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Does Short Selling Amplify Price Declines or Align Stocks with Their Fundamental Values?

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Critics of short selling argue that short sellers amplify price declines by targeting firms with falling prices in an unwarranted manner. Contrary to this viewpoint, we find that increases in short interest for firms following a price decline are associated with measures of overpricing based on financial statement analysis. Our results extend to short-selling activity following marketwide declines. We also find evidence consistent with the profitability of short selling following price declines being driven by valuation-based positions. Overall, our findings suggest short sellers primarily undertake valuation-based strategies following price declines and have implications for regulators. Limiting short selling following price declines is likely to impede efficient price discovery.

Keywords: short selling; price declines; fundamental analysis; market regulation

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1. Introduction

Regulators and academics generally agree that, when prices are rising, the activities of short sellers are beneficial to the economy. Short sellers are viewed as sophisticated investors who enhance market efficiency by targeting overpriced firms. When prices are declining, however, the activities of short sellers are highly controversial, and they are often blamed for amplifying price declines and targeting firms in an unwarranted manner. Across the world regulators have taken measures to limit the activities of short sellers when prices are falling. For example, the Securities and Exchange Commission (SEC) issued a temporary ban on the short selling of 799 financial firms in 2008 (from September 17 to October 8) in response to the sharp price declines in many financial firms. More recently, in 2010 the SEC revised Regulation SHO, exhibiting ongoing concern about the activities of short sellers when prices are declining. The revision restricts short-selling activity if a firm's price declines by 10% or more in a single trading day.¹ In sum, regulators are actively concerned with the positions of short sellers in firms following price declines.

An important issue is whether the strategies of short sellers enhance market efficiency. Prior research provides evidence of at least two non-mutually exclusive strategies that short sellers follow: momentum-based and valuation-based. As evidence of momentum-based positions, Lamont and Stein (2004) find that aggregate short interest for the NASDAQ increased sharply in the month following the 2001 market crash, Savor and Gamboa-Cavazos (2011) find that short sellers target firms following individual price declines, and Blau et al. (2012) find greater short selling increases following large declines in the S&P 500 than following large increases in the S&P 500. As evidence of valuation-based positions, Dechow et al. (2001) find that short interest is concentrated in firms with low fundamentals-to-price ratios, Drake et al. (2011) find that short sellers often trade opposite to analysts' optimistic recommendations, and Christensen et al. (2014) find that short sellers often trade opposite to potentially misleading optimistic pro forma disclosures. In sum, prior literature has generally considered momentum-based and valuation-based strategies as independent, providing evidence of both strategies.

Evidence on whether the strategies taken by short sellers are predominantly momentum-based or valuation-based is important from both academic and regulatory perspectives. First, momentum-based

¹ Specifically, the "circuit breaker" rule limits short sales to prices above the bid for the remainder of the day and the following day when prices decline by 10% from the prior close (Securities and Exchange Commission 2010).

short selling could create unwarranted selling pressure, forcing stock prices below fundamental values (see Allen and Gale 1992, Jarrow 1992, and Goldstein and Guembel 2008).² In contrast, valuation-based short selling targets overpriced stock facilitating the alignment of stock prices with fundamental values. Among momentum-based short positions, however, some positions will be valuation-based short selling, targeting overpriced stock in the process of declining to fundamental value. Abreu and Brunnermeier (2002) argue that because short selling is risky and costly, short sellers may delay taking valuation-based strategies until overpriced firms are expected to decline, which suggests that valuation-based short-selling activity is expected to increase following a price decline.

Second, the activities of short sellers following marketwide declines are extremely controversial. During these periods, instead of relying on evidence that short sellers typically undertake valuation-based strategies, regulators appear especially concerned about momentum-based short selling. For example, the SEC raised concerns that the activities of short sellers appear to be associated with “sudden unexplained price declines in the prices of securities” and that “[s]uch price declines can give rise to questions about the underlying financial condition of an issuer, which can in turn create a crisis of confidence without a fundamental underlying basis” (Securities and Exchange Commission 2008, p. 1). Practitioners, however, argue that prior to market declines, and especially during periods of strong market price increases, short selling is prohibitively expensive due to unfounded optimism sustaining overpricing,³ which suggests short-selling activity targeting overpriced stock could increase following market declines.

Thus, it is difficult to draw unambiguous inferences on the dominant role of short sellers by observing their activity following price declines alone, because either momentum-based or valuation-based strategies can lead to an increase in short selling following price declines. We contribute to the debate on the role of short selling following price declines by exploring whether the positions of short sellers in firms with prior price declines are explained by financial

statement analysis, allowing us to provide new empirical evidence on the role of short sellers in firms with price declines.

We examine the positions of short sellers over the period 1995–2011, a period that spans both significant regulatory change and the recent financial crisis. We find that the level of short interest is significantly higher for firms with prior price declines, a result consistent with short sellers undertaking significant momentum-based positions.⁴ We next examine whether, among firms with prior price declines, short sellers’ positions are concentrated in firms with valuation-based signals. We find evidence suggesting that short interest following a price decline is concentrated in firms with low fundamentals-to-price ratios (Dechow et al. 2001), high accruals (Sloan 1996), and high asset growth (Cooper et al. 2008).

Because the level of short interest may include open positions taken prior to the price decline, we next examine changes in short interest over the same 12 months as the price decline, as well as the 12 months following the price decline. We find that short-interest positions taken as prices are declining are concentrated in firms which appear overpriced. We also find that increases in short interest that occur as a firm’s price is declining are 3 to 10 times larger for firms that appear overpriced than other firms with a price decline. Following a price decline, we find that short-interest increases are valuation-based on average, with systematic decreases in momentum-based positions. Our results suggest that short sellers use price declines to minimize trading costs when targeting overpriced stock rather than targeting price declines on an unwarranted basis.

We next investigate the how the profitability of short-selling positions varies across firms experiencing a price decline. We find that valuation-based positions are associated with negative future market-adjusted returns, whereas other positions are associated with positive market-adjusted returns. These results are consistent with short sellers’ profitability being linked to their ability to analyze financial statement information rather than to trade on momentum. We finally examine momentum-based and valuation-based targets of short sellers following marketwide

² Anecdotally, it is those companies experiencing significant price declines that claim short sellers are manipulative. For example, Patrick Byrne of Overstock.com openly criticized short sellers taking positions in his company’s stock following significant price declines (see Byrne 2006, 2013). Lamont (2012), Leinweber and Madhavan (2001), and Karpoff and Lou (2010) provide additional cases of short sellers engaging in manipulative practices.

³ Asquith et al. (2005) document a significant reduction in the 99th percentile of short interest during 1999–2000. Chancellor (2001) and O’Neil (2005) provide anecdotal examples of short-only hedge funds closing during the late 1990s, citing a lack of trading opportunities due to overoptimism.

⁴ Consistent with much prior research, we examine short sellers’ aggregate holdings because short sellers’ trading activity is not directly observable. Our primary signals are annual, including price declines, which are based on cumulative price declines over the prior 12 months. Given the well-documented predictive ability of prior longer-term returns for future returns (Jegadeesh and Titman 1993) and the punitive nature of sustained unwarranted price declines, this setting provides a natural starting point for investigating the role of valuation-based explanations for short-selling activity in stocks with declining prices. Our results must be interpreted conditional on our data limitations and research design choices, which we discuss and explore in our robustness analysis.

declines (defined as negative returns on the S&P 500 in the preceding month), but do not find any compelling evidence of increases in momentum-based short selling.

Our paper contributes to the literature in the following three ways. First, prior research finds conflicting evidence when examining the targets of short sellers as they appear to target firms based on both momentum-based and valuation-based strategies. We find that when prices are declining, which on the surface appears to be a momentum-based strategy, increases in short interest are concentrated in firms identified as overpriced based on financial statement analysis, a (lower cost) valuation-based strategy. Regulators should be interested in this result given the ongoing concern about short sellers in firms with declining prices. Second, we contribute to the understanding of the sophistication of short sellers. Prior results suggest that short sellers' sophistication stems from their ability to analyze financial statements and to execute valuation-based strategies. Our results suggest that short sellers likely implement many of these strategies with a delay, waiting until the price is declining to minimize holding costs. Our finding that short sellers appear to deliberately delay the implementation of valuation-based strategies contributes empirical evidence on why some stocks may appear overpriced for extended periods of time. Third, we find that market crashes do not appear to systematically affect the targets of short sellers, on average. Regulators should be interested in this result because restrictions to short selling have been implemented following market declines. These regulations are likely to be dull instruments in preventing prices from falling below their fundamental values, and instead may even impede efficient price discovery for firms trading above their fundamental values.

