

Do Arbitrageurs Amplify Economic Shocks?

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Abstract: We examine whether arbitrageurs amplify fundamental shocks in the context of short arbitrage in equity markets. The ability of arbitrageurs to hold on to short positions depends on asset values: shorts are often reduced (increased) following good (bad) news about a stock. As a result, the prices of highly shorted stocks are excessively sensitive to economic shocks. Using monthly short interest data we find the following. (1) The price of a highly shorted stock is more sensitive to earnings news than a stock with little short interest. (2) The change in short interest around announcements (proxied by share turnover) is more sensitive to earnings surprises for highly shorted stocks. (3) For highly shorted stocks, returns to shorting are higher following better earnings news (after accounting for post earnings announcement drift). These results continue to hold when we exploit differences in short selling regulations across stock exchanges to instrument for the amount of shorting in a stock. These differential sensitivities tend to be driven by very good earnings news as opposed to very bad earnings news. Our findings point to the importance of limited arbitrage in affecting asset price dynamics and the potentially destabilizing role of speculators.

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I. Introduction

In this paper, we examine whether arbitrageurs amplify exogenous economic shocks in asset markets. This issue is related to a large literature dating back to Friedman (1953) on the role of speculators in affecting asset price dynamics. A number of theories indicate that asset prices are excessively sensitive to economic news when arbitrage is limited in various ways by leverage constraints or agency problems arising from delegated money management.¹ For example, suppose hedge funds subject to leverage constraints have positions in a stock and there is a negative earnings surprise about the stock that causes the price to fall. They are then forced to cut back on their positions and the stock price will move more with the news than an otherwise similar stock without any hedge funds. The key amplifying mechanism is that the ability of arbitrageurs to maintain their positions is tied to asset values, which imparts an upward tilt to asset demand schedules.² There is relatively little evidence on whether fundamental shocks are amplified by such speculative activity. In light of recent financial crises and the growing importance of hedge funds to the economy, an understanding of the effects of speculators on asset price dynamics has never been more important from both academic and public policy perspectives.

We tackle this issue in the context of short arbitrage in equity markets. There are several reasons why short selling in equity markets is an ideal setting to study this issue. First, we can measure the magnitude of arbitrage activity (on the short side) in different stocks. There are plentiful panel data on the magnitude of short selling and most of it is undertaken by professional speculators such as hedge funds as opposed to retail investors. This stands in contrast to the difficulty of measuring levered long speculative positions in equities. Second, in practice, the ability of arbitrageurs to hold on to short positions depends on asset values: shorts are often reduced (increased) following good (bad) news about a stock for a variety of reasons. Most notably, short sales tend to be highly levered transactions that require having enough funds in the margin account. Third, there is substantial anecdotal evidence in support of this amplification mechanism in the context of short arbitrage. The financial press often speaks of “short covering” (the cutting down of short positions through the purchase of shares) causing excess volatility in

¹ A few examples include Delong, Shleifer, Summers and Waldmann (1990), Shleifer and Vishny (1997), Kyle and Xiong (2001), and Gromb and Vayanos (2002).

² This leverage mechanism has been pointed out in a number of other settings including stocks (Garbade (1982)), corporate asset sales (Shleifer and Vishny (1992)), land (Kashyap, Scharfstein and Weil (1990)), Kiyotaki and Moore (1997)) and housing (Stein (1995)).

markets. A famous case in point is the internet stock eBay which reported significantly better earnings than expected in the summer of 2005. Its stock price soared the same day. The press pointed to short covering as a likely source of the price movement (see Nassar (2005)).

We begin by developing a simple three date model of asset price dynamics in which arbitrageurs have a profitable opportunity to short an over-priced stock subject to positive sentiment.³ The key ingredient is that the ability of arbitrageurs to hold on to short positions depends on asset values (*i.e.* the past performance of these positions). There is also an earnings announcement which may affect the sentiment in the stock. The sensitivity of the stock price to earnings news is simply the regression coefficient of the stock return around the earnings announcement date on the earnings surprise (or the difference between the earnings and the consensus forecast scaled by previous price). We derive three key predictions, which we test using monthly data on short sales in U.S. equities from the period of 1990 (4Q) to 2004 (4Q).

The first prediction is that price sensitivity to earnings news is higher for a stock with positive short selling (*i.e.* arbitrage presence) than for a stock with no short selling (*i.e.* no arbitrageurs). We test this prediction by running a pooled regression of cumulative abnormal returns around (quarterly) earnings announcement dates (from 5 days before to one day after) on an earnings surprise decile score (defined from 1 (lowest) to 10 (highest) for that quarter), a dummy variable for whether a stock is highly shorted before the earnings date (defined as a short ratio, short interest to shares outstanding, in the top decile for that quarter), and the highly shorted dummy interacted with the earnings surprise decile score. The coefficient for the interaction then tells us the difference in the sensitivity of stock price to news between highly shorted stocks and stocks with little short interest. We focus on highly shorted stocks because stocks may have a small amount of short interest due to hedging trades. Only those with substantial short ratios are likely subject to genuine valuation motivated arbitrage activity.

In estimating this relationship, we naturally worry about unobserved heterogeneity, *e.g.* highly shorted stocks may be more in the “media spotlight” than other stocks and hence their prices respond more to news. To deal with this issue, we take great care to estimate this regression specification (and indeed all the other specifications below) in a variety of ways such

³ Our short-selling set-up is consistent with empirical studies on the source of short seller profits. Dechow et.al. (2001) and D’avolio (2003) argue that the source of profits for short sellers is that they short mis-priced stocks: short sells increase with price-to-earnings stocks and short sellers cover as the mis-pricing corrects, *i.e.* as price converges towards earnings.

as controlling for a number of stock characteristics (*e.g.* interacting news with stock characteristics such as firm size, institutional ownership), using stock fixed effects and using industry by quarter effects (to capture potentially time-varying spotlight effects). Regardless of how we estimate this relationship, we find that the price of a highly shorted stock is more sensitive to earnings news than a stock with little shorting. For stocks with little short interest, increasing the earnings surprise by one decile leads to a higher cumulative abnormal return of about 0.73 percentage points. In contrast, for highly shorted stocks, the comparable figure is conservatively around 1.03 percentage points. This difference (about 28% larger for highly shorted stocks) is economically and statistically significant. We verify that this relationship (as well as all the other ones established below) is robust to a variety of different specification checks such as different sub-periods and ways of measuring abnormal returns and earnings surprises. Importantly, we can simultaneously test several other predictions that do not follow from an unobserved heterogeneity story but do from our arbitrage model.

The second prediction is that the change in the short interest ratio of a stock should be negatively correlated with the earnings surprise (*i.e.* a positive earnings surprise should lead to a fall in this ratio). That is, we are verifying the key mechanism behind the amplification effect. Ideally, we want to measure the sensitivity of changes in daily short interest to unexpected earnings announcements. Unfortunately, we can only observe short interest at a monthly frequency (during the middle of months whereas earnings announcements tend to occur at the end of months). Such monthly changes are too coarse to pick up the short covering effect around earnings dates. Therefore, we use a stock's turnover as a proxy for changes in short interest.

The prediction we test is that turnover is more sensitive to the absolute value of unexpected earnings (*i.e.* either good or bad news) for highly shorted stocks than for other stocks. Consistent with our model, we find that, for stocks with little short interest, moving up one decile of the absolute value of unexpected earnings increases turnover by about 0.025 percentage points. For highly shorted stocks, the comparable figure is conservatively around 0.053 percentage points. This is also an economically and statistically significant difference.⁴

Our third prediction is that arbitrageurs are forced to get out of short positions that turn out to be profitable. This means that for highly short stocks, short positions after the event date

⁴ These findings control for level differences in turnover between highly-shorter stocks and other stocks. Consistent with our model, highly-shorter stocks have higher turnover than other stocks. However, this could also be consistent with other asset pricing models without our effects (see, *e.g.*, Scheinkman and Xiong (2003)).

should be more profitable after better earnings news forces short covering. We find that for stocks that are un-shortened, good news leads to higher subsequent returns (from 2 days after to 7 days after the announcement) to holding the stock. This is consistent with the well documented post earnings announcement drift (see, *e.g.*, Bernard and Thomas (1989, 1990)). However, for highly shorted stocks, good news leads to slightly negative excess return. In other words, short positions are more profitable after good earnings news for these stocks (after accounting for a baseline post earnings announcement drift in the data). This difference is economically and statistically significant.

We then evaluate a number of specific alternative explanations (other than unobserved heterogeneity) for these results other than our arbitrage story. One possible reason for price being more sensitive to news for highly shorted stocks is that shorts are informed bets that there are going to be negative earnings surprises. As a result, good news means these bets are wrong and price naturally reacts more to good news. However, additional analysis indicates that shorts actually have little predictive power for earnings surprises but, consistent with existing work and the premise of our paper, tend to be driven by high price-to-earnings ratios. Also, if this alternative explanation is correct, then one would not expect to find an over-reaction on the event date that translates into short positions being more profitable about good news. This post announcement return finding strongly cuts against a number of alternative explanations for our first two findings. We also evaluate a number of other alternatives. And while it is difficult to definitively rule out everyone, we argue that the evidence is broadly consistent with the amplification mechanism due to short covering.

We think that our OLS estimates for these three predictions strongly support the arbitrage story. As a further robustness check, for the specifications described above we instrument for the short interest of stocks. It is not clear that our OLS estimates need be biased upward or downward if short interest is endogenous. For instance, arbitrageurs may want to avoid shorting stocks whose price is very sensitive to news because these stocks pose more fundamental risk.⁵ Alternatively, the highly shorted stocks may be much more in the media spotlight and hence their stock returns maybe more sensitive to earnings surprises. The estimation bias using ordinary least squares (OLS) can go either way.

⁵ For example, suppose some stocks have more investors who sleep through the news, so that price reacts less to earnings news. All else equal, these stocks are less risky to short for arbitrageurs and hence they are more likely to attract short interest.

We exploit differences in short selling regulations across stock exchanges to instrument for the amount of shorting in a stock. For reasons which we detail below, short selling regulations are much more lax for stocks listed on NASDAQ than on the NYSE. Indeed, we find that short interest ratios are substantially higher for NASDAQ stocks all else equal. We use this regulatory difference to instrument for short interest. The exclusion restriction that allows this instrument to identify the causal effect of differentials in shorting on the price sensitivity of stocks to earnings shocks is that the price sensitivity of NASDAQ stocks to earnings news is different than NYSE stocks (conditional on observable stock characteristics such as volatility and the industry classification) only because of this difference in shorting propensity across exchanges and not for any other unobservable reason. As with all instrumental variables estimation, we have to caveat that our findings depend on the validity of this exclusion restriction. Our IV results are larger than the OLS estimates; however, they are very imprecise. With these caveats in mind, the IV estimates do suggest that the OLS results are not biased toward finding an effect.

