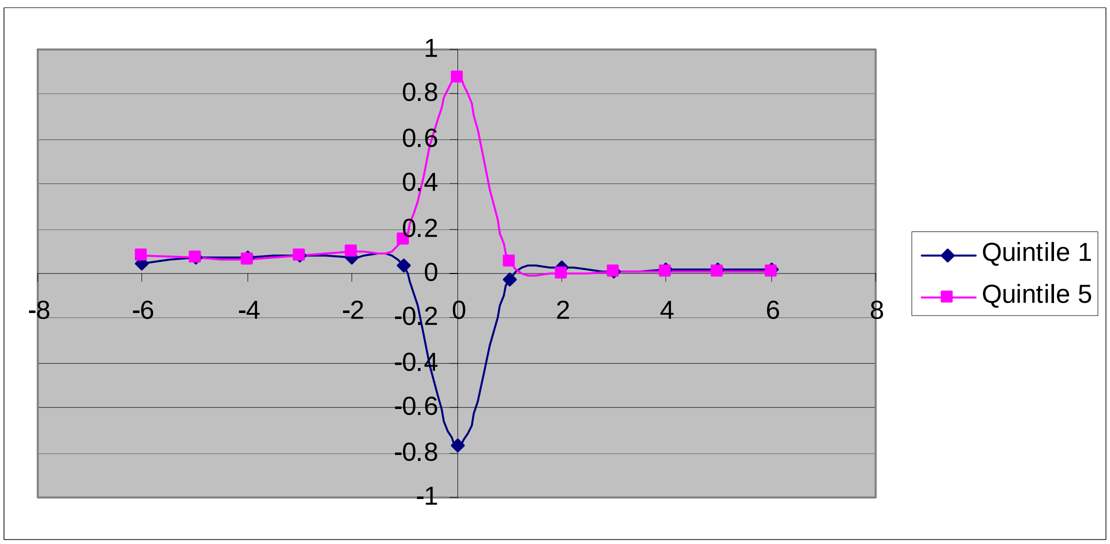
The main purpose of this study is to examine reasons why heavily shorted stocks experience subsequent lower stock returns. We explore two plausible explanations for such an association: 1) short sellers target stocks where the market has over-estimated the fundamentals (such that these firms will experience poor operating performance in the future, which has been shown to be associated with negative returns); and 2) short sellers target stocks of firms where the market has under-estimated risk (such that these firms will encounter significant upward shifts in risk in the future, leading to an immediate decline in stock price). Our results are consistent with the first explanation, not the second. In particular, we find that analysts revise downward their earnings expectations for firms with the largest unexpected short interest positions. The magnitude of analysts' downward forecast revisions is significantly more negative than matched-in-time forecast revisions observed for a control sample of firms which experienced the smallest unexpected short interest. Because our calculation of forecast revisions is done after the unexpected short interest position is identified, our design rules out the possibility that the downward forecast revision motivates the short position.

Figure 1
Time Series of Mean Raw Short Interest and Mean Unexpected Short Interest for the Lowest and Highest Unexpected Short Interest Quintiles

Panel A: Raw Short Interest



Panel B: Unexpected Short Interest



Month 0 is the event month in which observations are grouped into five quintiles using unexpected short interest, measured as the residual estimated from equation (1). The Panel A figure tracks the mean raw short interest positions for the quintile of firms with the lowest unexpected short interest (Quintile 1) and the quintile of firms with the highest unexpected short interest (Quintile 5), over the preceding and succeeding six months. The Panel B figure tracks these same firms mean unexpected short interest positions.

Table 1
Regression Results for Model of Expected Short Interest

Variable	**Pooled Regression**	**Mean of Monthly Regressions**
Intercept	0.000	0.000
t-statistic	3.21	2.90
$Beta_{i,t}$	0.001	0.001
t-statistic	10.73	5.71
$\mathrm{Retvar}_{i,t}$	0.048	-0.003
t-statistic	1.91	-0.09
$Convdebt_{i,t}$	0.000	0.000
t-statistic	6.40	4.28
$Option_{i,t}$ *100	0.031	-0.014
t-statistic	4.64	-0.08
$\mathrm{Return}_{i,t-3}$ *100	-0. 013	0. 030
t-statistic	-1.45	1.31
$Size_{i,t}$	-0.000	-0.000
t-statistic	-5.72	-8.95
$\mathrm{B/M}_{i,t}$ *100	-0. 051	-0.502
t-statistic	-8.06	-7.29
$Short_{i,t-1}$	0.960	0.968
t-statistic	980.24	203.67
R^2	92.23%	93.11%
N	93,045	106