2. Related Research and Predictions

2.1. Background

A short sale is the sale of a stock that the investor does not own. Short selling can be profitable if the price of the firm declines following the short sale but unprofitable if the price of the firm increases. Typically short sellers locate the parties willing to lend them the stock they intend to sell short before selling shares. A short position taken before locating the borrowable shares is called a naked short position. Taking a short position is more heavily regulated than taking a long position.⁵ A large literature in economics,

finance, and accounting suggests that short sellers are sophisticated investors, because their positions are associated with low future returns (see, e.g., Boehmer et al. 2008). In general, regulators agree that short sellers enhance market efficiency when prices are rising, but this view does not extend to settings where prices are falling. For example, (i) in 2008, regulators in the United States, the United Kingdom, Europe, Australia, and Asia directly intervened in the market by preventing short sellers from targeting financial firms; (ii) the SEC revised Regulation SHO in 2010 to restrict short selling from securities that drop 10% from the prior closing price; and (iii) in 2012, regulators in Spain and Italy reinstated short-selling bans following significant market declines in those countries. In sum, regulators are actively concerned with the positions of short sellers in firms following price declines, both at the firm level and at the marketwide level.

Like the recent regulatory period, a common historical theme is that regulation over short selling is introduced following marketwide declines that follow significant bull markets. Many lament that those responsible for driving up prices do not share in the blame for these periods of increased volatility (Chancellor 2001). Bernard Baruch articulated this view in his criticism of short-selling restrictions before the Committee on Rules and the House of Representatives in 1917, where he stated that "bears can only make money if the bulls push up firms to where they are overpriced and unsound" (Chancellor 2001).

2.2. Related Literature

Several studies find evidence that short sellers target firms with recent price declines, consistent with momentum-based strategies. 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. Using a cross-sectional sample of monthly short interest, Savor and Gamboa-Covazos (2011) find that short sellers increase their holdings following prior month price declines. Blau et al. (2012) find that short sellers increase their positions in firms on days with extreme price declines, but that they do not appear to anticipate these extreme price declines on the prior day.

There is also evidence, in the full cross section of firms, of valuation-based short selling. For example, Dechow et al. (2001) find that short interest is concentrated in firms with low fundamentals-to-price ratios (i.e., overpriced relative to their fundamentals) and that short sellers appear to take strategies that minimize trading costs. Their evidence is consistent with sophisticated short sellers undertaking a valuation-based strategy as they target overpriced firms based on the use of financial statements.

⁵ For a historical review of short-selling regulation in the United States, see Taulli (2004), Chancellor (2001), and Jones and Lamont (2002); for a review of differences in the regulatory constraints worldwide, see Bris et al. (2007).

Short sellers also appear to refine their valuation-based strategies through a sophisticated use of forecast information. For example, Drake et al. (2011) find that short sellers' positions are at odds with analysts' optimistic recommendations, and Christensen et al. (2014) suggest that short sellers target firms with potentially misleading pro forma disclosures. Evidence is mixed on whether short sellers are sophisticated users of related valuation-based strategies such as trading on high accruals. Hirshleifer et al. (2011) find evidence of a positive association between short interest and accruals, with a concentration in the highest accrual decile, whereas Richardson (2003) does not find reliable evidence of short sellers targeting high-accrual firms. Perhaps one reason for these conflicting results is that earlier samples predate the original publication of the accrual anomaly by Sloan (1996).

Overall there is strong evidence of valuation-based trading in the full cross section, but these firms generally have experienced price *increases*, contributing to their overvaluation. Thus, it is important to determine whether valuation-based trading is a prevalent strategy within firms experiencing price declines.

2.3. Empirical Predictions

We expect short interest to be positively associated with prior price declines. The positive association could be due to either momentum-based strategies aimed at profiting from the amplification of a price decline, or valuation-based strategies aimed at minimizing trading costs when targeting overpriced firms. In the cross section, both of these strategies will lead to a positive association between short interest and prior price declines. Stated formally as a hypothesis:

HYPOTHESIS 1. Short interest is positively associated with prior price declines.

Hypothesis 1 suggests that short sellers target firms with prior price declines; however, it does not provide evidence on the dominant strategies used by short sellers. Among the targets of short sellers momentum-based strategies, some firms are expected to be targeted as part of a valuation-based strategy aimed at minimizing trading costs. Specifically, to profit from shorting an overpriced firm as it declines to its fundamental value, short sellers must identify a firm that appears to be sufficiently overpriced *ex ante* to profit net of expected trading costs (Dechow et al. 2001). Abreu and Brunnermeier (2002) suggest that for sophisticated arbitrageurs, trading costs include both holding costs and the risk that the target overpriced firm will not converge to its fundamental value. For example, margin requirements (i.e., holding costs) on a short position are lower when the firm price is decreasing. If valuation-based short selling is the dominant strategy taken by short sellers

in firms with price declines, we expect that short interest will be concentrated in overpriced firms (i.e., low fundamentals-to-price ratios, high accruals or high asset growth) consistent with a valuation-based strategy aimed at minimizing holding costs (which are smaller for firms with falling firm prices).⁶ Conversely, if unwarranted short-selling activity is the dominant strategy taken by short sellers in firms with price declines, then we do not expect short interest will be concentrated in overpriced firms. Formally as a hypothesis in the alternative form:

HYPOTHESIS 2. Short interest in firms following price declines is concentrated in overpriced firms.

3. Sample and Measurement of Variables

3.1. Sample

We use 576,640 firm-month observations of common stock (share codes 10 and 11) listed on the NASDAQ, New York Stock Exchange (NYSE), and American Stock Exchange (AMEX) (exchange codes 1, 2, or 3) over the period 1995–2011, with data available on the main variables used in our study. Specifically, all observations are required to have data available on the number of shares shorted as a percentage of shares outstanding, the variables required to compute the fundamentals-to-price ratios, accruals, asset growth, and the 12 month prior market return. We collect financial variables, market prices, and returns from the intersection of the Compustat Xpressfeed and the Center for Research in Security Prices (CRSP) monthly databases.

3.2. Measurement of Short interest

We collect short-interest data prior to 2003 from the NASDAQ and the NYSE and after 2003 from Compustat's Supplemental Short Interest file.⁷ For NYSE firms, short interest for the month is required to be reported in the third week of the month (usually within the 17th to the 20th day of the month) and becomes publicly available within two to three days. For NASDAQ listed firms, short interest is required to be reported on the 15th day of the month (or if the 15th is not a business day, the preceding business day) and becomes publicly available on the eighth subsequent business day.⁸ We deflate the raw short

⁶ Although we motivate our second hypothesis using holding costs, other costs such as the rebate rate also affect short sellers' positions (D'Avolio 2002). Data are not available, however, to directly investigate these different costs in large samples.

⁷ Compustat has limited coverage of short interest in years prior to 2003.

⁸ From October 2007, the exchanges began reporting the data twice a month, we use the "A-series" because it is the most similar to our earlier data sources.

interest by the CRSP number of shares outstanding at the end of the month to obtain a percentage measure.⁹ Because the level of short interest is defined as a percentage, we calculate the change in short interest as the simple change in this percentage.¹⁰ We match short interest for each month t , with one-month lagged financial statement signals, prior return variables, and control 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.¹¹ We lag the return one month relative to the measurement of the short-interest data (i.e., over the 12 month period $t - 13$ to $t - 1$). We use this return period to measure price declines because price declines measured over medium term periods (3, 6, 9, and 12 months) tend to predict additional price declines (Jegadeesh and Titman 1993), whereas shorter holding periods such as a week or a month tend to reverse (Jegadeesh 1990, Lehmann 1990).¹²

3.4. Measurement of Fundamentals-to-Price Ratios

We expect short sellers to target firms with low fundamentals-to-price ratios. Following Dechow et al. (2001) we consider three ratios: book-to-market, earnings yield, and value-to-price, where value is measured using the residual income model (Ohlson 1995). Specifically, we use the following one-period residual income model:

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

⁹ 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.

¹⁰ Our results are also robust to various measures of unusually high levels of short interest, because typical levels of short interest could be due to activities that are not related to valuation-based or momentum-based trading, such as hedging (Dechow et al. 2001, Asquith et al. 2005).

¹¹ 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.

