

# **Does short-selling amplify price declines or align stocks with their fundamental values?<sup>†</sup>**

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Comments Welcome.

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## **Does short-selling amplify price declines or align stocks with their fundamental values?**

**ABSTRACT:** We examine whether short sellers predominantly target stocks with recent price declines, amplifying the price decline and resulting in prices falling below fundamental values, or target apparently overpriced stocks facilitating prices that reflect fundamental values. We find evidence of short-sellers holding significant positions in stocks following price declines, and of short-sellers increasing their positions while the stock price is declining. When we condition on fundamental value, however, we do not find any reliable evidence that the targets of short-sellers are trading below their fundamental values. Instead a significant proportion of short-sellers' positions are concentrated in stocks that appear overvalued relative to their fundamentals. While there is significant heterogeneity in the positions of short-sellers, including large positions in stocks with price declines, we find compelling evidence that a significant proportion of short positions following price declines appear to align prices with fundamentals rather than force prices below fundamental values.

*Keywords:* Short-selling, price declines, fundamental analysis.

*Data availability:* All data is available from the sources described in the text.

## 1. Introduction

We examine whether, in general, short-sellers target stocks with recent price declines, amplifying falling stock prices below fundamental values, or rather target overpriced stock to facilitate prices that reflect fundamental values. Repeated, uninformed selling by short-sellers can be falsely interpreted as informed selling, lowering equilibrium stock prices leading to a lengthy period of undervaluation (Allen and Gale, 1992), inflating the firm's cost of capital and leading the firm to forego investment opportunities that would have had a positive net present value (Goldstein and Guembel, 2008).<sup>1</sup> Informed short-selling, however, allows short-sellers to act as information intermediaries and aid in the facilitation of equilibrium stock prices that reflect fundamental values (e.g., Abreu and Brunnermeier, 2001; Dechow, Hutton, Meulbroek and Sloan, 2001), and more efficient functioning of capital markets.

The contribution of our study is to distinguish between these two possible explanations for evidence of short selling activities in firms with prior price declines. Evidence that short-sellers take positions in firms with price declines is provided by Lamont and Stein (2004) who find that aggregate short-interest for firms on the NASDAQ is positively associated with prior month declines in the NASDAQ index and Savor and Gamboa-Cavazos (2005) who show that short-sellers increase their holdings following price declines in the prior month. There is however also evidence that short-sellers take fundamental value based strategies, that is, short-selling stocks with high prices relative to fundamental values (Dechow, Hutton, Muelbroek and Sloan, 2001).

Our study is motivated from the concern over the potential punitive damage that short-sellers can have on the efficient functioning of capital markets and recent significant regulatory actions aimed at preventing this concern (e.g., Securities and Exchange Commission, 2008b;

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<sup>1</sup> There is also empirical evidence that suggests short-sellers are involved in manipulative practices such as front-running, following equity offerings and destabilizing intra-day market prices (e.g., Henri and Koski, 2008; Shkilko, Van Ness and Van Ness, 2008; Khan and Lu, 2008).

Financial Services Authority, 2008;).<sup>2</sup> Regulators are acutely concerned with extrapolative short-selling activity, that is, short-selling that follows price declines. For example the current SEC proposal is to impose trading halts on the short-selling following significant price declines (Securities and Exchange Commission, 2009). Our results, however, suggest that many of the positions that appear to be extrapolating price declines can also be considered as targeting stocks with high prices relative to their fundamentals.

We show that the positions of short-sellers are significantly concentrated in stocks with prior price declines and that they increase these positions while the price is declining, which is consistent with both the short-selling critic's view that short-selling exacerbates price declines, and also the rational minimization of holding cost and an aversion to coordination risk.<sup>3</sup> We then investigate the positions of short-sellers in stocks following price declines but condition on the fundamental-to-price ratio. This approach attempts to provide evidence on the extent to which the short-selling positions are related to price declines that move prices toward fundamentals, or move prices below fundamentals. The results indicate that in stocks with price declines the positions of short-sellers are concentrated in stocks that are overvalued relative to fundamentals and not in stocks that are undervalued relative to fundamentals. Thus, while the initial evidence appears to strongly support the critical view of short-selling, on closer inspection, a significant concentration of short-sellers' positions during price declines target overvalued stocks, aiding in the alignment of price with fundamental value rather than forcing stock prices below fundamental values.

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<sup>2</sup>Specifically, recent regulation has introduced rules to curb the influence of short-selling on market prices, including additional restrictions, monitoring and even complete bans on short-selling. For example, the SEC placed a temporary ban on the short-selling of 799 financial stocks in September and early October 2008, following the prolonged price declines in many financial stocks (SEC, 2008b). Similar bans on short-selling financial stocks occurred in developed markets throughout the world. The link between recent regulation of short-selling and concerns about extrapolative short-selling are discussed further in section 2.

<sup>3</sup> Our primary focus is on cumulative price declines over the prior 12 months. Given the well documented predictive ability of prior longer-term returns on future returns (Jeegadeesh and Titman, 1993; Lee and Swaminathan, 2000) and the regulatory interest in sustained price declines, our setting provides a natural starting point for investigating whether short-sellers are price amplification motivated.

We then examine future changes in short interest, and find evidence consistent with short-sellers unwinding their positions in stocks following price declines, on average, but increasing their holdings in stocks with prior price declines that continue to appear overvalued relative to fundamentals.

By examining longer-term price declines, our study contributes to the current debate on the regulation of short-sellers. Despite a large academic literature that shows constraints to short-selling reduce market efficiency,<sup>4</sup> regulators around the world appear to be predisposed to concerns regarding short-selling in responding to immediate problems by adding additional constraints to short-selling activity. Our evidence is important given this prevailing regulatory stance, as our evidence does not support the critic's view of short-selling. Our results highlight an important caveat when assessing short-selling that follows price declines, specifically, these positions may not be aimed at forcing prices below fundamental values by amplifying price declines, a negative role. Rather the evidence is consistent with implementation of fundamental-based trading strategies targeting over-valued stocks like those suggested in Dechow et al. (2001), a positive role.

By examining price declines and fundamental value concurrently, our study also contributes to the recent body of accounting research that examines how short-sellers use accounting information in selecting their targets (e.g., Dechow et al., 2001; Richardson, 2003; Desai, Krishnamurthy and Venkataraman, 2006a; Hirshleifer, Teoh and Yu, 2008). A straightforward interpretation of our results is twofold. First, limits to arbitrage affect the stock selection of short-sellers (e.g. Abreu and Brunnermeier, 2001) including those using accounting information in their trading strategies. Second, some short-sellers are likely to follow price momentum, rather than using accounting information. We find that, over longer horizons, short-sellers do take significant positions in stocks with price declines. To the best of our knowledge, our study is the first to

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<sup>4</sup> A direct example is provided by Chang, Cheng and Yu (2007) who document compelling evidence that short-selling constraints imposed on individual stocks in Hong-Kong induced overvaluation.

examine the association between short-interest and the pattern of longer-term price declines previously documented in studies of price momentum, and the first to examine price declines and fundamental-to-price ratios concurrently.

## **2. Background and predictions**

### *2.1. Background and prior research*

A short-sale is the sale of a stock that the investor does not own. A short-seller profits if the price of the stock declines and incurs a loss if the price of the stock increases. Taking a short position has been, and continues to be, more heavily regulated than taking a long position. This regulation of short-sellers in the United States appears to have developed from the wide-spread beliefs that short-sellers have the ability to cause stock prices to spiral downward (Dechow et al., 2001; Chancellor, 2001).<sup>5</sup> A recent example of regulators responding to concerns that short-sellers amplify price declines, were the regulatory actions taken against short-sellers in September 2008. The prevailing general opinion appeared to be that the worsening credit crisis was being amplified by short-sellers. Regulators in the U.S. and around the world directly intervened in the market by preventing short-sellers from targeting financial stocks.<sup>6</sup>

### *2.2. Prior research*

Much of the prior literature indirectly addresses the question of whether short-sellers are able to identify when current prices deviate from fundamental values by examining the future returns to stocks with large short-interest (see Boehmer et al., 2008). Another approach in the literature is to directly examine the targets of short-sellers. The first of these studies, Dechow et al.

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<sup>5</sup> See Chancellor (2001) and Jones and Lamont (2001) for reviews of the early history of short-selling regulation. Bris et al, (2005) provides a discussion of differences in the regulation of short-sellers worldwide.

<sup>6</sup> The SEC required additional disclosure from short-sellers, on September 18, 2008 with the mandated disclosure of Form SH, requiring any investment vehicle that currently lodges 13-F filings to file weekly short positions with the SEC (note, however, that these disclosures are not publicly available).

(2001) finds that short-interest is concentrated in stocks with low fundamental-to-price ratios (i.e., overpriced relative to their fundamentals), and short-sellers appear to take strategies that minimize trading costs. Their finding is consistent with sophisticated short-sellers targeting overvalued stocks based on the use of accounting information in measuring fundamental value. Desai et al. (2006a) present additional evidence of short-sellers' sophisticated use of accounting information by showing that short-sellers anticipate downwards earnings restatements. Daske, Richardson and Tuna (2005), however, find no evidence consistent with short-sellers anticipating negative earnings shocks. There is also mixed evidence on whether short-sellers target high accrual firms. Hirshleifer et al. (2008) provide evidence of a positive association between short-interest and accruals, with a concentration in the highest accrual decile, whereas Richardson (2003) does not find any reliable evidence to suggest that short-sellers target high accrual stocks.

There is also empirical evidence that short-sellers target firms with recent price declines. At the aggregate level, Lamont and Stein (2004) examine the short-interest ratio of the NASDAQ and find that it is positively associated with prior month declines in the NASDAQ index. They discuss their finding as possible evidence that short-sellers use price declines to minimize arbitrage costs. Using a cross-sectional sample of monthly short-interest Savor and Gamboa-Cavazos (2005) provide evidence of short-sellers increasing their holdings following price declines in the prior month. Overall the evidence on the sophistication and motives of short-sellers are mixed, suggesting that short-sellers are not a homogenous group.