Table 1 summarizes the coefficients estimated from the regression equation:

$$Short_{i,t} = \lambda_0 + \lambda_1 Beta_{i,t} + \lambda_2 Retvar_{i,t} + \lambda_3 Convdebt_{i,t} + \lambda_4 Option_{i,t} + \lambda_5 Return_{i,t-3} + \lambda_6 Size_{i,t} + \lambda_7 B/M_{i,t} + \lambda_8 Short_{i,t-1} + \varepsilon_{i,t}$$

where $Short_{i,t}$ = firm i's short interest in month t scaled by number of shares outstanding in month t; $Beta_{i,t}$ = firm i's market model beta estimated from three years of daily data up through the last fiscal quarter; $Retvar_{i,t}$ = residual variance from market model estimated from prior three years of daily data up through the last fiscal quarter; $Convdebt_{i,t}$ = a dummy variable that takes the value of 1 if firm i has outstanding convertible debt at the end of the prior fiscal year and zero otherwise; $Option_{i,t}$ = a dummy variable that takes a value of 1 if firm i has options trading at the beginning of month t and zero otherwise; $Return_{i,t-3}$ = firm i's cumulative return over the previous three months; $Size_{i,t}$ = firm i's market value at the beginning of month t; $B/M_{i,t}$= firm i's book to market ratio calculated as the book value of equity at the end of prior fiscal quarter scaled by the market value of equity at the beginning of month t. The t-statistic for the monthly regressions is based on the time-series of the standard errors of the 106 monthly coefficient estimates.

Table 2
Descriptive Statistics and Trends in Raw and Unexpected Short Interest Positions

Panel A: Descriptive Statistics by Quintiles of Unexpected Short Interest

Quintile	Variable	N	Mean	Median	Std. dev	1st quartile	3rd quartile
1	Raw short interest	18,567	2.387	1.249	3.272	0.501	2.874
	Unexpected short interest		-0.767	-0.482	1.025	-0.808	-0.335
2	Raw short interest	18,627	0.953	0.426	1.657	0.115	1.091
	Unexpected short interest		-0.161	-0.153	0.067	-0.196	-0.113
3	Raw short interest	18,630	0.784	0.335	1.418	0.086	0.904
	Unexpected short interest		-0.042	-0.038	0.044	-0.094	-0.016
4	Raw short interest	18,627	1.296	0.716	1.872	0.276	1.571
	Unexpected short interest		0.093	0.082	0.065	0.044	0.134
5	Raw short interest	18,594	4.223	2.585	4.644	1.279	5.405
	Unexpected short interest		0.876	0.531	1.076	0.323	0.987

Panel B: Time Series of Mean Unexpected Short Interest and Mean Raw Short Interest

Month	Unexpected short interest		Raw short interest	
	Quintile 1	Quintile 5	Quintile 1	Quintile 5
-6	0.046	0.077	2.823	3.018
-5	0.068	0.069	2.888	3.084
-4	0.070	0.067	2.948	3.124
-3	0.080	0.079	3.024	3.194
-2	0.071	0.095	3.093	3.274
-1	0.035	0.153	3.125	3.402
0	-0.767	0.876	2.386	4.223
1	-0.026	0.056	2.374	4.220
2	0.023	0.000	2.424	4.143
3	0.009	0.009	2.432	4.088
4	0.014	0.005	2.446	4.028
5	0.016	0.005	2.461	3.963
6	0.017	0.007	2.480	3.901

The sample is partitioned into five quintiles according to the levels of unexpected short interest. Unexpected short interest is the residual estimated from equation (1) [see Table 1 for details). Panel A provides summary statistics on both raw and unexpected short interest levels for each of the five quintiles. Panel B summarizes the time series of unexpected and raw short interest for the extreme quintiles: firms with the lowest unexpected short interest (Quintile 1) and firms with the highest unexpected short interest (Quintile 5). Month 0 is the event month in which observations are grouped into five quintiles of unexpected short interest.