¹² Although a short sale is only profitable when the price of the stock declines, short-selling stocks with (abnormally) low returns can contribute to a profitable hedge strategy. In additional analysis not tabulated here, we find similar results when examining the association between short interest and stocks in the lowest decile of prior returns, or “loser” momentum stocks.

where r is the one-year constant yield-to-maturity Treasury bond rate plus an equity premium of 6%, and we set g equal to 3%.¹³ Book value, b_t , is the end of year book value from the most recent fiscal year end, $f(1)$ is the mean one-year forecast of earnings per share inflated to firm-level earnings by multiplying it by the I/B/E/S (Institutional Brokers’ Estimates System) number of shares outstanding.¹⁴ When the second term (residual income) in Equation (1) is negative, we assume that it is equal to 0 (hence value equals book value). We use Compustat Xpressfeed item CEQ (legacy data item #60) in the market-to-book ratio and Compustat Xpressfeed item IB (legacy data item #18) in the earnings yield ratio. We form ratios by dividing these accounting variables by the month end market value of equity on CRSP.

3.5. Measurement of Accruals

We expect short sellers to target firms with high accruals because Sloan (1996) finds that high accruals are associated with low future returns. We measure accruals using the cash-flow approach following Hribar and Collins (2002), who find that balance sheet accruals as defined by Sloan (1996) can be affected by acquisitions and other nonarticulating events. Hribar and Collins (2002) measure accruals as the difference between income and cash flows from operations on the statement of cash flows. Specifically, we take the difference between income before discontinued operations and extraordinary items (Xpressfeed item IBC, legacy data item #123) and the sum of cash flows from discontinued operations and extraordinary items (Xpressfeed item XIDOC, legacy data item #124) and net cash flow from operating activities (Xpressfeed item OANCF, legacy data item #308), all scaled by average *Total assets* (Xpressfeed item AT, legacy data item #6).¹⁵

¹³ Our results are quantitatively similar for values of the equity premium ranging from 0% to 12% (not tabulated). Because changing the forecast horizon, as in Lee et al. (1999) and Frankel and Lee (1998), requires assumptions regarding payout policy (Dechow et al. 1999), we present a parsimonious one-period model in our main analysis. We find similar results when implementing longer-horizon models (not tabulated).

¹⁴ 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 (not tabulated). Because Gode and Mohanram (2008) provide evidence of valuation model bias when using analyst forecasts, we examine a residual income model that does not use analyst forecasts, but instead the most recent historical earnings. Our results are similar when we use this alternative measure of residual income (not tabulated).

¹⁵ Our results are similar when we use the balance sheet measure of accruals following Sloan (1996) (not tabulated).

3.6. Measurement of Asset Growth

We measure asset growth following the approach in Cooper et al. (2008) as follows:

$$AssetGrowth_t = \frac{TotalAssets_{t-1} - TotalAssets_{t-2}}{TotalAssets_{t-2}}, \quad (2)$$

where *TotalAssets* is Compustat Xpressfeed item AT (legacy data item #6). Asset growth measures the year-on-year percentage change in total assets. We expect short sellers to target firms with high asset growth because Cooper et al. (2008) find high asset growth is associated with low future returns.

3.7. Measurement of Transaction Cost Variables

In our multivariate tests, we also include controls for transaction costs associated with short selling (Dechow et al. 2001, p. 93). We include the dividend yield because dividends must be paid by the short seller out of their own capital (D'Avolio 2002). We measure dividend yield, $DivP_{it}$, using the most recent prior annual dividend amount). We include a control for firm size and the percentage of institutional holdings because prior research suggests that these characteristics affect the supply of shares available to be shorted (Geczy et al. 2002, Asquith et al. 2005). We measure firm size ($SzRank_{it}$) based on the within sample rank of market value of equity at time t , and the percentage of institutional holdings

($InstHold_{it}$) as the sum of the institutional holdings in the firm from the Thomson Reuters Institutional (13f) Holdings database divided by the CRSP number of shares outstanding. Since the institutional holdings are reported quarterly, we use the same percentage for all months in the quarter. To be consistent with the financial statement signals and prior returns, we lag the institutional holdings variable by one month relative to the measurement of short interest.

4. Empirical Analysis

4.1. Descriptive Statistics

In Table 1, we report the means for the main variables used in our analysis. We report our descriptive statistics for all firms in column (1), separately for firms with prior price increases and declines in columns (2) and (3), and for each of the short-interest quintiles where firms in Q1 (Q5) have the lowest (highest) level of short interest in columns (4)–(8). In column (1), the average short interest for all firms in the sample is 3.645%. Comparing columns (2) and (3), firms with prior price declines have significantly higher levels of short interest at 3.867% than firms with prior price increases at 3.464%. We also report the means of the financial statement signals used in this study to identify over- and underpriced firms. Comparing columns (2) and (3), firms with prior price declines tend to have higher book-to-market and

Table 1 Descriptive Statistics on the Relation Between Short Positions with Prior Returns and Fundamentals-to-Price Ratios

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	All firms	Increase	Decline	Q1 (low)	Q2	Q3	Q4	Q5 (high)
Short interest	3.645	3.464	3.867	0.080	0.764	2.132	4.068	11.182
Prior return	0.175	0.566	−0.307	0.098	0.162	0.193	0.209	0.212
Decline	0.448	0.000	1.000	0.502	0.438	0.405	0.422	0.474
Book-to-market	0.717	0.522	0.958	1.123	0.734	0.597	0.569	0.564
Earnings yield	−0.087	0.001	−0.195	−0.151	−0.117	−0.032	−0.033	−0.101
Value-to-price	1.140	0.933	1.394	1.504	1.170	1.028	1.023	0.975
Accruals	−0.063	−0.060	−0.065	−0.064	−0.066	−0.061	−0.060	−0.062
Asset growth	0.172	0.152	0.196	0.099	0.142	0.157	0.181	0.280
Dividend yield	0.513	0.543	0.475	0.225	0.430	0.565	0.641	0.702
Market value	3,354	4,281	2,213	492	7,045	4,828	2,758	1642
Institutional holdings	0.012	0.010	0.015	0.013	0.013	0.012	0.012	0.010
Change in short interest	0.196	0.501	−0.191	0.442	0.753	0.750	0.516	−1.454
Market-adjusted return	0.051	0.022	0.087	0.096	0.068	0.043	0.033	0.018

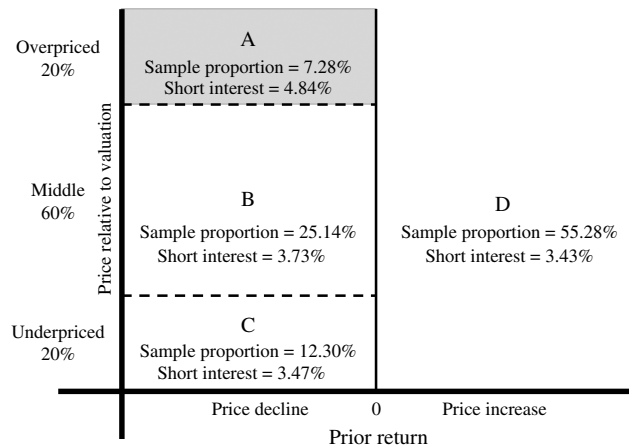
Notes. We define *short interest* as the number of shares held short divided by the number of shares outstanding from CRSP; *prior return* is the buy-and-hold return excluding dividends over the prior 12 months ending at the closing price of the month prior to the measurement of the short position; *decline* is equal to 1 if prior return is negative and 0 otherwise. We define *book-to-market* as the ratio of book value divided by the monthly closing price, *earnings yield* as earnings before extraordinary items divided by market value of equity using month-end closing prices, and *value-to-price* as the ratio of fundamental value-to-price measured using the residual income model with analyst forecasts of earnings divided by market value of equity using month-end closing prices. *Accruals* are income before discontinued operations and extraordinary items less net cash flow from operating activities plus net cash flows to discontinued operations and extraordinary items divided by lagged total assets. *Asset growth* is the percentage change in total assets over the prior year. We define *dividend yield* as 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, *market value* as the product of CRSP shares outstanding and CRSP price per share, and *institutional holdings* as the number of shares owned by institutions (according to 13-F filings) divided by the number of CRSP shares outstanding. *Change in short interest* is the difference between short interest at time t less the 12-month lagged short interest. *Market-adjusted return* is the future 12 month buy and hold return for firm i less the buy and hold return on the S&P 500. We use 576,640 firm-month observations.

value-to-price ratios and lower accruals than firms with prior price increases (i.e., they are not overpriced on average). Firms with prior price declines have negative earnings yields, on average, consistent with firms in the price decline sample making accounting losses. The change in short interest suggests increasing positions in price increases, and unwinding positions in price declines, which is inconsistent with a critical view of momentum-based trading. These results confirm that momentum-based and valuation-based strategies are distinct strategies that occasionally overlap. Hence, given the characteristics of the firms experiencing price declines, random positions taken by short sellers should occur more frequently within underpriced firms, not overpriced firms. Our Hypothesis 2, however, predicts a concentration of short interest in overpriced firms.