Finally, we explore whether the differential sensitivities (between shorted and un-shorter stocks) are symmetric with regard to very good versus very bad earnings surprises. In our model, we assume that shorts are reduced following good and increased following bad news. But if the cutting back effect dominates, then we should see these differential sensitivities being largely driven by very good news as opposed to very bad news. To check if this is the case, we now divide earnings surprises in quintiles and create two dummy variables: a high earnings surprise (top 40%) dummy and a low earnings surprise (bottom 40%) dummy. We then re-run the regressions using these two dummies instead of the earnings surprise decile scores. We find evidence that the differential sensitivities documented above are driven by the comparison of the very good earnings news group to the medium group.

Our contribution is to show that arbitrageurs amplify exogenous fundamental shocks because their ability to hold on to positions depends on asset values. We are agnostic as to the cause of why short arbitrageurs, for instance, cut their positions following good news. We have naturally framed this short covering in terms of leverage, risk management or more general agency issues. But it could very well be due to other factors such as behavioral biases which lead arbitrageurs to cut their losses.

There is a growing literature testing the implications of limits to arbitrage models. Most closely related to ours is Savor and Gamboa-Cavazos (2005), who find that short sellers cover their positions after suffering losses and increase them after experiencing gains (measured using past returns), that this relationship is very strong for positions established due to perceived overvaluation and that expected returns do not explain the documented short seller behavior. Similarly, Lamont and Stein (2004) document a negative correlation between past index returns and the aggregate short interest ratio. The main innovation of our paper relative to these and other empirical papers in the literature more generally is that we show that arbitrage activity directly influences asset prices through at least one channel: the amplification of fundamental shocks.⁶ The important point is that this paper is a first in directly showing the economic mechanism that leads to destabilizing speculation in asset markets.

Our paper is also closely related to empirical papers looking at the relationship between leverage and asset prices. Most notably, Lamont and Stein (1999) test a similar hypothesis as ours but in the context of the housing market. Their principal finding is that in cities where a greater fraction of homeowners are highly leveraged, house prices react more sensitively to city-specific shocks such as changes in per capita income. In contrast to their very interesting paper, our setting provides a tighter test of the amplification-of-fundamental-shocks hypothesis for a few reasons. First, we have more and better ways to ruling out alternative explanations. Second, the horizon in which earnings shocks affect stock prices is a bit more straightforward than when per capita income shocks affect housing prices; *i.e.* we can do an event study around earnings announcements. And third, we have better data to more precisely measure our various predictions.

Our paper proceeds as follows. We present a simple model to derive the main predictions in section II. The data is presented in section III and the empirical findings in section IV. We conclude in section V. All proofs are in the Appendix.

II. Model

There is a single asset (the stock) available in unit net supply. There are three dates, numbered 0, 1, and 2. At date 2, the asset is liquidated with payoff v , which may take on the

⁶ Other recent examples related to testing limits of arbitrage models include Brunnermeier and Nagel (2004) who examine the holdings of certain hedge funds during the Internet bubble and Gabaix, Krishnamurthy and Vigneron (2005) who argue that prices of mortgage-backed securities are determined by specialized arbitrageurs.

value \bar{v} or \underline{v} with equal chance. At date 1, the value of v is announced to all. We denote the price at time t by p_t .

There are two sets of agents in the economy: noise traders and risk neutral rational speculators (*e.g.* hedge funds). The noise traders over-estimate the fundamental payoff by an amount $S > 0$ at time 0. This sentiment (optimism) may widen or narrow to $S(v)$ at time 1 (depending on the nature of the earnings announcement) and disappears completely by time 2. More formally, we assume that aggregate noise trader demands time 0 and 1 are given by (in share terms)

$$Q_0^N = \frac{E_0[v] + S}{p_0} = \frac{\frac{1}{2}\bar{v} + \frac{1}{2}\underline{v} + S}{p_0} \quad (1)$$

and

$$Q_1^N = \frac{E_1[v] + S(v)}{p_1} = \frac{v + S(v)}{p_1} \quad (2)$$

respectively.

Arbitrageurs undertake short positions to partially counteract the noise traders, but we assume their resources in the two periods, given by F_0 and $F_1(v)$, are insufficient to bring prices to fundamental value. For simplicity, initial aggregate speculator demand is given by

$$Q_0^S = -\frac{F_0}{p_0} \quad (3)$$

where $F_0 < S$. (In the Appendix, we solve the more general model in which arbitrageurs can determine how much of their resources ($D_0 \leq F_0$) to invest at time 0. The remainder is invested in cash and yields a zero net return as a safeguard against running out of funds at time 1.) At time 1, all uncertainty has been resolved and speculators take the maximum possible short position, yielding a demand of

$$Q_1^S = -\frac{F_1}{p_1} \quad (4)$$

provided $F_1(v) \leq S(v)$. Due to the unit net supply assumption, the short demand of speculators in this model is also the short ratio, or the ratio of shares shorted to total shares outstanding.

We also make the following assumption regarding the time evolution of the arbitrageurs' resources

$$F_1(v) = F_0 + aF_0 \left(1 - \frac{p_1(v)}{p_0} \right), \quad (5)$$

where $a > 1$. If the arbitrageurs do not short at time 0, then $F_1(v) = F_0$. But since they are assumed to short an amount F_0 , their capital at time 1 depends on the return of shorting, $\left(1 - \frac{p_1(v)}{p_0} \right)$, between time 0 and 1. How sensitive their resources are at time 1 to asset values or past returns (*i.e.* their ability to hold on to shorts) is given by the parameter a . We are agnostic as to the source of why $a > 1$. Most naturally, it reflects the fact that short sellers tend to be levered. Also plausibly, it may be an internal risk management control or imposed on the speculators by outside investors, (see, *e.g.*, Shleifer and Vishny (1997)). For instance, one interpretation is that there are loss-limits at the position level or related value-at-risk (VAR) considerations and when a short position suffers a loss, the position is dramatically cut back. (Plentiful anecdotal evidence (cited in the Introduction) seems to bear this assumption out.)

We now solve for the asset prices. Date 2 represents the long-run in which price reverts to fundamental value, *i.e.* by no arbitrage, $p_2 = v$. Since aggregate demand in each period must equal the unit supply, *i.e.*

$$Q_t^S + Q_t^N = 1, \quad (6)$$

price at time 0 is

$$p_0 = \frac{1}{2}\bar{v} + \frac{1}{2}v + S - F_0. \quad (7)$$

Equating supply and demand at time 1 and then substituting from equation (5), we get

$$p_1(v) = \frac{v + S(v) - F_0(1+a)}{1 - a \frac{F_0}{p_0}}. \quad (8)$$

Finally, we introduce an important variable for our empirical work. This variable, the sensitivity of stock price to earnings news (or often called the earnings response coefficient) denoted by β , is:

$$\beta(v) = \frac{\frac{\Delta p}{P_0}}{\frac{\Delta v}{v - E[v]}} = \frac{P_1 - P_0}{v - E[v]} \quad (9)$$

The earnings response coefficient is the percent change in price divided by the percent change in the value of the stock (scaled by price). It represents the responsiveness of price to innovations in fundamental value. Higher values of β denote higher sensitivity of prices to news. Alternatively, we can also scale the earnings innovations by the expectation of earnings. The theoretical results are similar and so we stay with the definition in equation (9) since it is the one most often used in papers that measure the sensitivity of price to earnings news.

The following three propositions are the key predictions of the model that we test. For all three propositions, we are assuming there is not enough capital to bring prices close to fundamental value.

Proposition 1: *The sensitivity of stock price to earnings news, β , is greater for shorted stocks than for un-shorted stocks.*

The key amplifying mechanism is that the ability of arbitrageurs to maintain their positions is tied to asset values. The effect is similar to that of leverage constraints for long positions.⁷

The second proposition is that the change in the short interest ratio of a stock should be negatively correlated with the earnings surprise (*i.e.* a positive earnings surprise should lead to a drop in the short ratio). Unfortunately, our monthly short interest data is too coarse to capture this short covering effect around earnings announcements, particularly in light of the findings in Diether, Lee and Werner (2005). Due to the inability to measure daily short covering, we show that this short covering effect translates into turnover being more sensitive to unexpected earnings for highly shorted stocks than un-shorted stocks.

⁷ Though this model is very stylized, it is possible to perform some back of the envelope calculations to gauge the differential in sensitivity of price to news between highly shorted compared to un-shorted stocks (the details of these calculations are available upon request from the authors). The upshot is that the results are sensitive to the unobservable parameter a (the amplification parameter) and the differential sensitivity can vary between being 30% to 350% greater for highly shorted stocks depending on what one assume about this parameter. Our empirical estimates fall comfortably within this wide range of calibration magnitudes.

Proposition 2: *For shorted stocks, the change in short ratio is inversely related to the earnings surprise. Share turnover around earnings announcements is more sensitive to (the absolute value) unexpected earnings for highly shorted stocks than for un-shorted stocks.*

It is the latter implication of this proposition that we focus on in our empirical work, *i.e.* we can only test that turnover is more sensitive to (absolute value of) unexpected earnings news for shorted stocks.

Finally, the premise of the amplification mechanism is that arbitrageurs are forced to get out of profitable short positions. Proposition 3 formalizes this premise by allowing sentiment to rise even after good news so that the short position remains profitable. This is a modeling device meant to capture the fact that short positions may be fundamentally profitable but arbitrageurs may have difficulty hanging on to short positions if their ability to do so depends on asset values. In a more dynamic set-up with multiple earnings dates, we could also accomplish the same result by introducing transitory earnings shocks.

Proposition 3: *If sentiment increases proportionally with unexpected earnings news, then for highly shorted stocks, the expected return to shorting is higher after a good earnings surprise.*

We test Proposition 3 by comparing subsequent stock returns after earnings announcements for highly shorted stocks to un-shorted stocks. The only caveat in testing Proposition 3 is that there is the well-documented post earnings announcement drift in the data, *i.e.* stocks with good (bad) news) continue to drift in the direction of the news after the announcement (see, *e.g.*, Bernard and Thomas (1989, 1990)). We do not model post earnings announcement drift in this paper, though we could by assuming a degree of under-reaction to news as in Barberis, Shleifer and Vishny (1998) or Hong and Stein (1999). As such, we need to account for this in testing this proposition. So, another way of posing this proposition is that there should be less drift in highly shorted stocks compared to other stocks.