Table 3
Changes in Analysts' Earnings Forecasts for Firms with Extreme Unexpected Short Interest

Variable	Firms with Highest Unexpected Short Interest (Q5)	Firms with Lowest Unexpected Short Interest (Q1)	Mean Difference
Panel A: Changes in Current-Year EPS Forecasts			
$\Delta FCST_{i,t}$	-0.049	-0.037	-0.012
t-statistic	-35.44	-28.89	-6.32 (-3.37)
$\Delta FCST_i / P_{i,t-1}$	-0.36%	-0.30%	-0.06%
t-statistic	-41.72	-36.97	-4.91 (-2.78)
$\Delta FCST_{i,t}$ %	-6.61%	-5.49%	-1.12%
t-statistic	-35.80	-30.93	-4.25 (-2.93)
Panel B: Changes in One-Year-Ahead EPS Forecasts			
$\Delta FCST_{i,t}$	-0.040	-0.026	-0.014
t-statistic	-18.10	-13.08	-4.60 (-1.87)
$\Delta FCST_i / P_{i,t-1}$	-0.20%	-0.25%	-0.05%
t-statistic	-23.68	-20.37	-3.69 (-1.48)
$\Delta FCST_{i,t}$ %	-3.42%	-2.58%	-0.74%
t-statistic	-19.19	-15.65	-3.48 (-2.07)

Panel A of Table 3 summarizes and compares the current-year raw EPS forecast change, the current-year EPS forecast change standardized by price and the current-year EPS forecast change standardized by the absolute value of forecasted EPS. Results are shown separately for Quintile 1 and Quintile 5. Panel B summarizes and compares the one-year-ahead raw EPS forecast change, the one-year-ahead EPS forecast change standardized by price and the one-year-ahead EPS forecast change standardized by the absolute value of forecasted EPS. The raw forecast revision iss: $\Delta FCST_{i,t}^{k} = FCST_{i,Post}^{k} - FCST_{i,Pre}^{k}$, where $FCST_{i,Pre}^{k}$ = the pre-consensus forecast for firm i's earnings for year k (k= current year or one-year ahead) made just before the event month; $FCST_{i,Post}^{k}$ = the post-consensus forecast for firm i's earnings for year k made just after the event month. The price scaled forecast revision is: $\frac{\Delta FCST_{i,t}^{k}}{P_{i,t-1}} = \frac{FCST_{i,Post}^{k} - FCST_{i,Pre}^{k}}{P_{i,t-1}}$ and the forecast scaled forecast revision is $\Delta FCST_{i,t}^{k}\% = \frac{FCST_{i,Post}^{k} - FCST_{i,Pre}^{k}}{\left|FCST_{i,Pre}^{k}\right|}$.
We report both pooled t-statistics and, in parentheses, Fama-MacBeth t-statistics based on the standard errors determined from the 106 monthly mean differences in forecast revisions of the extreme quintiles.

Table 4
Forecast Errors for Firms with Extreme Unexpected Short Interest

Variable	Firms with Highest Unexpected Short Interest (Q5)	Firms with Lowest Unexpected Short Interest (Q1)	Mean Difference
Panel A: Current-Year EPS Forecasts Errors			
$FE_{i,t}$	-0.267	-0.201	-0.066
t-statistic	-49.50	-40.71	-9.35 (-3.48)
$FE_i / P_{i,t-1}$	-1.63%	-1.36%	-0.27%
t-statistic	-51.41	-45.31	-6.12 (-2.96)
$FE_{i,t}$ %	-33.60%	-29.35%	-4.25%
t-statistic	-43.76	-39.44	-3.94 (-2.24)
Panel B: One-Year-Ahead EPS Forecasts Errors			
$FE_{i,t}$	-0.590	-0.476	-0.114
t-statistic	-45.02	-38.85	-6.31 (-2.74)
$FE_i / P_{i,t-1}$	-2.52%	-2.07%	-0.45%
t-statistic	-45.07	-39.66	-5.82 (-3.34)
$FE_{i,t}$ %	-59.00%	-47.69%	-11.31%
t-statistic	-37.37	-33.77	-5.07 (-2.87)