Turning to columns (4)–(8), similar to Dechow et al. (2001) and Drake et al. (2011), some firms have a very large proportion of their shares outstanding held short; for example, the highest quintile of short interest, reported in column (8), has an average level of short interest equal to 11.182% of shares outstanding. The mean prior returns for firms with low levels of short interest tend to be lower than the prior returns of firms with high levels of short interest. This suggests that, on average, the short sellers target firms with prior price increases. On the surface, this trend seems 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 firms with the highest level of short interest have the highest proportion of firms with prior price declines (at 47.4%). Similar to Dechow et al. (2001), we find a negative association between short interest and fundamentals-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. The proxies for transactions costs are also consistent with prior research, with high levels of short interest in larger firms with higher institutional holdings. Future changes in short interest suggest that short interest is decreasing following a price decline, and for the highest quintile of short interest, and future market-adjusted returns are lowest for firms with the highest level of short interest.

We summarize our hypotheses in Figure 1. We split firms into four categories, those with price increases (which make up 55.28% of the sample), and then within the 44.72% of firms with price declines, we identify overpriced firms (7.28% of the sample), firms in the “middle” of the valuation distribution (25.14% of the sample), and underpriced firms (12.30% of the sample). Because we sort firms on their price relative to valuation for the entire sample, cell sizes are not expected to be equal. We find that short interest is

Figure 1 Average Short Interest for Firms with Price Declines by Level of Mispricing



Notes. The horizontal axis describes how short-selling strategies are expected to relate to momentum-based strategies. The vertical axis describes how short-selling strategies are expected to relate to valuation-based strategies. All positions left of the vertical axis have a prior return less than zero, and are considered as momentum-based strategies. Hypothesis 1 predicts greater short selling in momentum-based strategies, that is, the average of $(A + B + C) > D$. Hypothesis 2 predicts that within momentum-based strategies, there will be greater short selling in valuation-based strategies, that is, the average of $A > (B + C)$. We report the proportion of firms in each of the four cells along with the average short interest for each of the four cells. Cell sizes are not expected to be equal because firms are sorted into overpriced, middle, and underpriced groups using both price decline and price increase firms. We use 576,640 firm-month observations with data available on both the number of shares shorted as a percentage of shares outstanding, the variables required to compute the fundamentals-to-price ratios, accruals, asset growth, and the 12-month prior market return.

higher for all groups with price declines than for firms with price increases. Whereas we find that overpriced firms are underrepresented in the decline sample and underpriced firms are overrepresented,¹⁶ short interest is highest for the overpriced firms (short interest = 4.84%). Because there are fewer targets available to short sellers that are both overpriced and have a price decline, our results suggest that short sellers actively target these firms. These unconditional means are also consistent with the predictions in Hypotheses 1 and 2; however, multivariate tests are required to control for the costs of short selling.

4.2. Test of Hypothesis 1

Our initial hypothesis posits that short sellers target firms with prior price declines. To test this prediction, 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 firms which

¹⁶ If overpriced and underpriced were expected to be equal for the price decline firms, then the proportion of firms in each of these cells would be equal to 8.94% (20% times 44.72%).

appear overpriced based on financial statement analysis. In our first model, we examine the level of short interest:

$$SI_{it} = b_0 + b_1 \text{Overpriced}_{it} + b_2 \text{Decline}_{it-12} + b_3 \text{DivP}_{it} + b_4 \text{SzRank}_{it} + b_5 \text{InstHold}_{it} + e_{it}, \quad (3)$$

where SI_{it} is the level of shares held short reported in month t divided by the CRSP shares outstanding in month t . We define our independent variables as follows: Overpriced_{it} refers to signals of overpricing based on financial statement analysis. For the fundamentals-to-price ratios (book-to-market, earnings yield, value-to-price), Overpriced_{it} equals 1 if the firm is in the lowest quintile of the fundamentals-to-price ratio (i.e., overpriced relative to fundamental value) and 0 otherwise; for accruals and asset growth, Overpriced_{it} equals 1 if the firm is in the highest quintile of accruals and asset growth and 0 otherwise. Our variable of interest in Hypothesis 1, 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.¹⁷ Following Dechow et al. (2001, p. 93), we include DivP_{it} , SzRank_{it} , and InstHold_{it} to proxy for expected costs of short selling.

In this and all subsequent tests, we estimate ordinary least squares (OLS) regressions with robust standard errors based on the evidence in Gow et al. (2010).¹⁸ We cluster our standard errors by firm (using CRSP Permno) and time (at the monthly frequency) and include year fixed effects because of the upward trend in the level of short interest over time. This method is more appropriate than the Fama and MacBeth (1973) approach because there is significant time-series dependence due to firm-level short interest being highly persistent (e.g., Pownall and Simko 2005), and cross-sectional dependence due to general market conditions influencing the overall level of short interest, and there is evidence of a trend in the level of short selling, which has increased over time.

The results in Table 2 are consistent with Hypothesis 1, that short sellers are positioned in firms with

prior price declines. The coefficient on Decline_{it-12} is positive and significant in the three specifications of the model that use the different fundamentals-to-price ratios and for accruals and asset growth. For example, in the book-to-market regression, the coefficient on Decline_{it-12} is 0.782 with a t -statistic of 13.83 ($p < 0.001$). This implies that when controlling for other factors expected to influence the level of short interest, firms with prior price declines have an average short-interest level that is 0.782% higher than that of firms with price increases. Consistent with Dechow et al. (2001) and Drake et al. (2011), we find evidence of valuation-based short selling with a significant positive association between the level of short interest and financial statement signals of overpricing. For example, in the book-to-market specification, Overpriced_{it} , is 1.357 with a t -statistic of 12.78 ($p < 0.001$), suggesting that firms with low book-to-market ratios have a 1.357% higher level of short interest on average.

4.3. Tests of Hypothesis 2

4.3.1. Concentration of Valuation-Based Trades in Level of Short interest. In this section, we investigate Hypothesis 2 by examining the level of short interest for the subsample of firms following a price decline. In Table 3, we include signals of underpricing and overpricing based on financial statement information. If valuation-based short selling is prevalent among firms with prior price declines, then we expect signals of overpricing to be significantly positively associated with the level of short interest (i.e., $A > B + C$ in Figure 1). We also include an indicator for signals of underpricing as a proxy for strategies that amplify price declines below fundamentals, or potentially predatory short selling. Specifically, we examine the following model:

$$SI_{it} = b_0 + b_1 \text{Overpriced}_{it} + b_2 \text{Underpriced}_{it} + b_3 \text{DivP}_{it} + b_4 \text{SzRank}_{it} + b_5 \text{InstHold}_{it} + e_{it}, \quad (4)$$

where Underpriced_{it} equals 1 if the firm is in the highest quintile of the fundamentals-to-price ratio (i.e., underpriced relative to fundamental value) and 0 otherwise; for accruals and asset growth, Underpriced_{it} equals 1 if the firm is in the lowest quintile of accruals and asset growth and 0 otherwise. This model is one of three empirical tests that jointly speak to Hypothesis 2. Evidence of a significantly positive coefficient on Overpriced_{it} , b_1 , is consistent with the holding cost prediction and supports the existence of valuation-based positions. Evidence of a significantly positive coefficient on Underpriced_{it} , b_2 , is consistent with the critics' view of short sellers, providing potential evidence of predatory positions.

We report results in Table 3. We find that short interest is associated with both Overpriced_{it} and Underpriced_{it} in all specifications except for the

¹⁷ We also examined an indicator variable that equals 1 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 loser-momentum stock). In general, the results are qualitatively similar to our price decline indicator. In particular, an indicator variable for the lowest quintile of buy and hold returns is significantly and positively associated with short interest. However, when we use loser momentum (which identifies 20% of firms), we cover fewer firms in the cross section with overlapping signals based on fundamental analysis (relative to around 40% with price declines).

¹⁸ We also estimated the standard errors clustered by firm only, finding similar results at conventional significance thresholds (i.e., $p < 0.05$). In some cases, however, the magnitudes of the t -statistics are inflated by a factor of 2 or more, consistent with the need to correct for both time-series dependence and cross-sectional dependence.