### *2.3. Predictions*

While in general, short-sellers may play a positive role in the market, the possible damaging effects that short-sellers can have on market efficiency and resource allocation suggests that it is important to examine the positions of short-sellers in stocks following price declines. Hence, our aim is to shed light on the role of short-sellers in stocks with price declines. On one hand, critics

claim that short-sellers play a negative role by forcing prices below fundamental values. On the other hand, much of the prior research on short-sellers suggests they play a positive role by aligning prices and fundamentals and thus aiding market efficiency. We investigate the evidence in support of these contrasting views by examining the positions of short-sellers in stocks with prior longer-term price declines.

The focus of our study is on longer-term price declines for four main reasons. (1) the effects of longer term undervaluation potentially gives rise to inefficient resource allocation (e.g., Allen and Gale, 1992; Goldstein and Guembel, 2008), (2) Short-sellers taking short-term positions could be doing so to counter order imbalance, affecting short-term price stability that is unlikely to have long-term effects on the disparity between price and fundamental value (e.g., Stoll, 1978; Grossman and Miller, 1988). (3) Short-term price movements tend to reverse quickly, within a week, whereas longer-term price momentum tends to continue for at least a year (Jeegadesh, 1990; Lehmann, 1990; Jeegadeesh and Titman, 1993; 1996; Lee and Swaminathan, 2000). (4) The disparity between price and fundamental value is not expected to be corrected in the short-term, implying that sophisticated investors who are taking positions based on fundamental analysis are expected to take longer-term positions (Frankel and Lee, 1998; Dechow, Hutton and Sloan, 1999; Lee, Myers and Swaminathan, 1999). Taken together these four reasons suggest that longer-term short-sellers play an important role in the alignment of price with fundamental value, while short-term short-sellers will have relatively trivial effects on the alignment of price with fundamental value.

Based on the critical view of short-sellers, the trading strategies of short-sellers are expected to force prices below fundamental values by amplifying price declines. In the cross-section, the critical view predicts that the positions of short-sellers will be higher in stocks following longer-term price declines. Stated as a hypothesis:

H<sub>1</sub>: The level of short-interest is positively associated with prior longer-term price declines.



In levels, the positions of short-sellers will include positions taken prior to a price decline, during a price decline and following a price decline. While prior research has generally shown that levels of short-interest are associated with future price declines, there is less evidence on the changes in short-interest during price declines and following price declines. Based on the critical view, short-sellers are attempting to profit from the amplification of price declines. Following this view, short-sellers are expected to increase their positions as the price declines (rather than anticipating price declines) and following a price decline, in an attempt to gain from the amplification of price declines. Stated as hypotheses:

H<sub>2</sub>: The contemporaneous change in short-interest is positively associated with price declines.

H<sub>3</sub>: The (future) change in short-interest is positively associated with prior price declines.

Based on the critical view of short-sellers, the trading strategies of short-sellers are expected to amplify price declines and result in prices below fundamental values. However, the margin requirements, and hence the holding costs, on a short-position are lower when the stock price is decreasing. Both the critical and the holding cost views predict that the level of short-interest will be higher for stocks with prior price declines. Our following hypotheses attempt to identify and exploit differences in the expected correlations for strategies that amplify price declines below fundamentals and strategies that merely align prices with fundamentals.

If short-sellers are averse to holding costs and associated risks, the correlation between price decline and short holdings is caused by this group of short-sellers taking positions in overvalued stocks with prior price declines (or as the price declines). Conversely, for short-sellers aiming to force stock prices below fundamental values by amplifying price declines, the correlation between the price decline and short holdings is due to this group of short-sellers taking positions in undervalued stocks with prior price declines. Stated as hypotheses in the null form:

H<sub>1A</sub>: Given a price decline, short-interest is equally associated with low fundamental-to-price ratios and high fundamental-to-price ratios.

H<sub>2A</sub>: Given declining prices, the contemporaneous change in short-interest is equally associated with low fundamental-to-price ratios and high fundamental-to-price ratios.

H<sub>3A</sub>: Given a price decline, changes in short-interest are equally associated with low fundamental-to-price ratios and high fundamental-to-price ratios.

While we are primarily interested in assessing which of the two strategies is dominant, we also discuss the individual associations to gain insight on the prevalence of the different motives of short-sellers.

### **3. Sample and measurement of variables**

#### *3.1. Sample*

We collect financial variables, market prices and returns from the intersection of the Compustat Xpressfeed database and the CRSP monthly database. Our sample initially includes all common stock (share codes 10 and 11) over the period 1995–2008, which includes changes in the regulation of short-sellers. We exclude ADR stocks as their shares outstanding only include the shares listed on US exchanges which leads to measurement error in ratios of accounting variables to price.<sup>7</sup> We require that the stock has income before extraordinary items (Xpressfeed item IB; legacy Compustat data 18) and positive common shareholders' equity (Xpressfeed item CEQ; legacy Compustat data 60). After this file is matched to the monthly short-interest records of the NYSE/AMEX and the NASDAQ our sample includes 562,308 firm-month observations.

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<sup>7</sup> ADRs are also not subject to the same short-selling regulations as common shares. Arbitrage trades made on ADRs are exempt from the up-tick rule under Section 10a-1 subsection (e)(8) of the 1934 Securities Exchange Act.

### 3.2. *Measurement of short-interest*

We collect the level of short-interest from the monthly records of the NYSE and the NASDAQ. For NYSE stocks, short-interest for the month is required to be reported in the third week of the month (usually within the 17<sup>th</sup> – 20<sup>th</sup> day of the month) and becomes publicly available within two to three days. For NASDAQ listed stocks, short-interest is required to be reported on the 15<sup>th</sup> day of the month (or if the 15<sup>th</sup> is not a business day, the preceding business day) and becomes publicly available on the eighth business day following this report.<sup>8</sup> We deflate the raw short-interest by the CRSP number of shares outstanding at the end of the month to obtain a percentage measure.<sup>9</sup> As the level of short-interest is defined as a percentage, we calculate the change in short-interest as the simple change in this percentage.<sup>10</sup> We match short-interest for each month  $t$ , with lagged accounting, price and prior return variables.

### 3.3. *Measurement of prior price declines*

We primarily examine price declines over the prior 12 months based on buy-and-hold returns over the holding period excluding dividends. The return is lagged a month relative to the measurement of the short-interest data (i.e., over the 12 month period  $t-13$  to  $t-1$ ).<sup>11</sup> We use this

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<sup>8</sup> From Month 2007, the exchanges began reporting the data twice a month, we use the B series.

<sup>9</sup> The NYSE and NASDAQ levels of short-interest are reported as adjusted for share-splits for the month if the share-split occurred before the reporting period. For share-splits that occurred after the reporting date for short-interest, our percentage measure of short-interest understates the true proportion of the stock held short.

<sup>10</sup> In our sensitivity analysis we also identify unusually high levels of short-interest, as typical levels of short-interest could be due to activities that are not related to valuation based trading or trading on recent price declines, such as hedging (Dechow et al., 2001). In untabulated, results we define “high short-interest” as the top quintile of the percentage of short-interest for the month for our sample of stocks (Asquith et al., 2005), or as percentage threshold-based measures of over 0.05%, 1% and 5% (Dechow et al., 2001). We find qualitatively similar results in all cases.

<sup>11</sup> In our robustness analysis (section 5) we report results using medium-term price declines over the prior 3, 6, and 9-month holding periods and shorter-term price declines over a 1-month holding period. We use buy-and-hold returns that exclude dividends but include a control variable for the amount of dividends being paid by a stock. By using returns that exclude dividends, we bias away from finding an association between price declines and short-interest. We also examined returns including dividends, raw (simple) returns based on month-end closing prices, changes in price, industry-adjusted returns, and size-adjusted returns using CRSP size deciles, finding similar results.

return period to measure price declines as Jegadeesh and Titman (1993) show that price declines measured over medium term periods (3, 6, 9 and 12 months) tend to predict additional price declines, whereas shorter holding periods such as a week or a month tend to reverse (Jegadeesh, 1990; Lehmann, 1990). We are also interested in measuring the most extreme price declines as these stocks are the most likely to be subject to the most egregious price amplification. Each month, we rank the stocks into five portfolios based on prior returns over the portfolio formation period. The stocks in the lowest quintile of prior returns, the extreme low return stocks are the most likely to have continued low returns (Jegadeesh and Titman, 1993).

### 3.4. Measurement of fundamental value

We use ratios of accounting-based measures of fundamental value to price to identify stocks that are relatively over and under priced. In our analysis we present the value-to-price, book-to-market and earnings yield ratios. We measure value in the value-to-price ratio using the residual income model (Ohlson, 1995). We use the following one-period residual income model:

$$Vf(1)_t = b_t + \frac{f(1)_t - r \cdot b_t}{r - g}, \quad (1)$$

where  $r$  equals to the one-year constant yield to maturity treasury bond rate plus an equity premium of 6% and  $g$  is set equal to 3%.<sup>12</sup> Book-value,  $b_t$ , is the end of year book-value from the most recent fiscal year-end,  $f(1)$  equals the mean one-year forecast of earnings per share inflated to firm-level earnings by multiplying it with the I/B/E/S number of shares outstanding.<sup>13</sup> When the second term (residual income) in Equation (1) is negative, we assume that it is equal to zero (hence

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<sup>12</sup> Our results are quantitatively similar for values of the equity premium ranging from 0% to 12%. Changing the forecast horizon, by adding additional forecasts to the model, as in Lee et al. (1999) and Frankel and Lee (1998), requires assumptions regarding payout policy (Dechow, Hutton and Sloan, 1999). We find similar results when implementing longer-horizon models.

<sup>13</sup> We use the most recently available consensus forecast at the end of the month from the unadjusted consensus database. We find similar results using the median forecast.

value equals book value). We use Compustat Xpressfeed item CEQ in the market-to-book ratio and Compustat Xpressfeed item IB in the earnings yield ratio.

### *3.5. Measurement of transaction cost variables*

In our multivariate tests we also include the following controls for transaction costs associated with short-selling. We include a control for the size of the firm (implemented as the CRSP size-decile rank using the NYSE/AMEX/NASDAQ breakpoints) as larger firms are more easily shorted (D'Avolio, 2002; Dechow et al., 2001). We include a measure of institutional holdings (the percentage of institutional holding) as prior research suggests that institutional holdings proxy for the supply of shares available to be shorted (e.g., Geczy et al., 2002; Asquith et al., 2005). We measure the percentage of institutional holdings as the sum of the institutional holdings in the firm's stock from the CDA Spectrum/Thomson One database divided by the CRSP number of shares outstanding. We lag the institutional holdings variable by one month relative to the measurement of short-interest. As the institutional holdings are reported quarterly we use the same percentage for all months in the quarter. We include the dividend yield as dividends must be paid by the short-seller out of their own capital (e.g., D'Avolio, 2002).