III. Data

Our data on monthly short interest, available for the period of November 1990 to December 2004, are obtained from Bloomberg. We use short interest to construct short ratios for each month. Each month's short interest data represents positions that closed on the first business day on or after the 15th of the month. Hence we approximate the short ratio by dividing total short interest positions by shares outstanding (from CRSP) on or closest to the 12th day of each month. We define *HISR* as a dummy equal to one if the stock is in the top 10% of the short ratio distribution for the quarter of the observation and zero otherwise. We focus on highly shorted stocks because previous studies find that stocks may have a small amount of short interest due to hedging trades (see, *e.g.*, Chen, Hong and Stein (2001), Asquith, Pathak and Ritter (2006)). In other words, these studies find that for the vast majority of stocks, there are very little valuation-motivated shorts at any point in time. Hence, only stocks with substantial short ratios are likely subject to genuine valuation-motivated arbitrage activity. The 10% cut-off is chosen because among this sub-group, there is a relatively high short ratio (about 24% on average). (Our results are robust to using other cut-offs such as the top quintile but they are naturally smaller since there is dramatically less shorting as one moves down the short ratio distribution.)

We combine these data with information from three other databases. First, quarterly earnings consensus estimates and actual initial (*i.e.* unadjusted) releases are collected from the I/B/E/S summary files. In practice, researchers have a few different ways of calculating unexpected earnings (*UE*). *UE* is the difference between the actual quarterly earnings according to I/B/E/S and the consensus forecast provided by I/B/E/S in the last month before the announcement date scaled by either past price, previous earnings or the consensus forecast (see, *e.g.*, Conrad, Cornell and Landsman (2002), Kothari (2001)). Different studies scale *UE* differently, typically by either past price or previous earnings and less frequently by the consensus forecast. Our results are fairly similar across these different measures. We follow convention and scale *UE* by past price and present in the robustness section the results when *UE* is scaled by previous earnings. We then transform *UE* into *UEDECILE*: the decile score of *UE* (defined from 1 (lowest) to 10 (highest) for that quarter).⁸

⁸ Hirshleifer et.al. (2006) suggest the use of decile scores as a way to model price-to-earnings news relationship as the use of decile scores explains much more of the variance of news than using raw earnings surprises.

Second, data on daily holding period returns, prices, trading volume and shares outstanding are obtained from the Center for Research in Securities Prices (CRSP). Using these data, we calculate cumulative abnormal returns around earnings announcement dates as follows. Each stock is assigned to a size-valuation category by assigning them each year first to size deciles based on their market capitalization at the start of the year and then to valuation deciles based on the ratio of market capitalization to last year's book equity. In this way we create one hundred different size-valuation categories. We use the entire sample to calculate the loadings of these one hundred portfolios using the Sharpe (1964) CAPM and the Fama and French (1993) three-factor model.

In addition to a simple return net of the risk-free, we then calculate daily abnormal returns for each stock using one of these two models. For each year, each stock inherits the loadings of its size-valuation category (determined at the beginning of the year) with which its abnormal return is calculated. Abnormal returns are then cumulated from five trading days before until one day after the earnings release date (*CAR*). We also calculate cumulative post-announcement returns (*POSTCAR*) using days +2 to +7 relative to earnings release. We have worked with various permutations of the timing in calculating these event day returns and the results are all similar. We use the two definitions here since they are again standards in event studies. Using the CRSP database, we also calculate daily share turnover (using trading volume and shares outstanding) and then take the average of daily share turnover from day -5 to day +1 surrounding the earnings announcement (*AVGTURN*). The timing is set to match that of the *CAR*.

Third, the following annual accounting variables are obtained from the CRSP/COMPUSTAT merged Industrial Annual data file: book equity (data item 60), convertible securities (data item 39), earnings per share (data item 57) and fiscal-year-end closing price (data item 199). The price-to-earnings valuation ratio is calculated as the lagged price as of 21 days before earnings release divided by the previous year's annual EPS.⁹

⁹ We have also performed (but do not report for brevity) a number of other robustness checks using the different valuation ratios. We calculate an alternative P/E ratio as previous year's fiscal-year-end closing price in the numerator and current release of earnings from I/B/E/S in the denominator (assuming earnings are greater than 0, otherwise, we keep these observations in the database but create a dummy variable for non-positive earnings firms). Other valuation ratios used for further robustness checks are market-to-book, market-to-assets and market-to-sales, all generated similarly using 21 day lagged prices and previous year's accounting numbers.

Finally, firm market capitalization is obtained from CRSP. Monthly return volatility is calculated using daily return data from CRSP. Quarterly data on institutional ownership is obtained from Spectrum. A measure of analyst disagreement, or the dispersion of analyst forecasts (calculated as in Diether, Malloy and Scherbina (2002)), is obtained from I/B/E/S.

The sample includes stocks that are listed on the NYSE or NASDAQ. We include stocks that are in the top three quintiles of the market cap distribution of our sample (to help make the NASDAQ stocks comparable to the NYSE stocks). Observations are dropped if the dependent variable is missing or the controls are missing. The summary statistics for these variables are presented in Table 1. The key statistic is that the mean of the short ratio distribution is about 5.1% and its standard deviation is 13%. For stocks in the top 10% of the short ratio distribution, the mean is 24% as we mentioned earlier. The statistics for the other variables are similar to those reported in other papers.

IV. Empirical Findings

A. Sensitivity of Price to Earnings News

We begin by testing Proposition 1. We want to measure how the sensitivity of price to earnings news varies by whether a stock is actively shorted or not. We first measure the overall effect of unexpected earnings shocks on returns: *i.e.* the price to earnings sensitivity for the typical firm in our sample. This will provide us with a benchmark. To this end, we estimate the following specification:

$$\begin{aligned}
 CAR_{i,t} = & \alpha + \beta_1 UEDECILE_{i,t} + \beta_2 HISR_{i,t} + SIZE\ dummies_{i,t} + P/E\ dummies_{i,t} \\
 & + IO\ dummies_{i,t} + DISAGREEMENT\ dummies_{i,t} \\
 & + CONVDEBT\ dummies_{i,t} + VOLATILITY\ dummies_{i,t} \\
 & + INDUSTRY\ dummies_i + QUARTER\ dummies_t + \varepsilon_{i,t}
 \end{aligned} \tag{10}$$

The left-hand side (LHS) variable is *CAR* (cumulative abnormal return from day -5 to +1). The right-hand side (RHS) variable of interest is *UEDECILE* (earnings surprise decile score defined from 1 (lowest) to 10 (highest) for that quarter). The other RHS variables include *HISR* (a dummy equal to one if the stock is in the top 10% of the short ratio distribution for the quarter of the observation and zero otherwise), *SIZE* (market cap divided into 25 dummies by quarter), *P/E*

(price-to-earnings divided into 25 dummies by quarter and one additional dummy variable for negative earnings stocks), *DISAGREEMENT* (the dispersion in analyst forecasts divided into 25 dummies by quarter), *IO* (institutional ownership divided into 25 dummies by quarter), *CONVDEBT* (convertible debt divided into 25 dummies by quarter), *VOLATILITY* (return volatility of firms in the previous month calculated using daily returns divided into 25 dummies by quarter), *INDUSTRY* dummies (SIC at the 2 digit level) and *QUARTER* dummies. We will explain the rationales behind each of these control variables as we build on this specification to test our predictions below.¹⁰

The result for this specification is reported in column 1 of Table 2. As expected, the coefficient on *UEDECILE* is positive and statistically different than zero. The coefficient implies that moving up one decile of unexpected earnings is associated with a 0.76 percentage point increase in the return of the stock (*CAR*). This is about 9% of a standard deviation of *CAR*. This number is in line with other studies of the sensitivity of stock price to earnings surprises mentioned earlier.¹¹

We then estimate the following model, which is the same as the previous one except for the addition of the interaction of *UEDECILE* and *HISR*:

$$\begin{aligned}
CAR_{i,t} = & \alpha + \beta_1 UEDECILE_{i,t} + \beta_2 HISR_{i,t} + \beta_3 UEDECILE_{i,t} \times HISR_{i,t} + SIZE\ dummies_{i,t} \\
& + P/E\ dummies_{i,t} + DISAGREEMENT\ dummies_{i,t} + IO\ dummies_{i,t} \\
& + CONVDEBT\ dummies_{i,t} + VOLATILITY\ dummies_{i,t} \\
& + INDUSTRY\ dummies_i + QUARTER\ dummies_t + \varepsilon_{i,t}
\end{aligned} \tag{11}$$

The coefficient of interest is β_3 , which measures the differential sensitivity of high short ratio stocks to unexpected earnings compared to other stocks. The result is reported in column 2. The estimates show that the sensitivity to high unexpected earnings shocks is greater for high short ratio stocks. β_1 suggests that for a low short ratio stock, moving up one decile of *UE* is associated with a 0.73 percentage point increase in *CAR*. β_3 is 0.31 and statistically significant

¹⁰ We have also included the age of the firm in all of our cross-sectional regressions as a control and find similar results.

¹¹ The positive coefficient on *HISR* is consistent with the shorting literature reviewed in Chen, Hong and Stein (2002), who point out that highly shorted stocks may be more fairly priced. However, this coefficient is much smaller and statistically insignificant in other specifications and when using our instrumental variables estimation approach.

from zero with a t-statistic of about 3.9. So a one decile increase of *UE* increases *CAR* by 0.31 percentage points more for a high short ratio stock than a low short ratio stock. β_3 suggests that the sensitivity of high short ratio stocks to unexpected earnings is about $0.31/0.73 = 42\%$ greater than for low short ratio stocks.