Panel A of Table 4 summarizes and compares current-year EPS forecast errors, current-year EPS forecast errors standardized by price and current-year EPS forecast errors standardized by the absolute value of forecasted EPS. Results are shown separately for Quintile 1 and Quintile 5. Panel B summarizes and compares one-year-ahead EPS forecast errors, one-year-ahead EPS forecast errors standardized by price and one-year-ahead EPS forecast errors standardized by absolute value of forecasted EPS. EPS forecast errors are calculated as: $FE_{i,t}^k = EPS_i^k - FCST_{i,Pre}^k$ where EPS_i^k = firm i's reported earnings for year k; $FCST_{i,Pre}^k$ = the pre-consensus forecast for firm i's earnings for year k (k= current year or one-year ahead) made just before the event month. Price-scaled forecast error is: $\frac{FE_{i,t}^k}{P_{i,t-1}} = \frac{EPS_i^k - FCST_{i,Pre}^k}{P_{i,t-1}}$, and forecast scaled forecast error is $FE_{i,t}^k \% = \frac{EPS_i^k - FCST_{i,Pre}^k}{\left|FCST_{i,Pre}^k\right|}$. We report both pooled t-statistics and, in parentheses, Fama-MacBeth t-statistics based on the standard errors determined from the 106 monthly mean differences in forecast errors of the extreme quintiles.

Table 5
Changes in Factor Loadings for Firms with Extreme Unexpected Short Interest

Coefficient	Firms with Highest Unexpected Short Interest (Q5)	Firms with Lowest Unexpected Short Interest (Q1)	Mean Difference
α_0 *100	0.051	0.055	-0.004
t-statistic	26.15	28.78	-1.29 (-0.22)
$\alpha_{\Delta 0}$*100	-0.024	-0.009	-0.015
t-statistic	-9.19	-3.54	-3.99 (-2.40)
β_m	1.237	1.271	-0.034
t-statistic	237.23	239.62	-4.53 (-2.64)
β_s	0.851	0.883	-0.032
t-statistic	126.24	127.42	-3.31 (-2.28)
β_h	-0.025	-0.038	0.013
t-statistic	-2.49	-3.84	0.95 (0.18)
$\beta_{\Delta m}$	-0.032	-0.059	0.027
t-statistic	-5.15	-9.19	3.00 (1.68)
$\beta_{\Delta s}$	-0.049	-0.055	0.006
t-statistic	-6.53	-7.20	0.58 (0.64)
$\beta_{\Delta h}$	0.042	0.067	-0.024
t-statistic	4.16	6.70	-1.80 (-0.42)

Table 5 summarizes and compares the changes in risk factor loadings for Quintile 1 and 5 around the event month. For Quintile 1 and Quintile 5, factor loadings are estimated using the following model over a 360-day trading period, comprising 180 trading days prior and 180 trading days after the event month (while excluding the event month):

$$R_{i,t} - R_{f,t} = \alpha_{0,i} + \beta_{m,i}(R_{m,t} - R_{f,t}) + \beta_{s,i}SMB_t + \beta_{h,i}HML_t + \alpha_{\Delta 0,i}D_t + \beta_{\Delta m,i}(R_{m,t} - R_{f,t}) * D_t + \beta_{\Delta s,i}SMB_t * D_t + \beta_{\Delta h,i}HML_t * D_t + \eta_{i,t}$$

where $R_{j,t}$ is the daily stock return for firm i, $R_{f,t}$ is the daily return on a 1-month Treasury bill rate, $R_{m,t}$ is the daily return on the value-weighted market portfolio comprising NYSE, AMEX, and NASDAQ firms, SMB_t is the size effect captured by the difference between the return on a portfolio of small stocks and a portfolio of large stocks, HML_t is the book-to-market effect captured by the difference between the return on a portfolio of high book-to-market stocks and a portfolio of low book-to-market stocks, D_t is a dummy variable that is equal to one when the time period relates to the 180 trading days subsequent to the end of the month in which short interest unexpectedly increased, zero otherwise. We report both pooled t-statistics and, in parentheses, Fama-MacBeth t-statistics based on the standard errors determined from the 106 monthly mean differences in the coefficients of the extreme quintiles.