## **4. Empirical analysis**

### *4.1. Descriptive statistics*

In Table 1 we report means and medians for the main variables used in our analysis. We report our descriptive statistics for all stocks in Column 2 and then for the five short-interest quintiles with the stocks in Q1 having the lowest level of short interest and the stocks in Q5 having the highest level of short-interest. Consistent with prior research, the average short-interest, expressed as a proportion of shares outstanding, appears low, at an average level of 2.4%. Similar to Asquith and Meulbroek (1996) and Dechow et al. (2001),

a number of stocks have a very large proportion of their shares outstanding held short, for example, the highest quintile of short-interest has an average level of short-interest equal to 7.2% of shares outstanding.

We also present the mean values of additional stock characteristics used in our study. The average prior returns for stocks with low levels of short-interest tend to be lower than the prior returns of stocks with high levels of short-interest. This suggests that on average, the stocks most targeted by short-sellers have recently experienced price increases. On the surface this trend is contrary to the prediction that short-sellers target firms with price declines. It is notable, however, when excluding the lowest levels of short-interest, that the stocks with the highest level of short-interest have the highest proportion of stocks with prior price declines (at 45.8%). Similar to Dechow et al. (2001) we find evidence of a negative association between short-interest and fundamental-to-price ratios. Specifically, the value-to-price ratio and the book-to-market ratio are both decreasing on average as the level of short-selling increases. Consistent with Asquith et al. (2005), the high short-interest quintiles are on average larger firms with a larger proportion of institutional holdings. The proxies for transactions costs are also consistent with prior research.

#### *4.2. Analysis of the level of short-interest*

Our initial hypothesis is that short-sellers target stocks with long-term price declines. To test this hypothesis, we use a multivariate regression framework to control for potential correlated omitted variables. Our independent variables of interest are indicator variables for prior price declines and for low fundamental-to-price ratios. Consistent with

Dechow et al. (2001)<sup>14</sup> we include size, institutional holdings and dividend yield as control variables in order to demonstrate that proxies for short-selling transactions costs do not subsume the predictive ability of the prior price decline and low fundamental-to-price ratio indicator variables. In our first model, we examine the level of short-interest:

$$ShortInterest_{it} = b_0 + b_1 Decline_{it-12} + b_2 LowF_{it} + b_3 SzRank_{it} + b_4 Institutions_{it} + b_5 DivYield_{it} + e_{it}, \quad (2)$$

where,  $ShortInterest_{it}$  which is the level of shares outstanding reported in month  $t$  divided by the CRSP shares outstanding in month  $t$ , our variable of interest,  $Decline_{it-12}$  is an indicator variable that equals 1 if the buy and hold return over the past 12 months is negative and 0 otherwise.<sup>15</sup>  $LowF_{it}$  equals 1 if the stock is in the lowest quintile of the fundamental-to-price ratio (i.e., overpriced relative to fundamental value), we use three fundamental ratios; book-to-market, earnings yield, and value-to-price. We also include controls for the expected costs of short-selling. Specifically, we include size ( $SzRank_{it}$ , using the NYSE/AMEX/NASDAQ breakpoints from CRSP), the expected ability to borrow shares (using the proxy  $Institutions_{it}$  which equals the number of shares held by institutions divided by the number of shares outstanding), and the stock's dividend yield ( $DivYield_{it}$ , using the most recent prior annual dividend amount).

We perform OLS regressions with robust standard errors following the methods in Petersen (2008). We cluster our standard errors by firm (using CRSP Permno) to control for firm-specific factors that affect the average level of a firm's short-interest and by time (monthly) to control for time-specific factors in our OLS regressions. As both short-interest and high-levels of short interest are highly persistent by firm (with autoregressive coefficients of 0.913 and 0.845) this method is more appropriate than Fama-MacBeth cross-sectional regressions, as it appears that firm-specific

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<sup>14</sup> Dechow et al. (2001, page 93) model high short interest as a function of low fundamentals ratio, log of market value, institutional holdings and dividend yield.

<sup>15</sup> We also report results using an indicator variable that equals one if the buy and hold return over the past 12 months is in the lowest quintile of buy and hold returns over the past 12 months (i.e., a momentum stock). Using this measure however, includes low return stocks which are not always negative. Results are similar; see Section 5

effects are the most important factor in examining short-interest.<sup>16</sup> We use this process to estimate the remaining regressions presented in this paper.

The results in Panel A of Table 2 support Hypothesis 1, the prediction that short-sellers target stocks with prior price declines. The coefficient on *Decline* is positive and significant in the three specifications of the model that use the different fundamental-to-price ratios, for example, in the book-to-market regression the coefficient on decline is 0.004 with a *t*-statistic of 6.59 ( $p < 0.001$ ). We also confirm the presence of valuation targeted short-selling in our sample, as we find a positive and significant association between the level of short interest and low fundamental-to-price ratios, consistent with Dechow et al. (2001). For example, the coefficient on a low book-to-market stock is 0.007 with a *t*-statistic of 9.35 ( $p < 0.001$ ). According to our *F*-tests, the coefficients on low fundamentals-to-price are significantly greater than the coefficients on price declines, consistent with the dominant positions of short-sellers being aimed at profiting from the correction of overpriced stocks. In Panel B, we test Hypothesis 1A by examining the association between the level of short-interest with price declines conditional on fundamental-to-price ratios. Specifically, we examine the following model:

$$Short_{it} = b_0 + b_1 Decline_{it-12} + b_2 LowF_{it} * Decline_{it-12} + b_3 HighF_{it} * Decline_{it-12} + b_4 SzRank_{it} + b_5 Institutions_{it} + b_6 DivYield_{it} + e_{it}, \quad (3)$$

where, *HighF* equals 1 if the stock is in the highest quintile of the fundamental-to-price ratio. As before, we use three fundamental ratios; book-to-market, earnings yield, and value-to-price. Evidence in support of the holding cost prediction would be found if the coefficient on the interaction between *LowF* with *Decline*,  $b_2$ , is positive and significant. Evidence in support of the critic's view of short-sellers would be found if the coefficient on the interaction between *HighF* with

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<sup>16</sup> In results not reported here, we also examined the robustness of our results to a Fama-MacBeth style regression with Newey-West corrections. As the level of short-interest is also expected to be autoregressive (Pownall and Simko, 2005; Francis, Venkatachalam and Zhang, 2006) we examined an autoregression correction as explained in Pontiff (1995). Our results are not qualitatively different using these alternative techniques, our reported *t*-statistics, however, are more conservative and consistent across specifications when using the firm-clustering than these alternatives.



*Decline*,  $b_3$ , is positive and significant. To formally test  $H_{1A}$  we examine whether  $b_2 = b_3$  using an  $F$ -test. We also examine the coefficient on  $b_1$ , which in this model provides the average association between short-interest and prior price declines controlling for the correlation between price declines and fundamental based strategies.

The results we report in Panel B reject the null that in stocks with prior price declines, short-interest is equally associated with low fundamental-to-price ratios and high fundamental-to-price ratios. Instead we find that in all specifications of the model, the positions of short-sellers in stocks with price declines are significantly concentrated in stocks with low fundamental-to-price ratios, suggesting that short-sellers use price declines to target overvalued stocks. For example, in the earnings yield specification, the coefficient on  $LowF_t * Decline_{t-12}$  is 0.006 with a  $t$ -statistic of 10.85 ( $p < 0.001$ ), while the coefficient on  $HighF_t * Decline_{t-12}$  is neither economically or statistically significant. The  $F$ -test strongly rejects the null that the coefficients are equal at the  $p < 0.001$  level. Our results provide evidence that the positions of short-sellers are significantly concentrated in stocks with price declines. We then show that the positions of short-sellers in stocks with prior price declines are significantly concentrated in stocks that appear overpriced relative to fundamentals.

#### 4.3. *Analysis of the contemporaneous changes in short-interest*

In the prior section our analysis is on the level of short-interest, however, in levels it is difficult to distinguish between short-sellers who short following a price decline and those who shorted during the price decline and have not unwound their position yet. In this section we examine the contemporaneous change in the percentage of short-interest over the 12-month period. We measure price declines to examine the accumulation of short-interest during the price decline. As short-interest is already measured as a percentage, we take the simple change in the percentage of shares held short over the 12-month price decline period (i.e.,

$\Delta Short_{it} = ShortInterest_{it} - ShortInterest_{it-12}$ ). We also include an indicator variable for high levels of short-interest at the beginning of the period (i.e., at time  $t-12$ ) we measure changes in short interest, as these positions are likely to be unwound (hence we expect a negative association). Our model for the contemporaneous change in short-interest is:

$$\Delta Short_{it} = b_0 + b_1 Decline_{it-12} + b_2 LowF_{it} + b_3 SzRank_{it} + b_4 Institutions_{it} + b_5 DivYield_{it} + b_6 HighShort_{it-12} + e_{it}, \quad (4)$$

where,  $\Delta Short_{it} = ShortInterest_{it} - ShortInterest_{it-12}$  is the change in the percentage of shares held short over the prior 12 months and  $HighShort_{it-12}$  equals 1 if the stock is in the top quintile of short-interest in month  $t-12$  and 0 otherwise, all remaining variables are as previously defined. As not all stocks in our sample have available data for the change in short-interest, our sample is reduced by approximately 19%.

In Table 3, the results we present confirm Hypothesis 2. In Panel A, there is a positive association between price declines and the changes in short-interest over the past 12-months suggesting that short-sellers are increasing their positions as the price is declining. Interestingly, the association is significantly lower than the association with a low fundamental-to-price ratio. For example, in the book-to-market model, the coefficient on *Decline* is 0.003 with a  $t$ -statistic of 3.54 ( $p < 0.001$ ) while the coefficient on *LowF* is 0.007 with a  $t$ -statistic of 8.35 which is significantly greater than 0.003 under an  $F$ -test, with an  $F$ -statistic of 44.37 ( $p < 0.001$ ). In all models, the coefficient on prior high short-interest is negative and significant providing strong evidence consistent with the unwinding of large prior short positions within 12 months.