This regression specification controls for a number of stock characteristics, but these controls do not allow for the sensitivity of price to news to vary by these stock characteristics. To remedy this, we estimate the following model, which is the same as the previous one except for the addition of the interactions of *UEDECILE* with the other firm characteristics:

$$\begin{aligned}
CAR_{i,t} = & \alpha + \beta_1 UEDECILE_{i,t} + \beta_2 HISR_{i,t} + \beta_3 UEDECILE_{i,t} \times HISR_{i,t} + SIZE\ dummies_{i,t} \\
& + SIZE\ dummies_{i,t} \times UEDECILE_{i,t} + P/E\ dummies_{i,t} + P/E\ dummies_{i,t} \times UEDECILE_{i,t} \\
& + DISAGREEMENT\ dummies + DISAGREEMENT\ dummies \times UEDECILE_{i,t} \\
& + IO\ dummies_{i,t} + IO\ dummies_{i,t} \times UEDECILE_{i,t} \\
& + CONVDEBT\ dummies_{i,t} + CONVDEBT\ dummies_{i,t} \times UEDECILE_{i,t} \\
& + VOLATILITY\ dummies_{i,t} + VOLATILITY\ dummies_{i,t} \times UEDECILE_{i,t} \\
& + INDUSTRY\ dummies_i + QUARTER\ dummies_t + \varepsilon_{i,t}
\end{aligned} \tag{12}$$

The coefficient of interest again is β_3 , which measures the differential sensitivity of high short ratio shocks to unexpected earnings shocks than other stocks. We include the additional interactions of *UEDECILE* with the other control variables because price sensitivity to news might vary by the different characteristics. For instance, the price of a high price-to-earnings stock is likely to have a different sensitivity to earnings news than a low one. Similarly, the price of a large capitalization stock might respond more to news than the price of a small capitalization stock if the investors in large stocks are more likely to be institutions and institutions pay closer attention to news compared to individuals. We also add interactions of *UEDECILE* and *DISAGREEMENT* because highly shorted stocks may simply have more analyst dispersion and the price of high divergence of opinion stocks may react more to news. The logic for institutional ownership and past volatility are similar. For convertible debt, short interest might be driven by hedging trades associated with the purchase of convertible securities. Because we want to measure short interest related to speculative trades as precisely as possible, we include convertible debt by *UEDECILE* interactions.

The results from this estimation are presented in column 3. β_3 is positive and statistically significant (0.19 with a t-statistic of over 2). The estimate shows that the sensitivity to *UE* is greater for high short ratio stocks; for these stocks, the increase in *CAR* is 0.19 percentage points more for an increase one decile move up in *UE*, similar to what we obtained in column 2. This is our most conservative estimate and it still implies an economically different sensitivity of highly shorted stocks to news than other stocks---it is greater by around 26% (0.19/0.73). (Note that we cannot obtain a unique estimate of β_1 in this specification because of all of the other interactions with *UEDECILE*.) It is comforting to find that the result in column 2 is robust to these controls.

In columns 4-6, we re-estimate the specifications in columns 1-3, except that we now include stock fixed effects (*i.e.* we only use a stock's time series variations in short ratio and price sensitivity to news to estimate the relationship between these two variables of interest). The logic of this estimation is that we are worried that even with all of our elaborate controls, there might still be fixed differences across stocks for which we have not yet accounted (*e.g.* some stocks are more in the spotlight in some un-measurable manner and these stocks attract both more shorts and react more to earnings surprises). We obtain similar estimates to our previous specification. The coefficient in front of *UEDECILE* in column 4 is 0.79 instead of 0.76 from column 1. In column 5, the coefficient in front interaction of *UEDECILE* and *HISR* is 0.34, similar to the estimate of 0.31 in column 2. Interacting *UEDECILE* with the other stock characteristics in column 6 does not significantly affect our estimate of β_3 .

In columns 7-9, rather than including stock fixed effects, we include quarter by industry effects to account for potential time varying effects that might spuriously be generating our findings in columns 1 through 3. For instance, maybe the spotlight effect changes over time (some stocks are in the spotlight more at certain times). If this spotlight effect is not specific to a stock but is common across all stocks in the same industry, then our quarter by industry effects will control for any spurious relationship generated by such a process. Again, the estimates are remarkably similar to columns 1-3. In column 7, the coefficient in front of *UEDECILE* is now 0.78 instead of 0.76 in column 1. In column 8, the coefficient in front of *UEDECILE* \times *HISR* is now 0.33 instead of 0.31. And the coefficient in front of *UEDECILE* \times *HISR* in column 9 is now 0.21 instead of 0.19. All these estimates are again statistically and economically significant.

In sum, the findings in Table 2 firmly establish the first prediction of our arbitrage hypothesis and strongly cut against the alternative of unobserved heterogeneity. We take an “everything but the kitchen sink” approach in this table. Below, we consider an alternative of instrumental variables estimation to deal with omitted variable bias. But an even better way to support our arbitrage story is to test our model’s additional implications that do not arise naturally out of an omitted variable bias story. We consider tests of these implications next.

B. Sensitivity of Turnover to Earnings News

The results presented in this section test Proposition 2. We want to measure how the sensitivity of turnover to earnings news varies by whether a stock is actively shorted or not. Our analysis proceeds in a manner similar to that of Table 2. The results are presented in Table 3; it is the equivalent of Table 2 except that the LHS variable is *AVGTURN*, the average (from day -5 to +1 around the earnings announcement) turnover of the stock minus the average turnover of the stocks in the exchange the stock is part of during the quarter of the observation, and *UEDECILE* is replaced by *ABSUEDECILE*, which is a decile score (defined from 1 (lowest) to 10 (highest) for that quarter) of the absolute value of the earnings surprise. The reason we use *ABSUEDECILE* instead of *UEDECILE* is that either good or bad earnings news will lead to turnover according to our model.

Columns 1 through 9 of Table 3 are analogous to those in Table 2. Column 1 shows that higher absolute *UE* increases turnover. Moving up one decile increases turnover by about 0.03 percentage points (about 3% of a SD of turnover). Column 2 shows that this sensitivity is greater for highly shorted stocks. β_3 is positive and statistically significant (0.044 with a t-statistic of about 3.1). For low short ratio stocks, the sensitivity of turnover to an increase in *ABSUEDECILE* is 0.025 percentage points. In contrast, the sensitivity for highly shorted stocks is 0.069 (0.025+0.044) percentage points, which is about 2.75 times bigger than the magnitude for low-short-ratio stocks. Column 3, which adds as controls interactions of *ABSUEDECILE* with other stock characteristics, confirms the results of column 2. Note that these findings control for level differences in turnover between highly shorted stocks and other stocks. Consistent with our model, highly shorted stocks (*HISR*) have higher turnover than other stocks; however, this could also be consistent with other asset pricing models without our effects. So,

our findings are not driven by these level differences. Rather, we are measuring differences in sensitivities to absolute earnings surprises.

In columns 4-6, we present the results using stock fixed effects. β_3 from column 5 is positive and statistically significant but is smaller than in column 3 (now 0.031 with a t-statistic of about 2.6). The economic effect is still quite large; for highly shorted stocks, the sensitivity of turnover to absolute earnings surprise is about 2.4 times larger than for other stocks. The results using quarter by industry effects (presented in columns 7-9) are similar to these. In sum, the results are consistent with the second prediction of our model. This finding suggests that any alternative story for our first finding regarding highly shorted stocks have a greater sensitivity to news should now also explain why turnover in highly shorted stocks is also more sensitive to news.

C. Subsequent Stock Returns and Earnings News

Perhaps an even more distinctive implication of our theory is Proposition 3. We want to measure how returns after the earnings announcement date differ between highly shorted stocks and un-shorted stocks. In essence, we want to verify that if the *CAR* results are due to the short covering mechanism we propose, then we should see returns to shorting being higher after a good earnings announcement. As we explained in the theory section, the only caveat in testing Proposition 3 is that there is the well-documented post earnings announcement drift in the data, *i.e.* stocks with good (bad) news) continue to drift in the direction of the news after the announcement. Accounting for this drift, we then expect to find that there should be less drift in highly shorted stocks compared to other stocks.

Our analysis proceeds in a manner similar to that of Table 2. The results are presented in Table 4. In other words, Table 4 is the equivalent of Table 2 except that the LHS variable is *POSTCAR* (from 2 days after to 7 days after the announcement) instead *CAR*. Columns 1-3 show the standard OLS results. Column 1 suggests that moving up one decile of *UE* raises *POSTCAR* by about 0.12 percentage points (about 2% of a SD). This is consistent with the well documented post earnings announcement drift. Column 2 shows that there is a negative effect of moving up one decile of *UE* on *POSTCAR* for highly shorted stocks relative to low short ratio stocks. β_3 is negative and statistically significant (-0.17 percentage points with a t-statistic of over 3). A one decile increase in *UE* for high *SR* stocks lowers *POSTCAR* by about 0.03

percentage points. Hence, for highly shorted stocks, there are actually lower returns following positive earnings surprises. In other words, short positions are more profitable after good earnings news for these stocks. The result in column 3 using more elaborate controls confirms the one in column 2.

In columns 4-6, we present the results using stock fixed effects. β_3 from column 5 is negative and statistically significant and similar in magnitude to column 2 (-0.15 with a t-statistic of over 3). The results using quarter by industry effects (presented in columns 7-9) are slightly larger (-0.19 with a t-statistic of just under 4). In sum, the results are consistent with the third prediction of our model.

D. Alternative Explanations

We now consider a number of alternative explanations for these three sets of findings. There are two closely related alternatives that can explain our main finding regarding high short ratio stocks having higher price sensitivity to news. The first is that high short ratio stocks proxy for stocks with high divergence of opinion. Hence, earnings news leads to more price discovery. We try to control for this alternative using explicit proxies for divergence of opinion such as analyst forecast disagreement and other controls such as stock fixed effects. But one might still argue that high short ratio is itself the best proxy. This alternative, however, does not naturally generate a predicted reversal associated with the price reaction. For high short ratio stocks, good news leads to a bigger price move up and subsequent reversal captured by the fact that shorting profitability after the event date increases with better news. A price discovery story would naturally imply that certain groups were right and certain groups were wrong and the bets are resolved through the earnings news, saying nothing about future returns associated with the news.

A closely related variant of this divergence of opinion story is that funds which short are informed and are betting that there is bad news about the company. That is, high short interest predicts a negative earnings surprise. When the news is good, this means that the informed short-sellers happen to be wrong. As before, price adjusts appropriately but with no implications for *POSTCAR*. Moreover, we can directly examine the underlying premise of this alternative by looking at whether high short interest predicts negative earnings surprises. This is presented in Table 5. The dependent variable is a firm's earnings surprise (*UE*). The main right hand side

variable of interest is *HISR* (whether a firm is highly shorted) and the other control variables as used in the above regressions. The coefficient on *HISR* is negative, but the implied economic effect is very small and is not significantly different from zero. For example, in column 1, being in the top 10% of the short ratio distribution lowers *UE* by only 0.01 (less than one percent of the standard deviation of *UE*). The estimated effect of *HISR* is similar when we include stock fixed effects or time-varying industry effects in the specification in columns 2 and 3. Hence, our findings reject this alternative. Indeed, existing literature (see, e.g. Dechow et.al. (2001)) find that shorts are driven by price-to-earnings ratios and that shorts are closed out as price-to-earnings ratios revert to the mean. In sum, our own findings, along with those in the literature, are consistent with our model of shorting as being driven by high price-to-earnings ratios and the predictable convergence of these ratios over time.