Table 6
Multivariate Regression of Unexpected Short Interest on Changes in Fundamentals and Risk

Variable	Current-Year Forecast		One-Year-Ahead Forecast	
	Forecast Revision	Forecast Error	Forecast Revision	Forecast Error
Intercept	0.000	0.000	0.001	0.000
t-statistic	6.70	5.78	5.56	3.99
$\Delta FCST_{i,t}/P_{i,t-1}$	-0.015		-0.019	
t-statistic	-2.50		-1.86	
$FE_{i,t}/P_{i,t-1}$		-0.007		-0.008
t-statistic		-4.47		-4.17
$Return_{i,t}$	0.002	0.002	0.003	0.003
t-statistic	5.82	5.97	4.93	5.00
$\beta_{\Delta m,it}*100$	0.016	0.019	0.012	0.016
t-statistic	1.38	1.61	0.67	0.87
$\beta_{\Delta s,it}*100$	0.003	0.002	-0.013	-0.016
t-statistic	0.34	0.27	-1.04	-1.22
$\beta_{\Delta h,it}*100$	-0.018	-0.019	-0.019	-0.018
t-statistic	-2.69	-2.86	-1.80	-1.73
R^2	0.12%	0.16%	0.16%	0.24%
Sample size	37,161	37,161	19,741	19,741

Table 6 summarizes the coefficients estimated from the regression equation:

$$UE\_SHORT_{i,t} = \gamma_0 + \gamma_1(\Delta FUND_{i,t}^k) + \gamma_2 Return_{i,t} + \gamma_3 \beta_{\Delta m,i} + \gamma_4 \beta_{\Delta s,i} + \gamma_5 \beta_{\Delta h,i} + \psi_{i,t}$$

using only observations from Quintile 1 and Quintile 5 of unexpected short interest distribution. $UE\_SHORT_{i,t}$ is the residual short interest, $\hat{\varepsilon}_{i,t}$, estimated from equation (1). $\Delta FUND_{i,t}^k \in \{\frac{\Delta FCST_{i,t}^k}{P_{i,t-1}}, \frac{FE_{i,t}^k}{P_{i,t-1}}\}$; $\frac{\Delta FCST_{i,t}^k}{P_{i,t-1}} = \frac{FCST_{i,Post}^k - FCST_{i,Pre}^k}{P_{i,t-1}}$ is the price-scaled forecast revision; $\frac{FE_{i,t}^k}{P_{i,t-1}} = \frac{EPS_i^k - FCST_{i,Pre}^k}{P_{i,t-1}}$ is the price-scaled forecast error; $Return_{i,t}$ = firm i's stock return in the event month. $\beta_{\Delta m}$, $\beta_{\Delta s}$, *and* $\beta_{\Delta h}$ represent changes in systematic risk factor loadings subsequent to the event month.

Table 7
Analysis of Returns Subsequent to Unexpected Short Positions

Panel A: Descriptive Statistics on Returns Subsequent to Unexpected Short Interest

Return Period	Firms with Highest Unexpected Short Interest (Q5)	Firms with Lowest Unexpected Short Interest (Q1)	Mean Difference	t-statistic
$Return_{t+1}$	0.98% [-0.40%]	1.88% [0.50%]	-0.90%	-4.82
$Return_{t+2}$	1.19% [-0.04%]	1.39% [0.16%]	-0.20%	-1.08
$Return_{t+3}$	0.89% [-0.25%]	1.41% [0.27%]	-0.52%	-2.75
$Return_{t+1,t+3}$	2.99% [-0.78%]	4.52% [0.75%]	-1.53%	-4.54
$Return_{t+1,t+6}$	6.96% [-0.45%]	9.49% [2.08%]	-2.53%	-4.66

Panel B: Results of Regressing 3-Month Cumulative Returns on Changes in Profitability and Risk