Table 2 Analysis of the Relation Between the Level of Short interest with Price Declines and Fundamental Analysis

	$SI_{it} = b_0 + b_1 \text{Overpriced}_{it} + b_2 \text{Decline}_{it-12} + b_3 \text{DivP}_{it} + b_4 \text{SzRank}_{it} + b_5 \text{InstHold}_{it} + e_{it}$						Adj. R^2 (%)	N
	b_0	b_1	b_2	b_3	b_4	b_5		
Prediction	?	+	+	—	+	+		
Book-to-market								
Coefficient	−1.673*	1.357*	0.782*	0.337	−0.101*	7.35*		
<i>t</i> -statistic	[−11.31]	[12.78]	[13.83]	[0.96]	[−3.55]	[17.90]	17.50	576,640
Earnings yield								
Coefficient	−1.779*	0.762*	0.586*	0.126	−0.027	7.253*		
<i>t</i> -statistic	[−10.88]	[6.93]	[10.65]	[0.39]	[−0.90]	[17.70]	16.99	576,640
Value-to-price								
Coefficient	−1.904*	1.583*	0.765*	0.518	−0.062*	7.382*		
<i>t</i> -statistic	[−12.48]	[16.31]	[13.66]	[1.31]	[−2.24]	[18.16]	17.81	576,640
Accruals								
Coefficient	−1.657*	0.651*	0.63*	0.09	−0.051	7.237*		
<i>t</i> -statistic	[−11.65]	[7.88]	[11.02]	[0.28]	[−1.79]	[17.58]	16.95	576,640
Asset growth								
Coefficient	−1.714*	1.572*	0.588*	0.403	−0.069*	7.155*		
<i>t</i> -statistic	[−11.79]	[21.16]	[10.31]	[1.10]	[−2.49]	[17.59]	17.81	576,640

Notes. We define the dependent variable, SI_{it} , as the level of shares held short reported in month t divided by the CRSP shares outstanding in month t . We define the independent variable Overpriced_{it} as an indicator variable that equals 1 if the firm is in the lowest quintile of the monthly sorted fundamentals-to-price ratios (book-to-market, earnings yield, value-to-price) or is in the highest quintile of accruals and asset growth, and 0 otherwise. 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. We also include controls for the expected costs of short selling. We define DivP_{it} as the most recent annual dividend divided by price, SzRank_{it} as the within-sample rank of market value of equity at time t , and InstHold_{it} as the number of shares held by institutions divided by the number of shares outstanding. We correct t -statistics (in brackets) for firm and time clustering (see Petersen 2009, Gow et al. 2010), and we include year fixed effects in all specifications. We measure short interest monthly from 1995 to 2011 with available data listed on the NASDAQ and NYSE/AMEX.

* $p < 0.05$.

book-to-price specification. In other words, we find evidence of both valuation-based, and potentially predatory, positions. We first investigate which is the dominant strategy by examining the relative magnitude of the two coefficients. In all cases the coefficient, b_1 , on Overpriced_{it} is greater than the coefficient, b_2 , on Underpriced_{it} , suggesting that the dominant role of short sellers in firms following price declines is to target overpriced firms. For example, in the value-to-price specification, the coefficient $b_1 = 2.216$, whereas the coefficient $b_2 = 1.089$. Excluding the earnings yield and accrual specifications, we also confirm that the coefficients on Overpriced_{it} are statistically greater than the coefficients on Underpriced_{it} .¹⁹ For example, the difference between Overpriced_{it} is statistically greater than the coefficient on Underpriced_{it} in the value-to-price specification with $t = 5.24$ ($p = 0.022$). For the earnings yield and accrual specifications, the signals of Overpriced_{it} have greater coefficients than those on Underpriced_{it} , but these differences are not statistically significant at conventional levels.²⁰

¹⁹ We use pooled data to estimate

$$t = \frac{b_1 - b_2}{\sqrt{\text{var}(b_1) + \text{var}(b_2) - 2\text{cov}(b_1, b_2)}}$$

using the corrected covariance matrix from the two-way clustered robust regression (see Gujarati 1995, p. 254).

²⁰ Our results for high-accrual firms differ from those in Richardson (2003) primarily due to the differences in the time periods covered

We next explore the types of firms subject to the potentially predatory positions to investigate whether short sellers target underpriced firms following price declines. It is possible that this association is driven by the underlying firm performance, as low accruals, low asset growth, and high fundamentals-to-price ratios could also indicate poor performance, associated with poor fundamentals and bankruptcy risk. In untabulated analysis, we examine whether Piotroski's (2000) financial statement analysis score helps explain short interest in high fundamentals-to-price ratios, consistent with these short sellers targeting firms with low quality fundamentals.²¹ Excluding the earnings yield, the apparently predatory short

by the two studies. Specifically, our sample covers more time following the publication of Sloan (1996), a period where hedge funds were aware of the accrual anomaly and actively trading on the anomaly (Green et al. 2011). In results not tabulated here, we investigate the early years of our sample, which overlap with Richardson (2003). In these years (especially for 1995, which precedes the publication of Sloan 1996) we find that high-accrual firms are far less consistently targeted by short sellers, consistent with Richardson (2003). These results suggest that short sellers have paid more attention to high-accrual firms since the publication of Sloan (1996).

²¹ Piotroski (2000) provides a nine-point scale to measure the quality of the firms' fundamentals and defines firms that score 0 or 1, as those with low quality fundamentals. We examine only the short interest in stocks with prior price declines and which appear underpriced based on each of our five measures and find that an indicator for low quality fundamentals is positive and significant for all specifications except the earnings yield (not tabulated).

Table 3 Analysis of the Relation Between the Level of Short Interest and Fundamental Analysis for the Sample with Price Declines

	$SI_{it} = b_0 + b_1 \text{Overpriced}_{it} + b_2 \text{Underpriced}_{it} + b_3 \text{DivP}_{it} + b_4 \text{SzRank}_{it} + b_5 \text{InstHold}_{it} + e_{it}$							
	b_0	b_1	b_2	b_3	b_4	b_5	Adj. R^2 (%)	N
Prediction	?	+	—	+	—	+		
Book-to-market								
Coefficient	−1.654*	1.399*	0.471*	0.622	−0.014	7.985*		
<i>t</i> -statistic	[−8.68]	[7.76]	[3.03]	[1.43]	[−0.43]	[16.18]	18.90	257,897
Earnings yield								
Coefficient	−1.911*	0.957*	0.898*	0.566	0.029	7.896*		
<i>t</i> -statistic	[−10.4]	[6.77]	[5.42]	[1.37]	[0.86]	[15.92]	18.97	257,897
Value-to-price								
Coefficient	−1.992*	2.216*	1.089*	0.64	0.016	8.101*		
<i>t</i> -statistic	[−11.07]	[14.42]	[7.10]	[1.44]	[0.52]	[16.45]	19.62	257,897
Accruals								
Coefficient	−1.763*	1.028*	0.712*	0.752	0.002	7.947*		
<i>t</i> -statistic	[−9.82]	[7.70]	[4.83]	[1.53]	[0.06]	[15.97]	18.91	257,897
Asset growth								
Coefficient	−1.716*	1.821*	0.36*	0.801	−0.02	7.973*		
<i>t</i> -statistic	[−9.66]	[16.16]	[2.83]	[1.54]	[−0.60]	[16.06]	19.35	257,897

Notes. This sample is restricted to firms where the buy-and-hold return over the past 12 months is negative. We define the dependent variable, SI_{it} , as the level of shares held short reported in month t divided by the CRSP shares outstanding in month t . We define the independent variables Overpriced_{it} (Underpriced_{it}) as an indicator variable that equals 1 if the firm is in the lowest (highest) quintile of the monthly sorted fundamentals-to-price ratios (book-to-market, earnings yield, value-to-price) or is in the highest (lowest) annually sorted quintile of accruals and asset growth, and 0 otherwise. We also include controls for the expected costs of short selling. We define DivP_{it} as the most recent annual dividend divided by price, SzRank_{it} as the within-sample rank of market value of equity at time t , and InstHold_{it} as the number of shares held by institutions divided by the number of shares outstanding. We correct t -statistics (in brackets) for firm and time clustering (see Petersen 2009, Gow et al. 2010), and we include year fixed effects in all specifications. We measure short interest monthly from 1995 to 2011 with available data listed on the NASDAQ and NYSE/AMEX.