To test Hypothesis 2A, we examine the association between changes in short-interest and price declines conditional on fundamental-to-price ratios:

$$\Delta Short_{it} = b_0 + b_1 Decline_{it-12} + b_2 LowF_{it} * Decline_{it-12} + b_3 HighF_{it} * Decline_{it-12} + b_4 SzRank_{it} + b_5 Institutions_{it} + b_6 DivYield_{it} + b_7 HighShort_{it-12} + e_{it}. \quad (5)$$

The results we present in Panel B of Table 3 reject the null that given a price decline, the positions of short-sellers are equally associated with low and high fundamental-to-price ratios. Specifically, in all specifications of the model, the coefficient on  $LowF_t*Decline_{t-12}$  is significantly positive, while the coefficient on  $HighF_t*Decline_{t-12}$  is negative but significant in only the book-to-market and earnings yield specifications. In all specifications, the  $F$ -test strongly rejects the null that the coefficients are equal at the  $p<0.001$  level. These results are consistent with short-sellers increasing their positions as the price declines (rather than just in anticipation of the price decline) and targeting stocks that appear overpriced relative to fundamentals as the price declines.

#### 4.4. Analysis of future changes in short-interest

In this section we provide tests of Hypothesis 3 and 3A by examining the change in short-interest over the subsequent 12 months. These tests allow us to investigate whether short-sellers appear to unwind positions in stocks following price declines or whether they appear to continue to increase their positions in these stocks. Our model for the change in short-interest is:

$$\Delta Short_{it+12} = b_0 + b_1 Decline_{it-12} + b_2 LowF_{it} + b_3 SzRank_{it} + b_4 Institutions_{it} + b_5 DivYield_{it} + b_6 HighShort_{it} + e_{it+12}, \quad (6)$$

where,  $\Delta Short_{it+12} = ShortInterest_{it+12} - ShortInterest_{it}$  is the raw change in the percentage of shares held short over the subsequent 12 months and  $HighShort_{it}$  equals 1 if the stock is in the top quintile of short-interest in month  $t$  and 0 otherwise, all remaining variables are as previously defined.

We present these results in Table 4. In Panel A, our results are consistent with short-sellers unwinding their short-positions after a price decline. This result is inconsistent with Hypothesis 3, and suggests that on average short-sellers do not attempt to amplify price declines. In all models the coefficient on  $Decline$  is negative and significant. For example, in the book-to-market specification, the coefficient on  $Decline$  is  $-0.004$  with a  $t$ -statistic of  $-7.57$  ( $p=0.002$ ). We also find

evidence of short-sellers increasing their holdings in firms with low fundamental-to-price ratios. For example, in the book-to-market specification, the coefficient on *LowF* is 0.004 with a *t*-statistic of 8.43 ( $p < 0.001$ ).

In Panel B, we test Hypothesis 3A by examining the association between future changes in short-interest and prior price declines conditional on fundamental-to-price ratios. Our model is written as:

$$\begin{aligned} \Delta Short_{it+12} = & b_0 + b_1 Decline_{it} + b_2 LowF_{it} * Decline_{it} + b_3 HighF_{it} * Decline_{it} + b_4 SzRank_{it} \\ & + b_5 Institutions_{it} + b_6 DivYield_{it} + b_7 HiShort_{it} + e_{it+12}. \end{aligned} \quad (7)$$

The results we present in Panel B are strongly consistent with the holding cost prediction. Specifically, in all of the models, the coefficient on  $LowF_t * Decline_{t-12}$  is positive and significant and while the coefficient on  $HighF_t * Decline_{t-12}$  is insignificant, but in all models negative, opposite to the prediction based on extrapolative short selling driving prices below fundamentals. In addition, the coefficient on  $Decline_{t-12}$  is negative and significant, suggesting that short-sellers unwind their positions following price declines unless they are low fundamental-to-price stocks. For example, in the book-to-market specification, the coefficient on  $Decline_{t-12}$  is  $-0.005$  with a *t*-statistic of  $-8.80$  ( $p < 0.001$ ), the coefficient on  $LowF_t * Decline_{t-12}$  is  $0.004$  with a *t*-statistic of  $5.60$  ( $p < 0.001$ ) and the coefficient on  $HighF_t * Decline_{t-12}$  is positive  $0.001$  but insignificant with a *t*-statistic of  $1.07$  ( $p = 0.528$ ). The coefficients on the interactions are significantly different with an *F*-statistic of  $33.40$  ( $p < 0.001$ ).

To summarize the tests of our hypotheses, we find support for  $H_1$  and  $H_2$  that in levels and contemporaneous changes short-sellers target firms with price declines. We do not however, find evidence consistent with  $H_3$  that short-sellers target firms following price declines. We also reject the null hypotheses  $H_{1A}$ ,  $H_{2A}$  and  $H_{3A}$  that given a price decline short-sellers equally target stocks with high and low fundamental-to-price ratios. Specifically, we find evidence consistent with short-sellers using price declines as a way of minimizing holding costs and coordination risks when

targeting stocks that appear overpriced relative to fundamentals. In the following section, we present further analysis that investigates the robustness of our analysis to changes in the measurement of key variables.

## 5. Further analysis

### 5.1. Robustness to the measurement of the length of prior price decline

As the focus of our analysis is on longer-term price declines, we measure longer-term price declines over the preceding 12-months. In this section, we consider medium and shorter-term price declines that are measured over the prior 1, 3, 6 and 9 months. While it is possible that shorter-term price declines, such as those over a one month measurement period or shorter, are expected to reverse, medium-term price declines are expected to continue. In Table 6 we present analysis of the association between medium-term future changes in short-interest and medium-term prior price declines. In general, these results are very similar to the results presented in Table 3. Specifically, the coefficients on *Decline* are negative and the coefficients on *LowF* are positive and the difference between them is significant. There are some noticeable trends in the coefficients that warrant further discussion. First, the coefficient on *Decline* is less negative when measured over shorter horizons, suggesting that there is less unwinding of positions in stocks following price declines over shorter horizons, or less unwinding on average over shorter horizons. For example, in the book-to-market specification, the coefficient on *Decline* is  $-0.002$  with a  $t$ -statistic of  $-5.70$  when declines and changes in short-interest are measured over a 9 month horizon, but is  $-0.001$  with a  $t$ -statistic of  $-2.39$  for the three month horizon, and is insignificant at the one month horizon. This horizon effect is also noticeable in the coefficient on *HighShort* which decreases monotonically as the horizon increases, consistent with high levels of short interest requiring time to be unwound. Second, there is some evidence that the coefficient on *LowF* declines as the duration of the horizon declines. These trends, however, are relatively small in magnitude, suggesting that the results we

documented for 12-month horizons are relatively robust to shorter periods. Finally, it is again noticeable that the adjusted  $R^2$  increases monotonically with the horizon of changes in short-interest.

## 5.2. Changes pre and post Regulation SHO

Since the Dechow et al. (2001) study, which covered short-interest over the period 1976-1993, the level of short-selling has substantially increased. In addition the attention paid to short-sellers by regulators and the media has increased substantially. As a robustness check, we examine whether our results vary following the most significant recent change to the regulation of short-sellers, Regulation SHO. In Table 6, we split our sample period into two sub periods, pre Regulation SHO and post Regulation SHO.

In Panel A, we examine the level of short-interest in the two periods comparing *Decline* with *LowF*. We report results only for the value-to-price ratio, with analysis of the other fundamental ratios providing similar results. Overall the model appears to fit better in the post Reg-SHO period, with a significantly higher coefficients on both *Decline* ( $F = 4.39, p = 0.036$ ) and *LowF* ( $F = 3.70, p = 0.054$ ). In Panel B, we investigate the levels model that includes the interactions between *Decline\*LowF* and *Decline\*HiF*. We find some evidence consistent with a lower level of short-interest associated with *Decline\*LowF* with the coefficient in the pre-period 0.009 higher than the coefficient in the post period, 0.007, weakly significant with an  $F$ -statistic of 2.79 ( $p = 0.095$ ). In this model it is also noticeable that the coefficient on *Decline\*HiF* is no longer significantly negative in the post period and the amount of short-interest associated with prior price declines, but not controlled for by the overlap with *LowF* has increased significantly from 0.001 in the pre period to 0.003 in the post period ( $F = 4.81, p = 0.028$ ).

### 5.3. Robustness to alternative measurement of 12-month price declines

While a short-sale is only profitable when the price of the stock declines, short-selling can contribute to a profitable hedge strategy. In this case, short-sellers would also target stocks with expected low returns (as part of a long-short hedge) and stocks with negative market-adjusted returns (for a market neutral fund). As such strategies could potentially lead to lengthy periods of undervaluation due to price pressure keeping prices low (but not necessarily falling) we examine the robustness of our results to different measures of prior price declines. Specifically, we examine momentum stocks and market adjusted negative returns in addition to raw price declines. We define momentum stocks as those stocks in the lowest quintile of returns over the prior 12-months. While momentum stocks are expected to underperform over the subsequent year, they are not always negative (Jegadeesh and Titman, 1993; Lee and Swaminathan, 2000). Our results are generally consistent with the results using raw price declines (in Table 2, Panel B). Specifically, the coefficient  $LowF_t * Momentum_{t-12}$  is positive and significant, and the coefficient on  $HighF_t * Momentum_{t-12}$  is negative and significant in the book-to-market and value-to-price specifications, and in all specifications these coefficients are statistically different from each other. Similar results are also found for contemporaneous changes.

We find similar results except for the coefficient on  $LowF_t * Momentum_{t-12}$  which is not significant in the value-to-price and earnings yield specifications and significantly negative in the book-to-market specification. The negative coefficient suggests that these positions are being unwound. In this case, the overlap between momentum and fundamental-to-price ratios appears to be dominated by momentum. Additional evidence that momentum effects are strongly evident in the data is the larger coefficients on  $Momentum_{t-12}$  relative to  $Decline_{t-12}$  in our earlier analysis. This suggests that there are significant momentum, or trend chasing, short-sellers in the cross-section. We do not however find any reliable evidence consistent with short-sellers targeting stocks that appear underpriced relative to fundamentals.