	Current-Year Forecast		One-Year-Ahead Forecast	
Variable	Forecast Revision	Forecast Error	Forecast Revision	Forecast Error
Intercept	0.043	0.060	0.039	0.058
t-statistic	24.57	33.72	16.49	23.51
$\Delta FCST_{i,t}/P_{i,t-1}$	0.451		0.824	
t-statistic	3.01		3.59	
$FE_{i,t}/P_{i,t-1}$		1.187		0.902
t-statistic		30.33		21.68
$Return_{i,t}$	-0.038	-0.062	-0.044	-0.057
t-statistic	-3.93	-6.64	-3.28	-4.37
$\beta_{\Delta m,it}*100$	0.054	0.047	0.049	0.043
t-statistic	18.72	16.69	12.07	10.85
$\beta_{\Delta s,it}*100$	0.000	0.002	-0.004	-0.001
t-statistic	0.17	1.08	-1.27	-0.24
$\beta_{\Delta h,it}*100$	-0.026	-0.023	-0.021	-0.021
t-statistic	-15.88	-13.91	-9.34	-9.36
R^2	1.23%	3.59%	0.95%	3.19%
Sample size	37,160	37,160	19,741	19,741

Panel C: Results of Regressing 6-Month Cumulative Returns on Changes in Profitability and Risk

	Current-Year Forecast		One-Year-Ahead Forecast	
Variable	**Forecast Revision**	**Forecast Error**	**Forecast Revision**	**Forecast Error**
Intercept	0.091	0.124	0.082	0.126
t-statistic	32.17	43.89	22.64	33.49
$\Delta FCST_{i,t}/P_{i,t-1}$	0.446		0.345	
t-statistic	1.86		0.97	
$FE_{i,t}/P_{i,t-1}$		2.293		1.920
t-statistic		36.66		30.11
$Return_{i,t}$	-0.053	-0.105	-0.050	-0.090
t-statistic	-3.48	-6.97	-2.41	-4.50
$\beta_{\Delta m,it}*100$	0.087	0.075	0.075	0.062
t-statistic	18.94	16.50	12.02	10.18
$\beta_{\Delta s,it}*100$	0.010	0.014	0.003	0.009
t-statistic	3.07	4.27	0.61	2.18
$\beta_{\Delta h,it}*100$	-0.042	-0.035	-0.030	-0.028
t-statistic	-15.77	-13.34	-8.38	-8.06
Adj. R^2	1.40%	4.83%	0.96%	5.30%
N	37152	37152	19741	19741

Panel A summarizes the average raw returns of the extreme quintiles of the unexpected short interest distribution for each of the 3 months following the event month; we also show cumulative returns for 3-months and 6-months after the event month. The numbers in brackets are the market-adjusted returns. (Note that the mean difference and t-statistics for the difference in raw returns and the difference in market-adjusted returns are identical.) Panels B and C summarize the coefficients estimated from the regression equation:
$Fut\_Return_{i,t+\tau} = \delta_0 + \delta_1(\Delta FUND^k_{i,t}) + \delta_2 Return_{i,t} + \delta_3\beta_{\Delta m,i} + \delta_4\beta_{\Delta s,i} + \delta_5\beta_{\Delta h,i} + \psi_{i,t}$, using only observations from Quintile 1 and Quintile 5 of unexpected short interest distribution. $Fut\_Return_{it,t+\tau}$ is the 3-month (Panel B) or 6-month (Panel C) cumulative returns after the event month. $\Delta FUND^k_{i,t} \in \{\frac{\Delta FCST^k_{i,t}}{P_{i,t-1}}, \frac{FE^k_{i,t}}{P_{i,t-1}}\}$; $\Delta FUND^k_{i,t} \in \{\frac{\Delta FCST^k_{i,t}}{P_{i,t-1}}, \frac{FE^k_{i,t}}{P_{i,t-1}}\}$;
$\frac{\Delta FCST^k_{i,t}}{P_{i,t-1}} = \frac{FCST^k_{i,Post} - FCST^k_{i,Pre}}{P_{i,t-1}}$ is the price-scaled forecast revision; $\frac{FE^k_{i,t}}{P_{i,t-1}} = \frac{EPS^k_i - FCST^k_{i,Pre}}{P_{i,t-1}}$ is the price-scaled forecast error; $Return_{i,t}$ = firm i's stock return in the event month. $\beta_{\Delta m}$, $\beta_{\Delta s}$, *and* $\beta_{\Delta h}$ represent changes in systematic risk factor loadings subsequent to the event month.

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