* $p < 0.05$.

positions are positively associated with low Piotroski (2000) scores, suggesting that these positions might not be predatory positions taken in underpriced firms, but based on sophisticated financial statement analysis identifying these firms as having poor fundamentals.

In sum, we find evidence of both valuation-based, and potentially predatory, short-interest positions in firms following price declines. Although the valuation-based positions are significantly larger, on average, than the potentially predatory positions, we next investigate changes in short interest to better assess the dominant strategy of short sellers.

4.3.2. Analysis of Changes in Short interest.

In this section, we investigate changes in short interest measured contemporaneously with the price decline. Our change analysis is important because the level of short interest includes all positions taken prior to a price decline, during a price decline, and following a recent price decline, which have not yet been unwound. Examining contemporaneous changes in short interest allows us to provide evidence on the positions taken during a price decline, which, according to Hypothesis 2, we expect to be incrementally associated with Overpriced_{it} . Because 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. We also include an indicator variable for high levels of short interest at the beginning of the period for which we measure changes in short interest, because these positions are more likely to be unwound. Specifically, we examine the following model:

$$\begin{aligned} \Delta SI_{it} = & b_0 + b_1 \text{Overpriced}_{it} + b_2 \text{Underpriced}_{it} \\ & + b_3 \text{DivP}_{it} + b_4 \text{SzRank}_{it} + b_5 \text{InstHold}_{it} \\ & + b_7 \text{HighSI}_{it-12} + e_{it}, \end{aligned} \quad (5)$$

where $\Delta SI_{it} = SI_{it} - SI_{it-12}$ is the change in the percentage of shares held short, measured monthly, over the prior 12 months, and HighSI_{it-12} equals 1 if firm i is in the top quintile of short interest in month $t - 12$ and 0 otherwise. All remaining variables are as previously defined. We estimate Equation (5), restricting the sample to firms with prior price declines.

Our focus in Table 4 is on the coefficients b_1 and b_2 . The results are generally more consistent with the valuation motivation than with a predatory motivation. Excluding the earnings yield model, we find consistent evidence that short interest increases as prices decline for firms that appear overpriced, but not for firms which appear underpriced. For example, in the accruals specification, the coefficient on Overpriced_{it} is 0.433 with a t -statistic of 6.05 ($p < 0.001$), whereas the

coefficient on $Underpriced_{it}$ is -0.230 with a t -statistic of -3.21 ($p < 0.001$). These results are consistent with short sellers using price declines as a way to minimize trading costs when targeting overpriced firms. We find some evidence consistent with increases in predatory short positions, in the earnings yield and value-to-price specifications; however, for the book-to-market, accruals, and asset growth, our results suggest that the predatory associations we found in levels are likely due to positions taken prior to the price decline.

To summarize our results, although we find that short sellers do take economically and statistically significant positions in firms with prior price declines, our evidence suggests that, on average, these positions are consistent with short sellers targeting overpriced firms. In contrast to these consistent results, we find only and weak inconsistent evidence that short sellers take positions in underpriced firms with prior price declines. Our results also suggest that apparently predatory short selling may reflect positions based on financial statement analysis that target firms with poor fundamentals.

5. Further Analysis

5.1. Further Analysis of Changes in Short Interest Following Price Declines

A related concern of the critics of short sellers is that they amplify price declines. In this section we examine the association between future changes in monthly short interest to focus on the changes in short interest following a price decline. These tests also allow us to investigate whether short sellers appear to unwind positions in firms following price declines or whether they appear to continue to increase their positions in these firms. Specifically, we include indicator variables for both prior price declines (over the period $t - 12, t$) and future price declines (over the period $t, t + 12$) and an indicator variable for future financial statement signals of overpricing (low fundamentals-to-price ratio, high accruals, and high asset growth at time $t + 12$). Our model for the change in short interest is as follows:

$$\begin{aligned} \Delta SI_{it+12} = & b_0 + b_1 Overpriced_{it} + b_2 FutureOverpricing_{it+12} \\ & + b_3 Decline_{it-12} + b_4 FutureDecline_{it+12} \\ & + b_5 DivP_{it} + b_6 SzRank_{it} + b_7 InstHold_{it} \\ & + b_8 HighSI_{it} + e_{it}, \end{aligned} \quad (6)$$

where $\Delta SI_{it+12} = SI_{it+12} - SI_{it}$ is the change in the percentage of shares held short over the subsequent 12 months; $HighSI_{it}$ equals 1 if the firm is in the top quintile of short interest in month t and 0 otherwise; $FutureOverpricing_{it+12}$ refers to the 12 month leading

$Overpriced_{it}$ indicator variable, which represents financial statement signals of overpricing at the end of the 12-month window; $FutureDecline_{it+12}$ is an indicator variable that equals 1 if the buy-and-hold return over the future 12 months is negative and 0 otherwise; and all remaining variables are as defined previously. The coefficients on the future indicator variables can be interpreted as the increase in short interest associated with new information about price declines and financial statement signals of overpricing controlling for the persistence of price declines and financial statement signals of overpricing.

We report these results in Table 5. Our focus is on the coefficient b_3 , which is negative and significant in each of our estimations. Thus, short sellers appear to systematically unwind positions following price declines, inconsistent with the critics' claims that short sellers attempt to amplify price declines. For example, in the value-to-price specification, the coefficient on the indicator variable for the coefficient on $Decline_{it-12}$ is significantly below zero ($-0.301, t = -6.71$). To summarize our results, we do not find any evidence that, on average, short sellers appear to take positions to amplify price declines. Our control variable for the persistence of price declines, $FutureDecline_{it+12}$, is inconsistent in all specifications, whereas the coefficient which controls for the persistence of overpricing, $FutureOverpricing_{it+12}$, is positive and significant in all specifications excluding the earnings yield. Taken together, these results provide further evidence in support of the dominant motive of short selling being valuation motivated.

5.2. Analysis of Future Returns for Firms with High Short Interest

Prior literature documents that short sellers appear to profit from trading in firms that appear to be overpriced using fundamental analysis (Dechow et al. 2001). In this section, we briefly examine whether short sellers appear to profit from the continuation of price declines. Asquith et al. (2005) document negative associations between short interest and future returns only for the portfolio of firms with high levels of short interest, so we focus our analysis on the portfolio of firms in the highest quintile of short interest. This design allows us to examine whether, within this set of firms, short sellers appear to profit from the continuation of prior price declines, or whether they appear to profit from the known association between overpricing based on financial statement information and future returns. In Figure 2, we plot the cumulative market-adjusted buy-and-hold returns using the CRSP value-weighted index (defined as the difference between CRSP variables "ret" and "vwretd") over the 12 months following the formation of high short-interest portfolios with prior

Table 4 Analysis of the Relation Between Contemporaneous Changes in Short interest with Price Declines and Financial Statement Signals

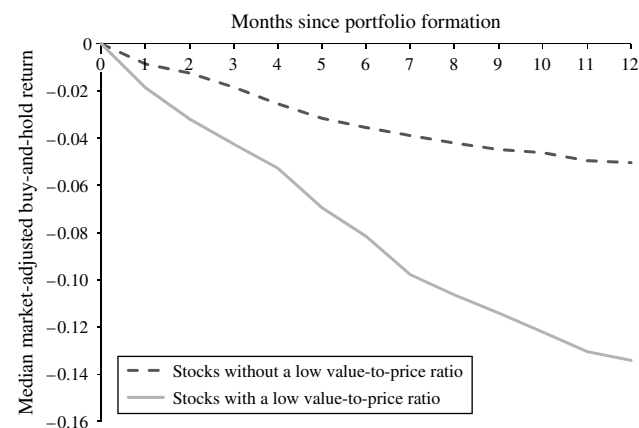
	$\Delta SI_{it} = b_0 + b_1 \text{Overpriced}_{it} + b_2 \text{Underpriced}_{it} + b_3 \text{DivP}_{it} + b_4 \text{SzRank}_{it} + b_5 \text{InstHold}_{it} + b_6 \text{HighSI}_{it-12} + e_{it}$								
	b_0	b_1	b_2	b_3	b_4	b_5	b_6	Adj. R^2 (%)	N
Predictions	?	+	—	?	?	?	—		
Book-to-market									
Coefficient	−1.04*	0.472*	0.104	0.274	0.024	2.841*	−2.541*		
<i>t</i> -statistic	[−5.70]	[5.73]	[1.27]	[0.46]	[1.06]	[9.33]	[−10.99]	8.19	220,778
Earnings yield									
Coefficient	−0.913*	−0.175*	0.303*	0.153	0.024	2.724*	−2.487*		
<i>t</i> -statistic	[−4.80]	[−2.03]	[3.91]	[0.26]	[1.12]	[8.79]	[−10.98]	8.21	220,778
Value-to-price									
Coefficient	−1.140*	0.408*	0.306*	0.213	0.041	2.804*	−2.562*		
<i>t</i> -statistic	[−6.35]	[4.98]	[3.51]	[0.36]	[1.83]	[9.22]	[−11.15]	8.21	220,778
Accruals									
Coefficient	−0.996*	0.433*	−0.23*	0.209	0.030	2.811*	−2.514*		
<i>t</i> -statistic	[−5.83]	[6.05]	[−3.21]	[0.35]	[1.33]	[9.17]	[−11.00]	8.21	220,778
Asset growth									
Coefficient	−0.879*	0.646*	−0.429*	0.464	0.009	2.815*	−2.573*		
<i>t</i> -statistic	[−5.09]	[9.04]	[−5.75]	[0.73]	[0.42]	[9.21]	[−11.17]	8.51	220,778