Again, we cannot rule out every alternative explanation of our results, but we feel that our three sets of findings do cut strongly against a number of reasonable alternatives, particularly when one takes into account the stock fixed effects and quarter by industry effects specifications.

E. Results Obtained with Instrumental Variables Estimation

Though we are comfortable with the OLS estimates, it is worthwhile to think of an instrumental variables estimation approach to dealing with the potential endogeneity of short interest. In general, the bias to the OLS results can go either way. On the one hand, arbitrageurs may want to avoid shorting stocks whose price is very sensitive to news because these stocks have more fundamental risk. In this scenario, the OLS result is biased downward. Alternatively, the highly shorted stocks may be much more in the media spotlight and hence their *CARs* maybe more sensitive to *UE*. Under this scenario, the OLS result is biased upward.

We can exploit differences in short selling regulations across stock exchanges to instrument for the amount of shorting in a stock. Short selling regulations are much more lax for stocks listed on NASDAQ than on the NYSE. Before 1994, there were not even any short selling regulations for NASDAQ stocks. It is generally thought that NASDAQ introduced some degree of regulation to compete with NYSE for firm listings because companies typically do not like to have their stocks shorted. The two exchanges also use somewhat different price tests (NYSE uses the tick test which is generally thought to be more stringent than the bid test used by NASDAQ).

This price-test difference aside, the NASDAQ regulations that were introduced and those currently in use are substantially weaker than those of the NYSE. First, NASDAQ exempts its market-makers from short selling regulations. Second, trades originating from Electronic Communications Networks (ECNs) are also exempt. This means that 30% of NASDAQ short sale trades are not even subject to a bid test, whereas all NYSE trades are subject to a tick test (see, e.g., Jickling (2005), O’Hara and Angstadt (2004)).

Therefore, we expect to find that short interest ratios are substantially higher for NASDAQ stocks all else equal. In particular, we see whether being listed on NASDAQ increases the likelihood that the stock is in the top 10% of the short ratio distribution using the following regression:

$$\begin{aligned}
 HISR_{i,t} = & \alpha + \beta_1 NASDAQ_{i,t} + SIZE\ dummies_{i,t} + P/E\ dummies_{i,t} \\
 & + DISAGREEMENT\ dummies_{i,t} + IO\ dummies_{i,t} \\
 & + CONVDEBT\ dummies_{i,t} + VOLATILITY\ dummies_{i,t} \\
 & + INDUSTRY\ dummies_i + QUARTER\ dummies_t + \varepsilon_{i,t}
 \end{aligned} \tag{13}$$

The coefficient of interest is β_1 , which measures how being listed on NASDAQ affects the probability that the stock is in the top 10% of the short ratio distribution. (We have also run this as a probit or logit and obtained similar results). The result is presented in Table 6; being a NASDAQ stock increases the probability that a stock is in the top 10% of the short ratio distribution by about 6 percentage points. The t-statistic of the coefficient is 4.72.

We use this regulatory difference to instrument for short interest. The exclusion restriction that allows this instrument to identify the causal effect of differentials in shorting on the price sensitivity of stocks to earnings shocks is that the price sensitivity of NASDAQ stocks to earnings news is different than NYSE stocks (conditional on observable stock characteristics) only because of this difference in shorting propensity across exchanges and not for any other unobservable reason. Our analysis is based on this exclusion restriction being reasonable, but one might worry that NASDAQ stocks are just different from NYSE stocks in ways we cannot control for. We have experimented with controls such as volatility, age and industry dummies (and even a technology stock dummy) and find similar results. Nonetheless, we still worry about this exclusion restriction and view these IV results as a robustness check of our OLS exercises, which we believe to be unbiased and reasonable.

In Table 7 we present the 2SLS or instrumental variables (IV) estimates. Column 1 is the IV version of equation (10). Our instrument is an indicator that the stock is traded on NASDAQ. Mechanically, the IV procedure works like this. First, we take the fitted values of $HISR$ from equation (13) above (the first stage) and substitute those fitted values into equation (10) instead of $HISR$ and run the ordinary least squares (OLS) (the second stage).¹² β_1 is now the causal effect of $HISR$ on CAR (if the assumption that $NASDAQ$ is a good instrument holds).

Column 2 is the IV version of equation (11). Notice that we now have two endogenous variables on the RHS of the specification: $HISR$ as before and the $HISR \times UEDECILE$ variable. To estimate equation (11) using IV we now need at least two instruments for the two endogenous regressors. We again use the $NASDAQ$ indicator and also the $NASDAQ$ indicator interacted with the $UEDECILE$ score.

Mechanically, the IV procedure for equation (11) works like this. There are two first stage equations; we must obtain fitted values of both endogenous regressors. The two first stages are:

$$\begin{aligned}
HISR_{i,t} = & \alpha + \beta_1 NASDAQ_{i,t} + \beta_2 NASDAQ_{i,t} \times UEDECILE_{i,t} + \beta_3 UEDECILE_{i,t} \\
& + SIZE\ dummies_{i,t} + P/E\ dummies_{i,t} + DISAGREEMENT\ dummies_{i,t} \\
& + IO\ dummies_{i,t} + CONVDEBT\ dummies_{i,t} + VOLATILITY\ dummies_{i,t} \\
& + INDUSTRY\ dummies_i + QUARTER\ dummies_t + \varepsilon_{i,t}
\end{aligned} \tag{14}$$

and

$$\begin{aligned}
HISR_{i,t} \times UEDECILE_{i,t} = & \alpha + \beta_1 NASDAQ_{i,t} + \beta_2 NASDAQ_{i,t} \times UEDECILE_{i,t} \\
& + \beta_3 UEDECILE_{i,t} + SIZE\ dummies_{i,t} + P/E\ dummies_{i,t} \\
& + DISAGREEMENT\ dummies_{i,t} + VOLATILITY\ dummies_{i,t} + IO\ dummies_{i,t} \\
& + CONVDEBT\ dummies_{i,t} + INDUSTRY\ dummies_i + QUARTER\ dummies_t + \varepsilon_{i,t}
\end{aligned} \tag{15}$$

We take the fitted values of these two regressions and substitute them for $HISR$ and $HISR \times UEDECILE$ in equation (11). This is the second stage; running OLS will give the correct

¹² Of course, the standard errors of the second stage are adjusted to account for the first stage estimation.

coefficients. Column 3 is similar, but like before we also interact *UEDECILE* with other controls (and again cannot estimate a level effect of *UEDECILE*).

In column 1 of Table 7, the coefficient on *UEDECILE* is positive and statistically significant. The magnitude suggests that moving up one decile of *UE* is associated with a 0.76 percentage point increase in *CAR*. In column 2, the coefficient on β_3 is positive (3.40 percentage points) and significant. Using the more conservative specification of column 3, we obtain a β_3 of 2.29. The economic magnitude of the IV estimate is much larger than that from the OLS. One interpretation is that arbitrageurs are indeed intentionally avoiding stocks that have a high earnings news sensitivity. As such, correcting for this endogeneity gives us a bigger causal effect associated with short covering. However, we are hesitant to make too much of this difference since the IV estimates are very imprecise. For instance, the coefficient 2.29 in column 3 has a standard error of 1.46 and is not statistically different from the analogous coefficient of 0.19 from column 3 of Table 2. However, the IV results do suggest that the OLS estimates are not upward biased; if anything, the IV results indicate that OLS underestimates the results.

Because the same potential endogeneity critique applies to our *AVGTURN* regressions as the *CAR* regressions, columns 4-6 present the IV results corresponding to the *AVGTURN* results of Table 3. Column 4 shows that moving up one decile of absolute *UE* increases turnover by about 0.039 percentage points. Column 5 compares the sensitivities of low-short-ratio to high-short-ratio stocks. The coefficient in front of the interaction term suggests that, among high-short-ratio stocks, moving up one decile of *ABSUE* increases turnover by an additional 0.174 percentage points. These results are economically large and marginally statistically significant. Column 6 presents results with more elaborate controls, confirming the results in column 5. Again the coefficients in columns 5 and 6 are not statistically different from the analogous OLS estimates in columns 5 and 6 of Table 3. In our model, all trading comes from the short covering effect since we only have arbitrageurs and noise traders. As such, our model would indeed predict that all of the effects related to turnover and earnings news should come from only high short ratio stocks. Of course, in reality, there are many different factors driving trading volume which we do not model. Nonetheless, it is interesting to note that the strength of the empirical findings is not out of line with the spirit of our model.

Columns 7-9 present the IV results analogous to the *POSTCAR* OLS regressions of Table 4. Again in column 7, moving up one decile of *UE* increases *POSTCAR* by about 0.12

percentage points. In column 8, β_3 (-0.61 percentage points) is much larger in magnitude than β_1 (0.18 percentage points), suggesting that the overall effect of *UE* for a highly shorted stock on *POSTCAR* is negative. Results with more elaborate controls, presented in column 9, are similar to those in column 8. Importantly, note that the economic magnitudes are in line with the *CAR* results. Notice that the IV estimates from the *CAR* results in column 2 suggests that *UE* increased *CAR* by around an extra 3.40 percentage points for highly short stocks. To the extent that this is an overreaction due to forced liquidations by arbitrageurs, we expect mean reversion in the subsequent days of a magnitude that is below that of this 3.40 percentage points figure. The *POSTCAR* number of -0.61 percentage points is in line with the *CAR* results. Hence, we conclude that the findings strongly support our Proposition 3. Again, the IV estimates are imprecisely measured and the conservative ones do not differ from their analogous counterparts.

As with all instrumental variables estimation, we have to caveat that our findings depend on the validity of this exclusion restriction. It might be that NASDAQ stocks are just different from other stocks in ways we cannot condition on or control for. Hence, we view our IV approach as a robustness check for our OLS results. Our IV results are larger than the OLS estimates; however, they are very imprecise. With these caveats in mind, the IV estimates do suggest that the OLS results are not biased toward finding an effect.