#### 5.4. Market-wide declines

As Lamont and Stein (2004) find that aggregate short-interest is associated with prior market declines, we expect that short-interest is higher on average following market-wide declines. It is not clear, however, whether or not, at the stock level, short-sellers will incrementally target stocks with price declines or low fundamental-to-price ratios. Critics of short-sellers would argue that short-sellers take an increased position following market-wide declines to profit from the amplification of price declines. To test this possibility, we add to the regression model in Equation (4) by including an indicator variable that equals 1 for the months in which the cumulative change in the S&P500 index over the past 12 months is negative and 0 otherwise (*MktDecline*) in Panel A and an indicator for one month S&P index declines in Panel B. We also include interaction terms between *MktDecline* with *Decline* (defined as the lowest quintile of prior 12 month returns) and with *LowF*. We do not find any evidence that, following a market decline, short-sellers increase their positions in firms with price declines. The coefficient on the interaction term *MktDecline\*Decline* is positive but is insignificant at traditional levels in all specifications of the model. There is also no reliable evidence of market-wide declines affecting the association with low fundamental ratios, however, following longer-term price declines there appears to be a weakly negative association for the *MktDecline\*LowF* interaction term. These results suggest that, at least during our time-period, while there is some evidence consistent with market-wide declines altering the behavior of short-sellers, the evidence is weak.

#### 5.5. Limitations and Caveats

Our results must be interpreted with the important caveat that many short positions are undertaken only for a short-period of time. As the focus of our study is on longer-term price declines, we do not capture the effects of positions that are opened and closed within the monthly



reporting dates and we cannot make any inferences on the motivation of such short-term positions. Our focus is on whether short-sellers appear to amplify sustained price declines or align stocks with fundamentals in the longer-term. As the alignment of price with fundamentals is generally considered to be a long-term process in the accounting literature (e.g., Frankel and Lee, 1998; Lee et al., 1999) we focus on sustained price declines that are expected to continue in the future (e.g., Jeegadeesh and Titman, 1993; Lee and Swaminathan, 2000). As such, we potentially exclude short-selling behavior that is aimed at exploiting short-term price declines rather than aligning prices with fundamentals. Our results should be interpreted as applicable to longer-term short-sellers.<sup>17</sup>

Our main results are also limited by our choices of how to measure firm-fundamentals. Consistent with Dechow et al. (2001) we use low ratios of price to accounting numbers to proxy for overvaluation, including the residual income model. While the residual income model has a strong theoretical and empirical support in prior literature (e.g., Ohlson, 1995; Frankel and Lee, 1998; Lee et al., 1999) the model is always implemented with error. As such, it is possible that our implementation of the residual income model proxies for something other than overvaluation and our results should be interpreted with this caveat in mind. Given our measurement of value, an alternative explanation that we cannot rule out is that short-sellers target firms with a lower cost of capital or higher expected growth, or some combination of the two.

Due to our focus on the alignment of prices with fundamentals, we focus on fundamental-to-price ratios. While outside of the scope of this paper, price declines may also aid short-sellers in minimizing holding costs associated with returns to accounting-based trading strategies, such as accruals (Sloan, 1996), earnings surprises (Bernard and Thomas, 1990; Doyle, Lundholm and Soliman, 2003) and restatements (Desai et al., 2006a; Efendi et al., 2005). Future research could explore this possibility.

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<sup>17</sup> For example, there is some evidence that intra-day short-selling is destabilizing during liquidity crises (Shkilko et al., 2008).

## 6. Concluding remarks

Our study is motivated by the recent and ongoing criticism of short-sellers as profiting from the amplification of price declines and forcing stock prices below their fundamental values. We find that there is significant heterogeneity in the positions of short-sellers, including large positions in stocks with price declines. In general, we find evidence consistent with a significant proportion of short positions following price declines appearing to be aimed at aligning prices with fundamentals. We do not find any compelling evidence that short-sellers' positions appear to be aimed at forcing prices below fundamental values, or maintaining lengthy periods of undervaluation.

When we condition our analysis on accounting fundamental to price ratios, we find evidence that, given a price decline, short-sellers' positions are concentrated in stocks that appear overpriced relative to fundamental value. We extend Dechow et al. (2001), who examine the level of short-interest and the unwinding of short-interest, to examine the build-up of short-interest, and further extend their insights by demonstrating the importance of both price relative to fundamentals and recent price momentum. One possible explanation for our results is that short-sellers use price declines to minimize trading costs when taking positions in overvalued stocks. We do not find evidence consistent with short-sellers taking positions in undervalued stocks with price declines.

Consistent with Dechow et al (2001) we find evidence consistent with short-sellers on average unwinding their positions in stocks following price declines. We also show that when the stock with a prior price decline appears overvalued relative to fundamentals, short-sellers appear to increase their positions. Again, we do not find any evidence of short-sellers increasing positions in stocks that appear underpriced relative to fundamental value. Our results are generally robust to alternative specifications of fundamentals, when examining shorter-term price declines, when examining market-wide price declines and when examining the largest levels of short interest rather than the cross-section.

In general, our results do not provide any reliable evidence to support the criticism of short-sellers. Instead, our results suggest that the dominant role of short-sellers is to facilitate the alignment of prices with fundamentals, promoting market efficiency. While short-sellers are not a homogenous group, short-sellers do not appear to target firms that are underpriced relative to their fundamental values. Our results are strongest for longer-term price declines, but weaker for shorter term price declines; future research could investigate this issue further. Given the ongoing regulatory interest in the actions of short-sellers, it is important for future research to further examine the role of short-sellers in the process of aligning prices with fundamentals.

## References

- Abreu, D. and M. Brunnermeier, 2002. Synchronization risk and delayed arbitrage. *Journal of Financial Economics* 66, 341–360.
- Abreu, D. and M. Brunnermeier, 2003. Bubbles and crashes. *Econometrica* 71, 173–204.
- Albright, A. M., 2004. Summary of comments: Related to proposed short sale rule, Regulation SHO, replacing rules 3b-3, 10a-1, 10a-2 and amending Rule 105 of Regulation M, available at <http://www.sec.gov/rules/extra/s72303comsum.pdf>.
- Allen, F. and D. Gale, 1992. Stock price manipulation. *Review of Financial Studies* 5, 503–529.
- Ali, A. and M. A. Trombley. 2006. Short sales constraints and momentum in stock returns. *Journal of Business Finance and Accounting* 33 (3-4): 587–615.
- Asquith, P., P. A. Pathak and J. R. Ritter. 2005. Short-interest, Institutional Ownership, and Stock Returns. *Journal of Financial Economics* 78: 277–309.
- Bernard V. and J. Thomas, 1990. Evidence that stock prices do not fully reflect the implications of current earnings for future earnings. *Journal of Accounting & Economics* 13, 305–340.
- Boehmer, E., C. M. Jones, and X. Zhang. 2008. Which shorts are informed? *Journal of Finance* 63 (2): 491–527.
- Bris, A., W.N. Goetzmann and N. Zhu. 2007. Efficiency and the bear: Short sales and markets around the world. *Journal of Finance* 62 (3): 1029–1079.
- Chancellor, E.. 2001. A Short History of the Bear. *Fortune*, October.
- Chang, E. C., J. W. Cheng, Y. Yu. 2007. Short-sales constraints and price discovery: Evidence from the Hong Kong market. *Journal of Finance* 62 (5): 2097–2121.
- Daske, H., S. A. Richardson, and I. Tuna. 2005. Is aggregate short selling a useful proxy for sophisticated information based trading? New evidence from NYSE daily data. Working paper, University of Pennsylvania, April 2006.
- D’Avolio, G., 2002. The market for borrowing stocks. *Journal of Financial Economics* 66: 271–306.
- Dechow, P. M., A. P. Hutton, and R. G. Sloan. 1999. An empirical assessment of the residual income valuation model. *Journal of Accounting and Economics* 26: 1–34.
- Dechow, P. M., A. P. Hutton, L. Meulbroek, and R. G. Sloan. 2001. Short-sellers, fundamental analysis, and stock returns. *Journal of Financial Economics* 61: 77–106.
- Desai, H., S. Krishnamurthy, and K. Venkataraman, 2006a. Do short-sellers target firms with poor earnings quality? Evidence from earnings restatements. *Review of Accounting Studies* 11, 71–90.
- Desai, H., S. Krishnamurthy and K. Venkataraman, 2006b. On distinguishing between valuation and arbitrage motivated short selling. Working paper, Southern Methodist University, available at: <http://ssrn.com/abstract=969432>
- Desai, H., K. Ramesh, S. R. Thiagarajan, and B. V. Balachandran. 2002. An investigation of the informational role of short-interest in the Nasdaq market. *Journal of Finance* 57 (5): 2263–2287.
- Diamond, D. W. and R. E. Verrecchia. 1987. Constraints on short-selling and asset price adjustment to private information. *Journal of Financial Economics* 18: 277–311.
- Diether, K.B., K-H. Lee and I. M. Werner, 2008. Short-sale strategies and return predictability. Forthcoming *Review of Financial Studies*.