Notes. We define the dependent variable, ΔSI_{it} , as $\Delta SI_{it} = SI_{it} - SI_{it-12}$ (i.e., the change in the level of shares held short reported in month t divided by the CRSP shares outstanding in month t). We define the independent variables *Overpriced* _{it} (*Underpriced* _{it}) as an indicator variable that equals 1 if the firm is in the lowest (highest) quintile of the monthly sorted fundamentals-to-price ratios (book-to-market, earnings yield, value-to-price), equals 1 if the firm is in the highest (lowest) annually sorted quintile of accruals and asset growth, and equals 0 otherwise. *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. We also include controls for the expected costs of short selling. We define *DivP* _{it} as the most recent annual dividend divided by price, *SzRank* _{it} as the within-sample rank of market value of equity at time t , *InstHold* _{it} as the number of shares held by institutions divided by the number of shares outstanding, and *HighSI* _{$it-12$} as an indicator variable that equals 1 if the firm is in the top quintile of short interest in month $t - 12$ and 0 otherwise. We correct *t*-statistics (in brackets) for firm and time clustering (see Petersen 2009, Gow et al. 2010), and we include year fixed effects in all specifications. We measure short interest monthly from 1995 to 2011 with available data listed on the NASDAQ and NYSE/AMEX.

* $p < 0.05$.

price declines. We use the value-to-price ratio in this figure to identify overpriced firms. The dashed line represents the market-adjusted returns to a portfolio

Figure 2 Average Returns to Short-Selling Positions With and Without Low Value to Price



Notes. We plot cumulative market-adjusted returns to short-interest targets following price declines. We calculate market-adjusted returns over the period 1995–2011 for all firms with short interest in the top decile sorted on a monthly basis and that had a price decline over the past 12 months ($N = 112,857$ firm-month observations). We plot the average market-adjusted return for the portfolio of firms with a low value-to-price ratio (decile 1) as the dashed line. We plot the average cumulative market-adjusted return for the remaining firms with a solid line (i.e., those with value-to-price ratios in deciles 2–10). Lower returns are consistent with higher profits from taking short positions in these portfolios.

of firms with low value-to-price ratios (quintile 1), and the solid line represents a portfolio of the remaining firms (quintiles 2–10). On average, short sellers trading in price decline firms have negative market-adjusted returns in the following 12 months. The plot indicates that the returns to the low value-to-price portfolio are much lower (at −13.42%) relative to the remaining firms (with a cumulative market-adjusted return of −5.03%). These results are consistent with the profitability of short selling following price declines being concentrated in firms that appear overpriced based on fundamental analysis.

We also undertake a multivariate analysis of the returns to firms with high short interest following price declines because the figure does not control for differences in risk or trading costs between the two portfolios. Specifically, we examine market-adjusted returns while controlling for possible differences in expected returns (using beta and size) and possible costs to short selling (using size, institutional holdings, and dividend yield). We estimate the following regression model:

$$\begin{aligned}
 Ret_{it+12} = & b_0 + b_1 \text{Overpriced}_{it} + b_2 \text{Underpriced}_{it} \\
 & + b_3 \text{Decline}_{it-12} + b_4 \text{Beta}_{it} + b_5 \text{DivP}_{it} \\
 & + b_6 \text{SzRank}_{it} + b_7 \text{InstHold}_{it} + e_{it}. \quad (7)
 \end{aligned}$$

Table 5 Analysis of the Relation Between Future Changes in Short Interest with Price Declines and Financial Statement Signals
$$\Delta SI_{it+12} = b_0 + b_1 \text{Overpriced}_{it} + b_2 \text{FutureOverpricing}_{it+12} + b_3 \text{Decline}_{it-12} + b_4 \text{FutureDecline}_{it+12} + b_5 \text{DivP}_{it} + b_6 \text{SzRank}_{it} + b_7 \text{InstHold}_{it} + b_8 \text{HighSI}_{it} + e_{it}$$

	b_0	b_1	b_2	b_3	b_4	b_5	b_6	b_7	b_8	Adj. R^2 (%)	N
Predictions	?	+	+	—	+	?	?	?	—		
Book-to-market											
Coefficient	0.113	0.092	0.457*	−0.295*	0.029	−0.555	0.059*	0.152	−2.172*		
<i>t</i> -statistic	[1.28]	[1.67]	[7.89]	[−6.46]	[0.54]	[−1.45]	[3.68]	[0.79]	[−15.93]	5.87	491,624
Earnings yield											
Coefficient	0.240*	0.105*	−0.249*	−0.306*	−0.001	−0.649	0.068*	0.054	−2.105*		
<i>t</i> -statistic	[2.66]	[2.16]	[−4.12]	[−6.59]	[−0.03]	[−1.48]	[4.58]	[0.28]	[−15.78]	5.74	491,624
Value-to-price											
Coefficient	0.038	0.306*	0.355*	−0.301*	−0.018	−0.48	0.073*	0.185	−2.225*		
<i>t</i> -statistic	[0.44]	[4.88]	[6.15]	[−6.71]	[−0.34]	[−1.40]	[4.51]	[0.95]	[−16.49]	5.91	491,624
Accruals											
Coefficient	0.093	0.029	0.386*	−0.317*	−0.037	−0.645	0.078*	0.104	−2.135*		
<i>t</i> -statistic	[1.00]	[0.53]	[8.04]	[−6.77]	[−0.71]	[−1.48]	[4.72]	[0.54]	[−15.77]	5.81	491,624
Asset growth											
Coefficient	0.053	0.094	0.722*	−0.259*	−0.037	−0.503	0.071*	0.083	−2.214*		
<i>t</i> -statistic	[0.61]	[1.79]	[13.28]	[−5.62]	[−0.70]	[−1.43]	[4.48]	[0.43]	[−16.19]	6.05	491,624

Notes. We define the dependent variable, ΔSI_{it} , as $\Delta SI_{it+12} = SI_{it+12} - SI_{it}$ (i.e., the change the level of shares held short reported in month t divided by the CRSP shares outstanding in month t). We define the independent variables *Overpriced* _{it} (*Underpriced* _{it}) as an indicator variable that equals 1 if the firm is in the lowest (highest) quintile of the monthly sorted fundamentals-to-price ratios (book-to-market, earnings yield, value-to-price), equals 1 if the firm is in the highest (lowest) annually sorted quintile of accruals and asset growth, and equals 0 otherwise. *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. We also include controls for the expected costs of short selling. We define *DivP* _{it} as the most recent annual dividend divided by price, *SzRank* _{it} as the within-sample rank of market value of equity at time t , *InstHold* _{it} as the number of shares held by institutions divided by the number of shares outstanding, and *HighSI* _{it} as an indicator variable that equals 1 if the firm is in the top quintile of short interest in month t and 0 otherwise. We include forward-looking variables *FutureOverpricing* _{it} and *FutureDecline* _{$it+12$} , which we define as the 12-month leading *Overpriced* _{it} and *Decline* _{$it-12$} , respectively. We correct t -statistics (in brackets) for firm and time clustering (see Petersen 2009, Gow et al. 2010), and we include year fixed effects in all specifications. We measure short interest monthly from 1995 to 2011 with available data listed on the NASDAQ and NYSE/AMEX.

* $p < 0.05$.