F. Asymmetries in Differential Sensitivities: Very Good versus Very Bad News

According to the model, these differential sensitivities are symmetric with regard to very good versus very bad earnings surprises because we assume that shorts are reduced following good news and increased following bad news. But anecdotal evidence suggests that the cutting back of shorts following bad news is more likely than the increase in shorts following good news. If shorts are often reduced (but are less likely to increase) following good (bad) news about a stock, then the above differential sensitivities should largely be driven by very good news as opposed to very bad news.

To test this, we divide earnings surprises into quintiles and create two dummy variables: a high earnings surprise (top 40%) dummy and a low earnings surprise (bottom 40%) dummy. We then run our OLS and IV regressions using these two dummies instead of the *HISR* dummy. The OLS specification is given by:

$$\begin{aligned}
CAR_{i,t} = & \alpha + \beta_1 HI40UE_{i,t} + LOW40UE_{i,t} + \beta_2 HISR_{i,t} + \beta_3 HI40UE_{i,t} \times HISR_{i,t} \\
& + \beta_4 LOW40UE_{i,t} \times HISR_{i,t} + SIZE\ dummies_{i,t} + P/E\ dummies_{i,t} \\
& + DISAGREEMENT\ dummies_{i,t} + IO\ dummies_{i,t} \\
& + CONVDEBT\ dummies_{i,t} + INDUSTRY\ dummies_i + QUARTER\ dummies_t + \varepsilon_{i,t}
\end{aligned} \tag{16}$$

where *HI40UE* is a dummy for being in the top 40% of the unexpected earnings distribution of the quarter, *LOW40UE* is a dummy for being in the bottom 40% of the unexpected earnings distribution of the quarter and the other variables are defined as above. For the IV, there are now three endogenous variables: *HISR*, *HI40UE* × *HISR* and *LOW40UE* × *HISR*. The three instruments are: *NASDAQ*, *HI40UE* × *NASDAQ* and *LOW40UE* × *NASDAQ*.

The results of the OLS and IV regressions are reported in Table 8. The first two columns present the *CAR* results. Using OLS and IV, we find some evidence of a bigger response to good news than bad news. In both cases, the absolute value of the coefficient on *HI40UE* × *HISR* is larger than the coefficient on *LOW40UE* × *HISR*. In columns 3 and 4, we estimate similar models with *AVGTURN* as the LHS variable. Again, for both the OLS and IV, the coefficient on the interaction for high earnings and high short ratio is substantially greater than the interaction for low earnings and high short ratio. Finally, the *POSTCAR* results are reported in columns 5 and 6. As with the *CAR* results, we find evidence of asymmetries. The interactions for good earnings and high short ratio are larger in absolute value than for bad earnings and high short ratio. However, for all of these estimates, the standard errors are large. This imprecision indicates that we cannot draw strong conclusions about these asymmetries.

G. Robustness Checks

Finally, we present a number of robustness checks. Table 9 takes the *CAR* regressions and splits them into two time periods: 1990-1996 and 1997-2004. The OLS results are similar for both time periods. The coefficient in front of the interaction of *UE* and *CAR* is 0.50 in the earlier period and 0.20 in the later period. The effect is larger in the earlier period, but both coefficients are economically and statistically significant. Table 10 presents the *CAR* and *POSTCAR* regressions using the CAPM and returns net of the risk-free instead of the three-factor adjusted returns we use previously. There is no important difference between the results using these different adjustments. Table 11 present our key findings in which we scale the earnings

surprise by previous earnings. The results are all consistent with those reported earlier. These robustness checks increase our confidence in concluding that the bulk of the findings support our model.

V. Conclusion

We develop a simple model to examine whether arbitrageurs amplify fundamental shocks in the context of short arbitrage in equity markets. The key amplifying mechanism is that the ability of arbitrageurs to hold on to short positions depends on asset values: shorts are often cut (increased) following good (bad) news about a stock. As a result, the prices of highly shorted stocks are excessively sensitive to fundamental shocks.

Consistent with this model, we find that, controlling for a host of other stock characteristics, the price of a highly shorted stock is more sensitive to earnings news than a stock with little short interest. Moreover, using daily share turnover as a proxy for short covering, we document that short interest changes in the predicted direction in response to earnings news. For highly shorted stocks, returns to shorting are actually somewhat higher following good earnings news. Finally, these differential sensitivities are related to very good earnings news as opposed to very bad earnings news. These findings are broadly consistent with theories which emphasize the limits of arbitrage in affecting asset price dynamics.

As we suggested in the introduction, understanding the potentially destabilizing effects of speculators on asset markets is of paramount importance in light of the rise of hedge funds in the last decade. There are a number of avenues for further research to clarify the various channels through which speculators might destabilize markets. Along the same lines as this paper, if better daily data on short trades becomes available, we can more directly verify the short covering effect around earnings announcements as opposed to simply using share turnover. We can also use options data as opposed to short interest data to measure levered long or short positions in stocks and perform a similar set of analyses as in this paper. We plan to pursue these avenues in future research.

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Appendix

In this appendix we relax our earlier assumption that speculators put all their resources, F_0 , at risk in the stock market immediately, and instead assume that they choose some amount, $D_0 \leq F_0$ to put at risk (the remainder is invested in cash and yields a zero net return). The speculators may want to put some money aside in case the stock becomes an even better short trade after the earnings announcement. To complete the model, we set up the speculators' incentives and solve their optimization problem. We set the problem up in terms of speculators maximizing wealth at the liquidation date. Since speculators are fully invested at time 1, profits from time 0 to 1 are already factored into this maximization. Hence speculators maximize the

expectation of $R(D_0) = F_1(D_0) \left(2 - \frac{v}{p_1(D_0)} \right)$ with respect to D_0 :

$$\max_{D_0} E[R] = \max_{D_0} \frac{1}{2} F_1(\bar{v}) \left(2 - \frac{\bar{v}}{p_1(\bar{v})} \right) + \frac{1}{2} F_1(v) \left(2 - \frac{v}{p_1(v)} \right) \quad (\text{A1})$$

Taking the first derivative with respect to D_0 above and substituting F_1 from (5) gives us the following FOC:

$$\frac{1}{2} \left(1 - \frac{p_1(\bar{v})}{p_0} \right) \left(2 - \frac{\bar{v}}{p_1(\bar{v})} \right) + \frac{1}{2} \left(1 - \frac{p_1(v)}{p_0} \right) \left(2 - \frac{v}{p_1(v)} \right) \geq 0 \quad (\text{A2})$$

If the FOC is strictly greater than 0 then $D_0 = F_0$. For $D_0 < F_0$ to be optimal the FOC must be equal to 0. Each term in (A2) represents the incremental gross return following either a positive or a negative fundamental value announcement, accounting for the returns accumulated at both period 1 and period 2. The optimization condition (A2) and the price equations define the equilibrium of this model.

We will make use of the following rearrangement of terms for the earnings-response-coefficient for the proofs below

$$\beta(v) = k \left(1 + \frac{S(v) - S - (F_0 - D_0)}{v - E[v]} \right), \quad (\text{A3})$$

where $k = \left(1 - a \frac{D_0}{p_0} \right)^{-1} \geq 1$ and $k > 1$ for stocks with nonzero initial short ratio $\frac{D_0}{p_0} > 0$. All the propositions below assume that there is not enough capital to bring prices close to fundamental

value.

Proof of Proposition 1: Note that the definition for β can be written as

$$\beta(v) = \frac{P_1 - P_0}{v - E[v]} \quad (\text{A4})$$

We will assume that sentiment S and $S(v)$ are raised uniformly for the shorted stock (for which $0 < D_0 < D^*$, where D^* is defined below) over the un-shorted stock ($D_0 = 0$) so that $S(v) - S$ does not change.

In order for the proposition to hold, speculators must be subject to capital constraints, *i.e.* $a > 0$. When $a = 0$, the initial decision regarding D_0 is made independently of the wealth maximization problem of period 1. Hence D_0 will be chosen equal to F_0 in order to maximize period 1 profits. Along with the fact that $k = \left(1 - a \frac{D_0}{p_0}\right)^{-1} = 1$, this implies that (A3) for $a = 0$ can be simplified to

$$\beta(v) = \left(1 + \frac{S(v) - S}{v - E[v]}\right). \quad (\text{A5})$$

Since $S(v) - S$, and v are the same for the shorted and un-shorted stock, all terms in (A5) are equal, and so the betas are equal.

Now return to the case of $a > 0$. First, we demonstrate that the partial derivative of β with respect to D_0 at the point $D_0 = F_0 = 0$ is greater than zero. Hence β is increasing for small D_0 . From (A3), β consists of the product of two positive terms, k and $\left(1 + \frac{S(v) - S - (F_0 - D_0)}{v - E[v]}\right)$. It is straightforward to show that $\frac{\partial k}{\partial D_0} > 0$ at $D_0 = 0$. To prove that $\frac{\partial \beta}{\partial D_0} > 0$, it is only necessary to show that the derivative of the second term is nonnegative. Since the first order condition is continuous in D_0 and is positive for $D_0 = 0$, it must be the case that $D_0 = F_0$ even for small $D_0 > 0$. Hence $\frac{\partial F_0}{\partial D_0} = 1$, and the derivative of the second term is zero.

So far we have shown that β is larger for positive short interest stocks so long as D_0 is small. Since $\frac{\partial k}{\partial D_0}$ is always positive, changes in the sign of $\frac{\partial \beta}{\partial D_0}$ must come from changes

in $\frac{\partial F_0}{\partial D_0}$. From the first order condition, we notice that as D_0 and F_0 increase, there will eventually come a point where $\frac{\partial F_0}{\partial D_0} < 1$, and at this point $\frac{\partial}{\partial D_0} \beta$ decreases and may eventually turn negative (we will see momentarily that it must turn negative). From all the equations involved, notice that this is the only possible source of change in the sign of $\frac{\partial}{\partial D_0} \beta$. Finally, consider what happens for very large D_0 and F_0 . In such a case, price equals fundamental value and $\beta = 1$. Hence there must exist D^* , and so too F^* , such that the proposition holds whenever initial capital is below F^* .