- Doyle, J. T., R. J. Lundholm and M. T. Soliman, 2003. The predictive value of expenses excluded from pro forma earnings. *Review of Accounting Studies* 8, (2-3): 145–174.
- Duffie, D., N. Garleanu, L. H. Pedersen, 2002. Securities lending, shorting, and pricing. *Journal of Financial Economics* 66: 307–339.
- Efendi, J., M. Kinney, E. Swanson, 2005. Can short-sellers anticipate accounting restatements? AAA 2005 Financial Accounting and Reporting Section (FARS) Meeting, available at: <http://ssrn.com/abstract=591361>
- Financial Services Authority, 2008. FSA statement on short positions in financial stocks. Available at: <http://www.fsa.gov.uk/pages/Library/Communication/PR/2008/102.shtml>
- Francis, J., M. Venkatachalam and Y. Zhang. 2005. Do Short Sellers Convey Information About Changes in Fundamentals or Risk? Working paper, Duke University, available at: <http://ssrn.com/abstract=815668>
- Frankel, R. and C. M. C. Lee, 1998. Accounting valuation, market expectation, and cross-sectional stock returns. *Journal of Accounting and Economics* 25, 283–319.
- Gezcy, C. C., D. K. Musto and A. V. Reed. 2002. Stocks are special too: an analysis of the equity lending market. *Journal of Financial Economics* 66: 241–269.
- Grossman, S. J., and M. H. Miller, 1988. Liquidity and market structure. *Journal of Finance* 43: 617–633.
- Goldstein, I. and A. Guembel. 2008. Manipulation and the allocational role of prices. *Review of Economic Studies* 75, 133–164.
- Henry, T. R., and J. L. Koski, 2008. Short selling around seasoned equity offerings. Working paper, University of Georgia.
- Hirshleifer, D., S. H. Teoh and J. Yu. 2008. Short arbitrage, return asymmetry and the accrual anomaly. Working paper, University of California – Irvine.
- Hulbert, M. 2008. It's fashionable, but probably wrong, to blame the short-sellers. Commentary, *Market Watch* available at: <http://www.marketwatch.com/news/story/short-sellers-blame/>
- Jegadeesh, N. 1990. Evidence of predictable behavior of security returns. *Journal of Finance* 45: 881–898.
- Jegadeesh, N. and S. Titman. 1993. Returns to buying winners and selling losers: implications for stock market efficiency. *Journal of Finance* 48: 65–91.
- Jones, C. M. and O. A. Lamont. 2002. Short-sales constraints and stock returns. *Journal of Financial Economics* 66: 207–239.
- Lamont, O. A. and J. C. Stein. 2004. Aggregate short-interest and market valuations. *American Economic Review* 94(2): 29–32.
- Lehmann, B., 1990. Fads, martingales and market efficiency. *Quarterly Journal of Economics* 105: 1–28.
- Lee, C. M. C., J. Myers, and B. Swaminathan, 1999. What is the intrinsic value of the Dow? *Journal of Finance* 54, 1693–1741.
- Lee, C. M. C., and B. Swaminathan. 2000. Price momentum and trading volume. *Journal of Finance* 55: 2017–2069.

- Miller, E. 1977. Risk, uncertainty and divergence of opinion. *Journal of Finance* 32: 1151–1168.
- Ohlson, J. A., 1995. Earnings, Book values, and dividends in equity valuation. *Contemporary Accounting Research* 11: 661–687.
- Penman, S. H., 2003. The quality of financial statements: Perspectives from the recent stock market bubble. *Accounting Horizons* 17, 77–96.
- Petersen, M. A., 2008. Estimating Standard Errors in Finance Panel Data Sets: Comparing Approaches. *Review of Financial Studies* forthcoming.
- Pownall, G. and P. J. Simko. 2005. The information intermediary role of short-sellers. *The Accounting Review* 80(3): 941 – 966.
- Richardson, S. A., 2003. Earnings quality and short-sellers. *Accounting Horizons* (Supplement): 1 – 41.
- Ross, S.A. 1976. The arbitrage theory of capital asset pricing. *Journal of Economic Theory* 13: 314–360.
- Santini, L., 2008. In Australia, Soul-Searching on Short-Selling: Investors turn to a familiar scapegoat as stock slump hits home. *The Wall Street Journal* Friday April 4<sup>th</sup>: C5.
- Savor and Gamboa-Covazos, 2005. Holding on to your shorts: When do short-sellers retreat? Working paper, Harvard University.
- Securities and Exchange Commission, 1999a. Concept Release: Short sales. Available at: <http://www.sec.gov/rules/concept/34-42037.htm>.
- Securities and Exchange Commission, 1999b. Summary of Comments SEC Concept Release: Short Sales. Available at: <http://www.sec.gov/rules/concept/s72499summary.htm>.
- Securities and Exchange Commission, 2004. Final Rule: Short sales. Available at: <http://www.sec.gov/rules/final/34-50103.htm>.
- Securities and Exchange Commission, 2008a. Naked Short Selling Anti-Fraud Rule; Proposed Rule. Available at: <http://www.sec.gov/rules/proposed/2008/34-57511fr.pdf>.
- Securities and Exchange Commission, 2008b. Emergency order pursuant to section 12(k)(2) of the securities exchange act of 1934 taking temporary action to respond to market developments. Release no. 58591, September 18<sup>th</sup>. Available at: <http://www.sec.gov/rules/other/2008/34-58591.pdf>
- Securities and Exchange Commission, 2009. Amendments to regulation SHO. <http://www.sec.gov/rules/proposed/2009/34-60509.pdf>
- Shkilko, A., B Van Ness and R. Van Ness, 2008. Price-destabilizing short selling. Working paper, available at: <http://ssrn.com/abstract=971210>
- Shliefer, A. and R. Vishny, 1997. The limits of arbitrage. *Journal of Finance* 52: 35–55.
- Sloan, R. G., 1996. Do Stock Prices Fully Reflect Information in Accruals and Cash Flows about Future Earnings? *The Accounting Review* 71, 289–315.
- Stoll, H. R., 1978. The pricing of security dealer services: An empirical study of Nasdaq stocks. *Journal of Finance* 33: 1153–1172.
- Taulli, T. 2004. *What is short-selling?* McGraw-Hill, New York, NY.

Table 1

Descriptive statistics on the relation between short-positions with prior returns and fundamental-to-price ratios

	<u>All stocks</u>		<u>Short-interest quintile</u>			
	Mean (Median)	Q1 (Low)	Q2	Q3	Q4	Q5 (High)
Short position (%)	0.024 (0.0109)	0.0006 (0.0002)	0.0040 (0.0026)	0.0129 (0.0117)	0.0290 (0.0259)	0.0720 (0.0667)
Prior return (12 months)	0.214 (0.095)	0.122 (0.049)	0.194 (0.102)	0.225 (0.126)	0.243 (0.115)	0.273 (0.073)
Decline	0.436 (0)	0.489 (0)	0.438 (0)	0.394 (0)	0.404 (0)	0.458 (0)
Book-to-market	0.646 (0.523)	0.816 (0.710)	0.713 (0.585)	0.609 (0.487)	0.562 (0.456)	0.544 (0.408)
Earnings yield	0.016 (0.047)	0.008 (0.055)	0.016 (0.052)	0.024 (0.050)	0.0215 (0.044)	0.006 (0.031)
Value-to-price	1.306 (1.002)	1.448 (1.214)	1.437 (1.128)	1.317 (1.007)	1.198 (0.908)	1.142 (0.770)
Size decile ranking	5.613 (6)	2.877 (2)	4.754 (4)	6.428 (7)	6.952 (7)	6.777 (7)
Dividend yield	0.013 (0)	0.013 (0)	0.015 (0)	0.015 (0.004)	0.012 (0)	0.008 (0)
Institutional holdings	0.447 (0.427)	0.196 (0.143)	0.340 (0.2957)	0.478 (0.492)	0.562 (0.600)	0.635 (0.668)

In this table we present descriptive statistics for the five quintile portfolios of the level of short-interest, sorted monthly. Short position (%) is defined as the number of shares held short from the exchanges divided by the number of shares outstanding from CRSP, the change in short position (%) is change in short interest over the prior 12-months, prior return is the buy-and-hold returns excluding dividends over the prior 12-months ending at the closing price of the month prior to the measurement of the short position, decline is equal to one if the buy and hold return over the prior 12 months ending at the closing price on the prior month is negative and zero otherwise, book-to-market is the ratio of book-value divided by the monthly closing price, earnings yield is the firms reported GAAP earnings divided by market value of equity using month-end closing prices, value-to-price is the ratio of fundamental value-to-price measured using the residual income model with analyst forecasts of earnings and price is the monthly closing price, size decile ranking is the average of the size decile of the portfolio (using NYSE/AMEX/NASDAQ breakpoints), dividend yield is the prior annual amount of common dividends per share paid (excluding preference shares and other disbursements) divided by the prior month closing price per share, institutional holdings is the number of shares owned by institutions (according to 13-F filings) divided by the number of shares outstanding.  $N = 562,308$ .

Table 2

Analysis of the relation between the level of short interest with price declines and fundamental analysis.

Panel A: Tests of Hypothesis 1								
Short Interest <sub>it</sub> = b <sub>0</sub> + b <sub>1</sub> Decline <sub>it</sub> + b <sub>2</sub> LowF <sub>it</sub> + b <sub>3</sub> SzRank <sub>it</sub> + b <sub>4</sub> Institutions <sub>it</sub> + b <sub>5</sub> DivYield <sub>it</sub> + e <sub>t</sub>								
	b <sub>0</sub>	b <sub>1</sub>	b <sub>2</sub>	b <sub>3</sub>	b <sub>4</sub>	b <sub>5</sub>	Adj. R <sup>2</sup>	
Predicted sign	?	+	+	+	+	-		
<i>Book-to-market</i>								
Coefficient	0.002	0.004	0.007	0.002	0.026	-0.073	0.178	
t-statistic	[0.91]	[6.59]	[9.35]	[3.13]	[3.27]	[-4.57]		
	b <sub>1</sub> = b <sub>2</sub> , F-statistic: 8.65 (p=0.003)							
<i>Earnings yield</i>								
Coefficient	0.000	0.003	0.008	0.002	0.026	-0.076	0.180	
t-statistic	[-0.19]	[4.29]	[14.48]	[4.26]	[3.28]	[-4.83]		
	b <sub>1</sub> = b <sub>2</sub> , F-statistic: 32.55 (p<0.001)							
<i>Value-to-price</i>								
Coefficient	0.000	0.003	0.010	0.002	0.026	-0.058	0.187	
t-statistic	[0.02]	[5.87]	[15.17]	[3.52]	[3.28]	[-3.80]		
	b <sub>1</sub> = b <sub>2</sub> , F-statistic: 57.89 (p<0.001)							
Panel B: Tests of Hypothesis 1A								
Short Interest <sub>it</sub> = b <sub>0</sub> + b <sub>1</sub> Decline <sub>it</sub> + b <sub>2</sub> Decline <sub>it</sub> *LowF <sub>it</sub> + b <sub>3</sub> Decline <sub>it</sub> *HighF <sub>it</sub> + b <sub>4</sub> SzRank <sub>it</sub> + b <sub>5</sub> Institutions <sub>it</sub> + b <sub>6</sub> DivYield <sub>it</sub> + e <sub>t</sub>								
	b <sub>0</sub>	b <sub>1</sub>	b <sub>2</sub>	b <sub>3</sub>	b <sub>4</sub>	b <sub>5</sub>	b <sub>6</sub>	Adj. R <sup>2</sup>
Predicted sign	?	+	+	+	+	-	-	
<i>Book-to-market</i>								
Coefficient	0.003	0.003	0.006	-0.001	0.002	0.026	-0.086	0.174
t-statistic	[1.52]	[4.36]	[6.66]	[-0.83]	[3.34]	[3.26]	[-5.27]	
	b <sub>2</sub> = b <sub>3</sub> , F-statistic: 21.56 (p<0.001)							
<i>Earnings yield</i>								
Coefficient	0.001	0.002	0.006	-0.001	0.002	0.026	-0.083	0.175
t-statistic	[0.80]	[3.93]	[10.85]	[-1.75]	[3.93]	[3.27]	[-5.23]	
	b <sub>2</sub> = b <sub>3</sub> , F-statistic: 64.84 (p<0.001)							
<i>Value-to-price</i>								
Coefficient	0.002	0.002	0.009	0.000	0.002	0.026	-0.081	0.177
t-statistic	[1.21]	[3.08]	[10.20]	[0.26]	[3.55]	[3.27]	[-5.05]	
	b <sub>2</sub> = b <sub>3</sub> , F-statistic: 28.66 (p<0.001)							

The dependent variable, *Short Interest* is ratio of the number of shares held short divided by the number of shares outstanding. *Decline* is equal to one if the buy and hold return over the prior 12 months ending at the closing price on the prior month is negative and zero otherwise. *LowF* is equal to one if the stock's fundamental-to-price ratio is in the lowest quintile of monthly fundamental-to-price ratios and zero otherwise. The fundamental to price ratios are: book-to-market is the ratio of book-value divided by market value of equity, earnings yield is the ratio of earnings divided by market value of equity, and value-to-price is the ratio of residual income value (using analyst forecasts of earnings when available) divided by market value of equity. Market value is measured using the monthly closing price. We also include controls for the costs associated with short-selling; *SzRank* is the size decile ranking of the stock using NYSE/AMEX/NASDAQ breakpoints, *Institutions* is the number of shares owned by institutions (according to 13-F filings) divided by the number of shares outstanding, *DivYield* is the prior annual amount of common dividends per share paid (excluding preference shares and other disbursements) divided by the prior month closing price per share. The *t*-statistics [in brackets] are corrected for firm and time-series clustering following the method in Petersen (2008). Observations are measured monthly, with the number of firm-month observations,  $N = 562,308$ . The sample period is from 1995 to 2008, we include all firms with available data listed on the NASDAQ, and NYSE/AMEX.



Table 3

## Analysis of the relation between contemporaneous change in short interest with price declines and fundamental analysis

## Panel A: Tests of Hypothesis 2

$$\Delta \text{Short Interest}_t = b_0 + b_1 \text{Decline}_{t-12} + b_2 \text{LowF}_t + b_3 \text{SzRank}_t + b_4 \text{Institutions}_t + b_5 \text{DivYield}_t + b_6 \text{HighShort}_{t-12} + e_t$$

	b <sub>0</sub>	b <sub>1</sub>	b <sub>2</sub>	b <sub>3</sub>	b <sub>4</sub>	b <sub>5</sub>	b <sub>6</sub>	b <sub>1</sub> = b <sub>2</sub>	Adj. R <sup>2</sup>
Predicted sign	?	+	+	+	+	-	-	F-statistic	
<i>Book-to-market</i>									
Coefficient	-0.034	0.003	0.007	0.003	0.025	-0.079	0.003	9.64	0.038
t-statistic	[-11.57]	[3.54]	[8.35]	[8.15]	[5.65]	[-3.34]	[2.02]	(p=0.002)	
<i>Earnings yield</i>									
Coefficient	-0.036	0.002	0.006	0.003	0.025	-0.088	0.004	8.48	0.038
t-statistic	[-11.39]	[2.35]	[5.22]	[9.31]	[5.64]	[-3.74]	[2.11]	(p=0.004)	
<i>Value-to-price</i>									
Coefficient	-0.036	0.003	0.008	0.003	0.025	-0.071	0.003	22.0	0.039
t-statistic	[-11.72]	[3.08]	[8.40]	[8.78]	[5.66]	[-2.97]	[1.71]	(p<0.001)	

## Panel B: Tests of Hypothesis 2A

$$\Delta \text{Short Interest}_t = b_0 + b_1 \text{Decline}_{t-12} + b_2 \text{LowF}_t * \text{Decline}_{t-12} + b_3 \text{HighF}_t * \text{Decline}_{t-12} + b_4 \text{SzRank}_t + b_5 \text{Institutions}_t + b_6 \text{DivYield}_t + b_7 \text{HighShort}_{t-12} + e_t$$

	b <sub>0</sub>	b <sub>1</sub>	b <sub>2</sub>	b <sub>3</sub>	b <sub>4</sub>	b <sub>5</sub>	b <sub>6</sub>	b <sub>7</sub>	b <sub>2</sub> = b <sub>3</sub>	Adj. R <sup>2</sup>
Predicted sign	?	+	+	+	+	+	-	-	F-statistic	
<i>Book-to-market</i>										
Coefficient	-0.034	0.002	0.007	0.001	0.003	0.025	-0.095	0.004	19.09	0.038
t-statistic	[-11.31]	[1.66]	[6.46]	[0.90]	[8.63]	[5.64]	[-4.08]	[2.24]	(p<0.001)	
<i>Earnings yield</i>										
Coefficient	-0.034	0.002	0.004	0.001	0.003	0.025	-0.097	0.004	4.2	0.037
t-statistic	[-11.25]	[1.97]	[3.14]	[1.03]	[9.10]	[5.65]	[-4.14]	[2.27]	(p=0.041)	
<i>Value-to-price</i>										
Coefficient	-0.034	0.001	0.008	0.003	0.003	0.025	-0.093	0.004	12.3	0.038
t-statistic	[-11.43]	[0.95]	[6.59]	[2.31]	[8.98]	[5.65]	[-3.98]	[2.15]	(p<0.001)	

The dependent variable,  $\Delta \text{Short Interest}_t$  is change in short interest over the prior 12-months. In Panel A, *Decline* is equal to one if the cumulative return over the prior 12 months ending at the closing price on the prior month is negative and zero otherwise. In Panel B, *Decline* is equal to one if the cumulative return over the prior 12 months ending at the closing price on the prior month is in the lowest quintile of cumulative sorted each month. *LowF* is equal to one if the stock's fundamental-to-price ratio is in the lowest quintile of monthly fundamental-to-price ratios and zero otherwise. The fundamental to price ratios are: book-to-market is the ratio of book-value divided by market value of equity, earnings yield is the ratio of earnings divided by market value of equity, and value-to-price is the ratio of residual income value (using analyst forecasts of earnings when available) divided by market value of equity. Market value is measured using the monthly closing price. We also include controls for the costs associated with short-selling; *SzRank* is the size decile ranking of the stock using NYSE/AMEX/NASDAQ breakpoints, *Institutions* is the number of shares owned by institutions (according to 13-F filings) divided by the number of shares outstanding, *DivYield* is the prior annual amount of common dividends per share paid (excluding preference shares and other disbursements) divided by the prior month closing price per share. *High Short* is equal to one if the stock is in the highest quintile of short interest in month  $t$ . The  $t$ -statistics [in brackets] are corrected for firm and time-series clustering following the method in Petersen (2008). Observations are measured monthly, with the number of firm-month observations,  $N = 456,125$ . The sample period is from 1995 to 2008, we include all firms with available data listed on the NASDAQ, and NYSE/AMEX.

Table 4

## Analysis of the relation between future change in short interest with price declines and fundamental analysis

## Panel A: Tests of Hypothesis 3

$$\Delta \text{Short Interest}_{t+12} = b_0 + b_1 \text{Decline}_{t-12} + b_2 \text{LowF}_t + b_3 \text{SzRank}_t + b_4 \text{Institutions}_t + b_5 \text{DivYield}_t + b_6 \text{HighShort}_t + e_t$$

	b <sub>0</sub>	b <sub>1</sub>	b <sub>2</sub>	b <sub>3</sub>	b <sub>4</sub>	b <sub>5</sub>	b <sub>6</sub>	b <sub>1</sub> = b <sub>2</sub> F-statistic	Adj. R <sup>2</sup>
Predicted sign	?	+	+	+	+	-	-		
<i>Book-to-market</i>									
Coefficient	0.014	-0.004	0.004	-0.001	-0.005	-0.018	-0.022	114.7	0.030
t-statistic	[13.79]	[-7.57]	[8.43]	[-3.57]	[-2.16]	[-1.62]	[-9.13]	(p<0.001)	
<i>Earnings yield</i>									
Coefficient	0.015	-0.004	-0.001	-0.001	-0.006	-0.033	-0.022	6.18	0.037
t-statistic	[13.76]	[-7.37]	[-1.87]	[-2.83]	[-2.31]	[-2.77]	[-8.92]	(p=0.013)	
<i>Value-to-price</i>									
Coefficient	0.014	-0.004	0.002	-0.001	-0.006	-0.023	-0.022	49.47	0.037
t-statistic	[12.81]	[-7.96]	[3.59]	[-2.70]	[-2.18]	[-2.03]	[-9.25]	(p<0.001)	

## Panel B: Tests of Hypothesis 3A

$$\Delta \text{Short Interest}_{t+12} = b_0 + b_1 \text{Decline}_{t-12} + b_2 \text{LowF}_t * \text{Decline}_{t-12} + b_3 \text{HighF}_t * \text{Decline}_{t-12} + b_4 \text{SzRank}_t + b_5 \text{Institutions}_t + b_6 \text{DivYield}_t + b_7 \text{HighShort}_t + e_t$$

	b <sub>0</sub>	b <sub>1</sub>	b <sub>2</sub>	b <sub>3</sub>	b <sub>4</sub>	b <sub>5</sub>	b <sub>6</sub>	b <sub>7</sub>	b <sub>2</sub> = b <sub>3</sub> F-statistic	Adj. R <sup>2</sup>
Predicted sign	?	+	+	+	+	+	-	-		
<i>Book-to-market</i>										
Coefficient	0.015	-0.005	0.004	0.001	-0.001	-0.006	-0.029	-0.022	10.61	0.079
t-statistic	[14.58]	[-8.80]	[5.60]	[1.07]	[-2.83]	[-2.25]	[-2.47]	[-8.96]	(p=0.001)	
<i>Earnings yield</i>										
Coefficient	0.015	-0.004	-0.001	0.001	-0.001	-0.006	-0.032	-0.022	2.46	0.078
t-statistic	[14.2]	[-6.73]	[-0.85]	[1.01]	[-2.65]	[-2.31]	[-2.71]	[-8.90]	(p=0.117)	
<i>Value-to-price</i>										
Coefficient	0.014	-0.005	0.003	0.002	-0.001	-0.006	-0.030	-0.022	1.17	0.079
t-statistic	[14.23]	[-8.68]	[4.02]	[1.96]	[-2.57]	[-2.26]	[-2.55]	[-8.98]	(p=0.279)	