Proof of Proposition 2: Intuitively, a positive (negative) earnings shock and resultant increase (decrease) in price cuts into (adds to) the speculator's selling power, implying a lower (higher) short ratio in the following period. A speculator subject to collateral constraints and/or performance based fund flow would also lose (gain) some collateral, inducing him to reduce (expand) his short position further. Now examine this statement algebraically. The initial short ratio is $\frac{D_0}{p_0}$ and the post-announcement short ratio is $\frac{F_1}{p_1}$. Consider the effect of positive news, $v - E[v] > 0$. The change in price, $p_1 - p_0$, is $v + S(v) - F_1 - (E[v] + S - D_0)$. This expression is the sum of the change in fundamental value, $v - E[v]$, and the change in unarbitrated sentiment, $S(v) - F_1 - (S - D_0)$. So long as the positive earnings news does not perversely cause the un-arbitrated sentiment to decrease, both terms are positive and the change in price is proportional to the earnings surprise. Now provided there is not enough capital to bring prices close to fundamental value in the sense of Proposition 1, D_0 is near F_0 , and $F_1 < D_0$. Therefore the short ratio changes inversely with the earnings surprise.

To show the statement regarding share turnover, note that the only traders in our model are noise traders and speculators. Hence aggregate share turnover is proportional to the (absolute value of) change in demand of either type of trader. As we've seen above, the speculator's demand is equal to the current short ratio, so turnover is exactly equal to the (absolute) change in short ratio.

Proof of Proposition 3: The expected return to shorting in our model is the ratio of price to fundamental value. Before and after a positive earnings surprise, this ratio is $\frac{p_0}{E[v]}$ and $\frac{p_1(\bar{v})}{\bar{v}}$, respectively. Of course, for $\bar{v} = E[v]$ (*i.e.* no earnings news), the expected return to shorting does not change. Hence our proposition is equivalent to $\frac{dp_1(\bar{v})}{d\bar{v}} > 1$. Our assumption that sentiment increases proportionally with unexpected earnings news is interpreted as $S'(\bar{v}) > 0$. From (8), $\frac{dp_1(\bar{v})}{d\bar{v}} = k(1 + S'(v))$. To prove the proposition, note that $k > 1$ for highly shorted stocks.

Table 1: Summary Statistics

	Mean	25 th percentile	Median	75 th percentile
	(1)	(2)	(3)	(4)
Short Ratio (% of shares outstanding)	5.10 [12.97]	.90	2.11	4.92
AVGTURN (mean turnover (%) from day -5 to +1)	.90 [1.17]	.27	.52	1.07
CAR (cumulative abnormal return (%) from day -5 to +1)	.65 [8.67]	-3.40	.51	4.79
POSTCAR (cumulative abnormal return from day +2 to +7)	.22 [5.90]	-2.82	.11	3.17
Unexpected Earnings (as a % of previous price)	-.01 [1.02]	-.02	.01	.08
Unexpected Earnings (as a % of previous earnings)	.12 [50.51]	-.34	.31	1.66
Market Capitalization (millions of dollars)	6077 [21807]	644	1364	3799
Price/Earnings (if positive)	38.4 [156.1]	14.6	20.3	30.7
Analyst Disagreement	.14 [.56]	.02	.05	.11
Past Volatility	2.52 [1.39]	1.51	2.15	3.10
Institutional Ownership (% of shares outstanding)	61.5 [20.1]	48.5	63.0	75.7
Convertible Debt (millions of dollars)	62.5 [234.2]	0	0	0

This table presents the summary statistics of the sample used in the regression estimations. The sample includes all stocks in the top three quintiles of the market capitalization distribution that are traded either on NASDAQ or the NYSE from 1990 (4Q)-2004 (4Q)3. Standard deviations are in brackets. There are 49540 observations.

Table 2: OLS Estimates of the Sensitivity of Stock Returns to Unexpected Earnings

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Unexpected Earnings Decile (UEDECILE)	.76 (.02)	.73 (.02)		.79 (.02)	.76 (.02)		.78 (.02)	.74 (.02)	
Indicator for High Short Ratio (HISR)	1.10 (.16)	-.60 (.48)	.06 (.48)	.81 (.20)	-1.05 (.52)	-.29 (.52)	1.00 (.16)	-.80 (.49)	-.12 (.49)
Unexpected Earnings Decile × High Short Ratio (UEDECILE × HISR)		.31 (.08)	.19 (.08)		.34 (.09)	.21 (.09)		.33 (.08)	.21 (.08)
Stock Fixed Effects	No	No	No	Yes	Yes	Yes	No	No	No
Quarter × Industry Effects	No	No	No	No	No	No	Yes	Yes	Yes

The dependent variable is CAR. The independent variables include UEDECILE (the decile of a stock's earnings surprise for the quarter of the observation), HISR (a dummy equal to one if the stock is in the top 10% of the short ratio distribution for the quarter of the observation and zero otherwise), SIZE (market cap divided into 25 dummies by quarter), P/E (price-to-earnings divided into 25 dummies by quarter and one additional dummy variable for negative earnings stocks), DISAGREEMENT (analyst disagreement divided into 25 dummies by quarter), IO (institutional ownership divided into 25 dummies by quarter), CONVDEBT (convertible debt divided into 25 dummies by quarter), VOLATILITY (past volatility divided into 25 dummies by quarter), INDUSTRY dummies (SIC at the 2 digit level) and QUARTER dummies. In columns (3), (6) and (9), interactions of UEDECILE and all of the other controls except the INDUSTRY and QUARTER dummies are included in the specification. The standard errors are adjusted by allowing for the errors to be correlated across observations of the same stock; *i.e.* the standard errors are clustered by stock.

Table 3: OLS Estimates of the Sensitivity of Turnover to Unexpected Earnings

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Absolute Unexpected Earnings Decile (ABSUEDECILE)	.030 (.003)	.025 (.003)		.025 (.002)	.022 (.002)		.029 (.003)	.025 (.003)	
Indicator for High Short Ratio (HISR)	.708 (.043)	.527 (.071)	.500 (.069)	.446 (.035)	.318 (.056)	.330 (.058)	.709 (.045)	.540 (.074)	.330 (.041)
Absolute Unexpected Earnings Decile× High Short Ratio (ABSUEDECILE× HISR)		.044 (.014)	.050 (.014)		.031 (.012)	.028 (.012)		.041 (.014)	.028 (.010)
Stock Fixed Effects	No	No	No	Yes	Yes	Yes	No	No	No
Quarter× Industry Effects	No	No	No	No	No	No	Yes	Yes	Yes

The dependent variable is AVGTURN. The independent variables include ABSUEDECILE (the decile of a stock's absolute earnings surprise for the quarter of the observation), HISR (a dummy equal to one if the stock is in the top 10% of the short ratio distribution for the quarter of the observation and zero otherwise), SIZE (market cap divided into 25 dummies by quarter), P/E (price-to-earnings divided into 25 dummies by quarter one additional dummy variable for negative earnings stocks), DISAGREEMENT (analyst disagreement divided into 25 dummies by quarter), IO (institutional ownership divided into 25 dummies by quarter), CONVDEBT (convertible debt divided into 25 dummies by quarter), VOLATILITY (past volatility divided into 25 dummies by quarter), INDUSTRY dummies (SIC at the 2 digit level) and QUARTER dummies. In columns (3), (6) and (9), interactions of ABSUEDECILE and all of the other controls except the INDUSTRY and QUARTER dummies are included in the specification. The standard errors are adjusted by allowing for the errors to be correlated across observations of the same stock; *i.e.* the standard errors are clustered by stock.

Table 4: OLS Estimates of the Effect of Unexpected Earnings on Subsequent Stock Returns

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Unexpected Earnings Decile (UEDECILE)	.12 (.01)	.14 (.01)		.13 (.01)	.14 (.01)		.13 (.01)	.15 (.01)	
Indicator for High Short Ratio (HISR)	.05 (.11)	.96 (.30)	.97 (.31)	-.03 (.13)	.80 (.31)	.82 (.32)	.03 (.11)	1.04 (.31)	1.06 (.32)
Unexpected Earnings Decile \times High Short Ratio (UEDECILE \times HISR)		-.17 (.05)	-.17 (.05)		-.15 (.05)	-.16 (.05)		-.19 (.05)	-.19 (.05)
Stock Fixed Effects	No	No	No	Yes	Yes	Yes	No	No	No
Quarter \times Industry Effects	No	No	No	No	No	No	Yes	Yes	Yes

The dependent variable is POSTCAR. The independent variables include UEDECILE (the decile of a stock's earnings surprise for the quarter of the observation), HISR (a dummy equal to one if the stock is in the top 10% of the short ratio distribution for the quarter of the observation and zero otherwise), SIZE (market cap divided into 25 dummies by quarter), P/E (price-to-earnings divided into 25 dummies by quarter and one additional dummy variable for negative earnings stocks), DISAGREEMENT (analyst disagreement divided into 25 dummies by quarter), IO (institutional ownership divided into 25 dummies by quarter), CONVDEBT (convertible debt divided into 25 dummies by quarter), VOLATILITY (past volatility divided into 25 dummies by quarter), INDUSTRY dummies (SIC at the 2 digit level) and QUARTER dummies. In columns (3), (6) and (9), interactions of UEDECILE and all of the other controls except the INDUSTRY and QUARTER dummies are included in the specification. The standard errors are adjusted by allowing for the errors to be correlated across observations of the same stock; *i.e.* the standard errors are clustered by stock.

**Table 5: OLS Estimates of the Relationship
Between Shorting and Earnings Surprises**

	(1)	(2)	(3)
Indicator for High Short Ratio (HISR)	-.010 (.017)	-.022 (.022)	-.011 (.017)
Stock Fixed Effects	No	Yes	No
Quarter×Industry Effects	No	No	Yes

The dependent variable is Unexpected Earnings. The independent variables include HISR (a dummy equal to one if the stock is in the top 10% of the short ratio distribution for the quarter of the observation and zero otherwise), SIZE (market cap divided into 25 dummies by quarter), P/E (price-to-earnings divided into 25 dummies by quarter and one additional dummy variable for negative earnings stocks), DISAGREEMENT (analyst disagreement divided into 25 dummies by quarter), IO (institutional ownership divided into 25 dummies by quarter), CONVDEBT (convertible debt divided into 25 dummies by quarter), VOLATILITY (past volatility divided into 25 dummies by quarter), INDUSTRY dummies (SIC at the 2 digit level) and QUARTER dummies. In column (2), stock fixed effects are added to the specification. In column (3), industry by quarter effects are added to the specification. The standard errors are adjusted by allowing for the errors to be correlated across observations of the same stock; *i.e.* the standard errors are clustered by stock.