The dependent variable,  $\Delta \text{Short Interest}_{t+12}$  is change in short interest over the subsequent 12 months. *Decline* is equal to one if the cumulative return over the prior 12 months ending at the closing price on the prior month is negative and zero otherwise. *LowF* is equal to one if the stock's fundamental-to-price ratio is in the lowest quintile of monthly fundamental-to-price ratios and zero otherwise. The fundamental to price ratios are: book-to-market is the ratio of book-value divided by market value of equity, earnings yield is the ratio of earnings divided by market value of equity, and value-to-price is the ratio of residual income value (using analyst forecasts of earnings when available) divided by market value of equity. Market value is measured using the monthly closing price. We also include controls for the costs associated with short-selling; *SzRank* is the size decile ranking of the stock using NYSE/AMEX/NASDAQ breakpoints, *Institutions* is the number of shares owned by institutions (according to 13-F filings) divided by the number of shares outstanding, *DivYield* is the prior annual amount of common dividends per share paid (excluding preference shares and other disbursements) divided by the prior month closing price per share. *HighShort* is equal to one if the stock is in the highest quintile of short interest in month *t*. The *t*-statistics [in brackets] are corrected for firm and time-series clustering following the method in Petersen (2008). Observations are measured monthly, with the number of firm-month observations,  $N = 456,137$ . The sample period is from 1995 to 2002, we include all firms with available data listed on the NASDAQ, and NYSE/AMEX.

Table 5

Further analysis of the relation between medium-term future changes in short interest with medium-term prior price declines and fundamental analysis

Panel A: Changes in short-interest over the subsequent month and declines over the prior month

$$\Delta \text{Short Interest}_{t+K} = b_0 + b_1 \text{Decline}_{t-1} + b_2 \text{LowF}_t * \text{Decline}_{t-K} + b_3 \text{HighF}_t * \text{Decline}_{t-K} + b_4 \text{SzRank}_t + b_5 \text{Institutions}_t + b_6 \text{DivYield}_t + b_7 \text{HighShort}_t + e_t$$

	b <sub>0</sub>	b <sub>1</sub>	b <sub>2</sub>	b <sub>3</sub>	b <sub>4</sub>	b <sub>5</sub>	b <sub>6</sub>	b <sub>7</sub>	b <sub>2</sub> = b <sub>3</sub> F-statistic	Adj. R <sup>2</sup>
Predicted sign	?	+	+	+	+	+	-	-		
<i>K = 1 Value-to-price</i>										
Coefficient	0.001	0.001	0.001	-0.001	-0.001	0.002	-0.003	-0.004	4.53	0.007
t-statistic	[0.15]	[1.03]	[4.25]	[-0.73]	[-0.55]	[0.93]	[-0.78]	[-2.67]	(p=0.033)	N=553,026
<i>K = 3 Value-to-price</i>										
Coefficient	0.003	-0.003	0.002	0.001	-0.001	0.003	-0.015	-0.012	6.27	0.041
t-statistic	[3.12]	[-2.80]	[5.57]	[0.93]	[-0.45]	[0.64]	[-1.75]	[-3.99]	(p=0.012)	N= 534,743
<i>K = 6 Value-to-price</i>										
Coefficient	0.006	-0.002	0.001	0.002	0.001	-0.004	-0.023	-0.015	1.75	0.019
t-statistic	[9.64]	[-4.82]	[1.33]	[3.51]	[1.17]	[-1.26]	[-3.03]	[-5.86]	(p=0.186)	N= 507,885
<i>K=9, Value-to-price</i>										
Coefficient	0.012	-0.005	0.001	0.002	-0.001	-0.005	-0.025	-0.019	0.1	0.023
t-statistic	[10.85]	[-11.62]	[1.96]	[2.84]	[-1.06]	[-1.71]	[-2.50]	[-7.86]	(p<0.749)	N= 481,602

The dependent variable,  $\Delta \text{Short Interest}_{t+J}$  is change in short interest over the subsequent  $J$ -months, where  $J = 1, 3, 6$  and  $9$ . *Decline* is equal to one if the cumulative return over the prior  $J$ -months ending at the closing price on the prior month is negative and zero otherwise, where  $J = 1, 3, 6$  and  $9$ . *LowF* is equal to one if the stock's fundamental-to-price ratio is in the lowest quintile of monthly fundamental-to-price ratios and zero otherwise. *HighF* is equal to one if the stock's fundamental-to-price ratio is in the highest quintile of monthly fundamental-to-price ratios and zero otherwise. The fundamental to price ratios are: book-to-market is the ratio of book-value divided by market value of equity, earnings yield is the ratio of earnings divided by market value of equity, and value-to-price is the ratio of residual income value (using analyst forecasts of earnings when available) divided by market value of equity. Market value is measured using the monthly closing price. We also include controls for the costs associated with short-selling; *SzRank* is the size decile ranking of the stock using NYSE/AMEX/NASDAQ breakpoints, *Institutions* is the number of shares owned by institutions (according to 13-F filings) divided by the number of shares outstanding, *DivYield* is the prior annual amount of common dividends per share paid (excluding preference shares and other disbursements) divided by the prior month closing price per share. *High Short* is equal to one if the stock is in the highest quintile of short interest in month  $t$ . The  $t$ -statistics [in brackets] are corrected for firm and time-series clustering following the method in Petersen (2008). Observations are measured monthly, with the number of firm-month observations reported above. The sample period is from 1995 to 2008, we include all firms with available data listed on the NASDAQ, and NYSE/AMEX.

Table 6

Analysis of changes following Reg-SHO of the relation between contemporaneous change in short interest with price declines and fundamental analysis

Panel A: Short Interest <sub>it</sub> = b <sub>0</sub> + b <sub>1</sub> Decline <sub>it</sub> + b <sub>2</sub> LowF <sub>it</sub> + b <sub>3</sub> SzRank <sub>it</sub> + b <sub>4</sub> Institutions <sub>it</sub> + b <sub>5</sub> DivYield <sub>it</sub> + e <sub>t</sub>							
	b <sub>0</sub>	b <sub>1</sub>	b <sub>2</sub>	b <sub>3</sub>	b <sub>4</sub>	b <sub>5</sub>	
Predicted sign	?	+	+	+	+	-	Adj. R <sup>2</sup>
<i>Value-to-price, pre Reg-SHO</i>							
Coefficient	-0.002	0.003	0.009	0.001	0.033	-0.066	0.185
t-statistic	[-1.79]	[5.14]	[16.03]	[2.83]	[8.97]	[-3.46]	
<i>Value-to-price, post Reg-SHO</i>							
Coefficient	-0.002	0.005	0.011	0.004	0.023	-0.100	0.249
t-statistic	[-0.63]	[5.43]	[12.92]	[5.95]	[2.53]	[-4.44]	
F-statistic pre = post		4.39 (p=0.036)	3.70 (p=0.054)				
Panel B: Short Interest <sub>it</sub> = b <sub>0</sub> + b <sub>1</sub> Decline <sub>it</sub> + b <sub>2</sub> Decline <sub>it</sub> *LowF <sub>it</sub> + b <sub>3</sub> Decline <sub>it</sub> *HighF <sub>it</sub> + b <sub>4</sub> SzRank <sub>it</sub> + b <sub>5</sub> Institutions <sub>it</sub> + b <sub>6</sub> DivYield <sub>it</sub> + e <sub>t</sub>							
	b <sub>0</sub>	b <sub>1</sub>	b <sub>2</sub>	b <sub>3</sub>	b <sub>4</sub>	b <sub>5</sub>	b <sub>6</sub>
Predicted sign	?	+	+	+	+	-	-
<i>Value-to-price, pre Reg-SHO</i>							
Coefficient	0.001	0.001	0.009	-0.001	0.001	0.033	-0.087
t-statistic	[0.03]	[2.35]	[14.3]	[-2.16]	[2.89]	[8.95]	[-4.01]
<i>Value-to-price, post Reg-SHO</i>							
Coefficient	0.001	0.003	0.007	0.001	0.004	0.022	-0.124
t-statistic	[0.32]	[3.64]	[4.68]	[0.55]	[5.99]	[2.52]	[-5.55]
F-statistic pre = post		4.81 (p=0.028)	2.79 (p=0.095)	1.72 (p=0.189)			

The dependent variable, *Short Interest* is ratio of the number of shares held short divided by the number of shares outstanding. *Decline* is equal to one if the buy and hold return over the prior 12 months ending at the closing price on the prior month is negative and zero otherwise. *LowF* is equal to one if the stock's fundamental-to-price ratio is in the lowest quintile of monthly fundamental-to-price ratios and zero otherwise. The fundamental to price ratios are: book-to-market is the ratio of book-value divided by market value of equity, earnings yield is the ratio of earnings divided by market value of equity, and value-to-price is the ratio of residual income value (using analyst forecasts of earnings when available) divided by market value of equity. Market value is measured using the monthly closing price. We also include controls for the costs associated with short-selling; *SzRank* is the size decile ranking of the stock using NYSE/AMEX/NASDAQ breakpoints, *Institutions* is the number of shares owned by institutions (according to 13-F filings) divided by the number of shares outstanding, *DivYield* is the prior annual amount of common dividends per share paid (excluding preference shares and other disbursements) divided by the prior month closing price per share. The *t*-statistics [in brackets] are corrected for firm and time-series clustering following the method in Petersen (2008). Observations are measured monthly, with the number of firm-month observations, pre-SHO  $N = 295,345$ , and post-SHO  $N = 266,963$ . The sample period is from 1995 to 2008, we include all firms with available data listed on the NASDAQ, and NYSE/AMEX.