**Table 6: The Effect of being Traded on NASDAQ
on the Probability of Having a High Short Ratio**

Indicator for NASDAQ traded stock	.060 (.013)
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The dependent variable is HISR. The independent variables include NASDAQ (a dummy equal to one if the stock is listed on NASDAQ and zero otherwise), UEDECILE (the decile of a stock's earnings surprise for the quarter of the observation), SIZE (market cap divided into 25 dummies by quarter), P/E (the decile of a stock's earnings surprise for the quarter of the observation), DISAGREEMENT (analyst disagreement divided into 25 dummies by quarter), IO (institutional ownership divided into 25 dummies by quarter), CONVDEBT (convertible debt divided into 25 dummies by quarter), VOLATILITY (past volatility divided into 25 dummies by quarter), INDUSTRY dummies (SIC at the 2 digit level) and QUARTER dummies. The standard errors are adjusted by allowing for the errors to be correlated across observations of the same stock; *i.e.* the standard errors are clustered by stock.

Table 7: IV Estimates of the Effect of Unexpected Earnings on Stock Returns, Turnover and Subsequent Stock Returns

	CAR			AVGTURN			POSTCAR		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Unexpected Earnings Decile (UEDECILE)	.76 (.02)	.44 (.07)					.12 (.01)	.18 (.03)	.09 (.16)
Absolute Unexpected Earnings Decile (ABSUEDECILE)				.039 (.005)	.022 (.010)	.008 (.019)			
Indicator for High Short Ratio (HISR)	.03 (2.16)	-18.36 (4.46)	-11.82 (8.03)	2.244 (.733)	1.634 (.681)	1.307 (1.031)	-1.20 (1.43)	2.07 (2.24)	7.23 (5.11)
Unexpected Earnings Decile× High Short Ratio (UEDECILE× HISR)		3.40 (.73)	2.29 (1.46)					-.61 (.34)	-1.54 (.94)
Absolute Unexpected Earnings Decile× High Short Ratio (ABSUEDECILE× HISR)					.174 (.113)	.271 (.275)			

The dependent variable is CAR in columns (1) through (3). The dependent variable is AVGTURN in columns (4) through (6), and the dependent variable is POSTCAR in columns (7) through (9). The independent variables include UEDECILE (the decile of a stock's earnings surprise for the quarter of the observation), ABSUEDECILE (the decile of a stock's absolute earnings surprise for the quarter of the observation), HISR (a dummy equal to one if the stock is in the top 10% of the short ratio distribution for the quarter of the observation and zero otherwise), SIZE (market cap divided into 25 dummies by quarter), P/E (price-to-earnings divided into 25 dummies by quarter and one additional dummy variable for negative earnings stocks), DISAGREEMENT (analyst disagreement divided into 25 dummies by quarter), IO (institutional ownership divided into 25 dummies by quarter), CONVDEBT (convertible debt divided into 25 dummies by quarter), VOLATILITY (past volatility divided into 25 dummies by quarter), INDUSTRY dummies (SIC at the 2 digit level) and QUARTER dummies. In columns (3), (6) and (9), interactions of UEDECILE and all of the other controls except the INDUSTRY and QUARTER dummies are included in the specification. The standard errors are adjusted by allowing for the errors to be correlated across observations of the same stock; *i.e.* the standard errors are clustered by stock

Table 8: OLS and IV Asymmetry Estimates

	CAR		AVGTURN		POSTCAR	
	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)
Indicator for Highest 40% Unexpected Earnings (HI40UE)	2.20 (.11)	1.00 (.30)	.068 (.012)	.055 (.047)	.49 (.07)	.74 (.18)
Indicator for Lowest 40% Unexpected Earnings (LOW40UE)	-2.07 (.11)	-1.66 (.26)	.100 (.013)	.124 (.041)	-.23 (.08)	-.40 (.17)
Indicator for High Short Ratio (HISR)	1.03 (.22)	-1.32 (2.16)	.682 (.058)	2.064 (.697)	.18 (.15)	-.82 (1.36)
Highest 40% Unexpected Earnings × High Short Ratio (HI40UE × HISR)	.80 (.33)	11.32 (2.83)	.081 (.068)	.574 (.483)	-.61 (.23)	-3.24 (1.61)
Lowest 40% Unexpected Earnings × High Short Ratio (LOW40UE × HISR)	-.50 (.37)	-5.12 (2.28)	-.025 (.068)	-.133 (.357)	.32 (.24)	1.88 (1.40)

The dependent variable is CAR in columns (1) and (2). The dependent variable is AVGTURN in columns (3) and (4), and the dependent variable is POSTCAR in columns (5) and (6). The independent variables include HI40UE (a dummy equal to one if the stock's earnings surprise is in the highest 40% of the distribution for the quarter of the observation and zero otherwise), LOW40UE (a dummy equal to one if the stock's earnings surprise is in the lowest 40% of the distribution for the quarter of the observation and zero otherwise), HISR (a dummy equal to one if the stock is in the top 10% of the short ratio distribution for the quarter of the observation and zero otherwise), SIZE (market cap divided into 25 dummies by quarter), P/E (price-to-earnings divided into 25 dummies by quarter and one additional dummy variable for negative earnings stocks), DISAGREEMENT (analyst disagreement divided into 25 dummies by quarter), IO (institutional ownership divided into 25 dummies by quarter), CONVDEBT (convertible debt divided into 25 dummies by quarter), VOLATILITY (past volatility divided into 25 dummies by quarter), INDUSTRY dummies (SIC at the 2 digit level) and QUARTER dummies. For each dependent variable, the first column presents the OLS estimates; the second column presents the IV estimates. The standard errors are adjusted by allowing for the errors to be correlated across observations of the same stock; *i.e.* the standard errors are clustered by stock.

**Table 9: OLS Estimates of the Sensitivity of
of Stock Returns to Unexpected Earnings by Time Period**

	1990-1996	1997-2004
	(1)	(2)
Unexpected Earnings Decile (UEDECILE)	.67 (.03)	.78 (.03)
Indicator for High Short Ratio (HISR)	-1.90 (.68)	.21 (.62)
Unexpected Earnings Decile × High Short Ratio (UEDECILE × HISR)	.50 (.11)	.20 (.11)

The dependent variable is CAR. The independent variables include UEDECILE (the decile of a stock's earnings surprise for the quarter of the observation), HISR (a dummy equal to one if the stock is in the top 10% of the short ratio distribution for the quarter of the observation and zero otherwise), SIZE (market cap divided into 25 dummies by quarter), P/E (price-to-earnings divided into 25 dummies by quarter and one additional dummy variable for negative earnings stocks), DISAGREEMENT (analyst disagreement divided into 25 dummies by quarter), IO (institutional ownership divided into 25 dummies by quarter), CONVDEBT (convertible debt divided into 25 dummies by quarter), VOLATILITY (past volatility divided into 25 dummies by quarter), INDUSTRY dummies (SIC at the 2 digit level) and QUARTER dummies. Column (1) presents the estimate using the 1990-1996 subsample; column (2) presents the estimates using the 1997-2004 subsample. The standard errors are adjusted by allowing for the errors to be correlated across observations of the same stock; *i.e.* the standard errors are clustered by stock.

**Table 10: OLS Estimates of the Effect
of Unexpected Earnings on Stock Returns, Alternative Benchmarks**

	CAPM		Net Risk-Free	
	CAR	POSTCAR	CAR	POSTCAR
	(1)	(2)	(3)	(4)
Unexpected Earnings Decile (UEDECILE)	.74 (.02)	.14 (.01)	.74 (.02)	.14 (.01)
Indicator for High Short Ratio (HISR)	-.60 (.48)	.93 (.30)	-.51 (.49)	1.08 (.32)
Unexpected Earnings Decile \times High Short Ratio (UEDECILE \times HISR)	.30 (.08)	-.16 (.05)	.28 (.08)	-.18 (.05)

The dependent variable in columns (1) and (3) is CAR. The dependent variable in columns (2) and (4) is POSTCAR. The independent variables include UEDECILE (the decile of a stock's earnings surprise for the quarter of the observation), HISR (a dummy equal to one if the stock is in the top 10% of the short ratio distribution for the quarter of the observation and zero otherwise), SIZE (market cap divided into 25 dummies by quarter), P/E (price-to-earnings divided into 25 dummies by quarter and one additional dummy variable for negative earnings stocks), DISAGREEMENT (analyst disagreement divided into 25 dummies by quarter), IO (institutional ownership divided into 25 dummies by quarter), CONVDEBT (convertible debt divided into 25 dummies by quarter), VOLATILITY (past volatility divided into 25 dummies by quarter), INDUSTRY dummies (SIC at the 2 digit level) and QUARTER dummies. Columns (1) and (2) present the estimates using the CAPM returns; columns (3) and (4) present the estimates using the returns net of the risk-free. The standard errors are adjusted by allowing for the errors to be correlated across observations of the same stock; *i.e.* the standard errors are clustered by stock.

Table 11: Alternative Scaling of Unexpected Earnings			
	CAR	AVGTURN	POSTCAR
	(1)	(2)	(3)
Unexpected Earnings Decile (UEDECILE)	.69 (.02)		.13 (.01)
Absolute Unexpected Earnings Decile (ABSUEDECILE)		.024 (.002)	
Indicator for High Short Ratio (HISR)	-.78 (.47)	.494 (.076)	.73 (.28)
Unexpected Earnings Decile \times High Short Ratio (UEDECILE \times HISR)	.32 (.08)		-.13 (.05)
Absolute Unexpected Earnings Decile \times High Short Ratio (ABSUEDECILE \times HISR)		.043 (.014)	

Unexpected earnings are now scaled by past earnings when calculating UEDECILE and ABSUEDECILE. The dependent variable is CAR in column (1). The dependent variable is AVGTURN in columns (2), and the dependent variable is POSTCAR in columns (3). The independent variables include UEDECILE (the decile of a stock's earnings surprise for the quarter of the observation), ABSUEDECILE (the decile of a stock's absolute earnings surprise for the quarter of the observation), HISR (a dummy equal to one if the stock is in the top 10% of the short ratio distribution for the quarter of the observation and zero otherwise), SIZE (market cap divided into 25 dummies by quarter), P/E (price-to-earnings divided into 25 dummies by quarter and one additional dummy variable for negative earnings stocks), DISAGREEMENT (analyst disagreement divided into 25 dummies by quarter), IO (institutional ownership divided into 25 dummies by quarter), CONVDEBT (convertible debt divided into 25 dummies by quarter), VOLATILITY (past volatility divided into 25 dummies by quarter), INDUSTRY dummies (SIC at the 2 digit level) and QUARTER dummies. The standard errors are adjusted by allowing for the errors to be correlated across observations of the same stock; *i.e.* the standard errors are clustered by stock.