We define the dependent variable Ret_{it+12} as monthly market-adjusted returns over the 12-month period following the formation of the portfolio; $Beta_{it}$ is the OLS beta from the regression of individual firm returns less the risk-free rate on the excess market return over the risk-free rate, using the Fama–French database available on the Wharton Research Database Service; and all remaining variables are as described previously. We again include indicator variables for firms that appear overpriced and underpriced based on financial statement signals, and for firms with a prior price decline. To the extent that expected returns of short sellers are larger for firms that appear overpriced based on fundamental analysis, we expect a significant negative coefficient on *Overpriced* _{it} , b_1 .

We report this analysis in Table 6. First, we find that market-adjusted returns are significantly lower for firms that appear overpriced based on fundamental analysis in all specifications except for the earnings yield. For example, high-accrual firms targeted by short sellers following price declines have significantly more negative market-adjusted returns than the average firm with a prior price decline. In this case, the coefficient of -0.04 indicates that high-accrual firms within the portfolio of highly shorted stocks contribute a return to the short seller of

4% (which is economically significant given the average market-adjusted return in our sample is 0.18% in column (8) of Table 1, suggesting a small loss to the short seller on a market-adjusted basis). In contrast we find no indication that market-adjusted returns are lower for the firms that appear underpriced based on fundamental analysis, as the coefficient on *Underpriced* _{it} is not significantly negative in any of the specifications. We find that short sellers' positions following price declines are not profitable on average, as they are associated with future positive market-adjusted returns (b_3). Overall, we find no support for critics' claims that the actions of short sellers lead to the amplification of price declines in firms that appear underpriced.

5.3. Examination of Marketwide Declines

The primary focus of our analysis is on the targets of short sellers following individual firm price declines, because, at least on the surface, these short sellers could be considered as naïvely targeting firms with falling prices. Part of the reason that the actions of short sellers appear so controversial when trading following a price decline is the significant increase in short-selling activity following marketwide price declines. In Figure 3, we plot the average monthly

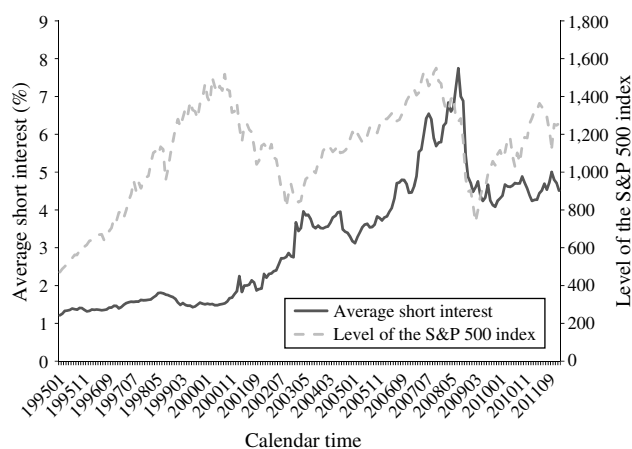
Table 6 Analysis of the Relation Between Future Market-Adjusted Returns and the High Short-Interest Portfolio with Prior Price Declines and Fundamental Analysis

	$Ret_{it+12} = b_0 + b_1 Overpriced_{it} + b_2 Underpriced_{it} + b_3 Decline_{it-12} + b_4 Beta_{it} + b_5 DivP_{it} + b_6 SzRank_{it} + b_7 InstHold_{it} + e_{it}$									
	b_0	b_1	b_2	b_3	b_4	b_5	b_6	b_7	Adj. R^2 (%)	N
Prediction	?	—	+	+	?	?	?	?		
Book-to-market										
Coefficient	−0.02	−0.029*	0.011	0.026*	−0.003	0.726*	−0.017*	0.112*		
t -statistic	[−0.63]	[−2.29]	[0.47]	[2.28]	[−0.29]	[2.6]	[−3.63]	[4.63]	3.43	112,857
Earnings yield										
Coefficient	−0.036	0.022	0.001	0.032*	−0.005	0.747*	−0.018*	0.124*		
t -statistic	[−1.18]	[1.18]	[0.06]	[2.65]	[−0.62]	[2.67]	[−3.67]	[4.97]	3.41	112,857
Value-to-price										
Coefficient	−0.016	−0.03*	0.008	0.028*	−0.002	0.724*	−0.018*	0.111*		
t -statistic	[−0.52]	[−2.04]	[0.40]	[2.43]	[−0.21]	[2.59]	[−3.74]	[4.63]	3.43	112,857
Accruals										
Coefficient	−0.011	−0.04*	−0.006	0.034*	−0.004	0.75*	−0.019*	0.117*		
t -statistic	[−0.35]	[−2.93]	[−0.46]	[2.69]	[−0.43]	[2.68]	[−3.87]	[4.69]	3.45	112,857
Asset growth										
Coefficient	−0.021	−0.046*	0.021	0.035*	−0.004	0.709*	−0.017*	0.118*		
t -statistic	[−0.70]	[−4.26]	[1.25]	[2.78]	[−0.42]	[2.52]	[−3.59]	[4.72]	3.53	112,857

Notes. We define the dependent variable, Ret_{it+12} , as the market-adjusted cumulative return over the following 12 months. We only include observations if the firm is in the top quintile of short interest in month t . We define the independent variable $Overpriced_{it}$ ($Underpriced_{it}$) as an indicator variable that equals 1 if the firm is in the lowest (highest) quintile of the monthly sorted fundamentals-to-price ratios (book-to-market, earnings yield, value-to-price) or if the firm is in the highest (lowest) annually sorted quintile of accruals and asset growth, and 0 otherwise. $Decline_{it-12}$ is an indicator variable that equals 1 if the buy-and-hold return over the past 12 months is negative, and 0 otherwise. We also include controls for risk and the expected costs of short selling. We define $Beta_{it}$ the OLS beta from the regression of individual firm returns less the risk-free rate on the excess market return (using the equal-weighted CRSP index) over the risk-free rate, $DivP_{it}$ as the most recent annual dividend divided by price, $SzRank_{it}$ as the within-sample rank of market value of equity at time t , and $InstHold_{it}$ as the number of shares held by institutions divided by the number of shares outstanding. We measure the level of short interest monthly over the period 1995–2011 with available data listed on the NASDAQ and NYSE/AMEX. We correct t -statistics (in brackets) for firm and time clustering (see Petersen 2009, Gow et al. 2010), and we include year fixed effects in all specifications.

* $p < 0.05$.

level of short interest (the solid line) against the level of the S&P 500 index (the dotted line). Similar to Lamont and Stein (2004), we find evidence that short

Figure 3 Aggregate Short Interest and the Level of the S&P 500

Notes. We plot the average level of short interest and the level of the S&P 500 index over the period 1995–2011. We plot the average percentage of outstanding shares shorted as the solid line and the level of the S&P 500 index as the dashed line. We use 576,640 firm-month observations with data available on the number of shares shorted as a percentage of shares outstanding, the variables required to compute the fundamentals-to-price ratios, accruals, asset growth, and the 12-month prior market return.

interest increased considerably following the large marketwide decline in 2001. The evidence surrounding the marketwide declines of the financial crisis period are less clear. At the beginning of the crisis, there is some evidence to suggest that short interest increased following the beginning of the financial crisis period, a large amount of which was covered or unwound by December of 2008. Although the increases in short selling around these large market declines are visible in the figure, we require formal tests to determine whether these positions tend to be valuation-based short positions.

We provide a formal test of the targets of short sellers following marketwide declines using the multivariate regression Equation (3), estimated with a complete set of interaction terms on the variables of interest to identify whether the associations differ in times of market declines. Specifically, we investigate whether the model of short-interest levels in Equation (3) is different for months following marketwide declines relative to marketwide increases. We report the results in Table 7. We use a model similar to Cooper et al. (2004) to identify market states. Specifically, when the one-month lagged market return is negative, we examine the short interest of the current

Table 7 Analysis of the Relation Between the Level of Short Interest with Price Declines and Fundamental Analysis for Marketwide Declines
$$SI_{it} = b_0 + b_1 \text{Overpriced}_{it} + b_2 \text{Decline}_{it-12} + b_3 \text{DivP}_{it} + b_4 \text{SzRank}_{it} + b_5 \text{InstHold}_{it} + b_6 \text{Down} + b_7 \text{Down}_{it} * \text{Overpriced}_{it} \\ + b_8 \text{Down}_{it} * \text{Decline}_{it-12} + b_9 \text{Down}_{it} * \text{DivP}_{it} + b_{10} \text{Down}_{it} * \text{SzRank}_{it} + b_{11} \text{Down}_{it} * \text{InstHold}_{it} + e_{it}$$

	b_0	b_1	b_2	b_3	b_4	b_5	b_6	b_7	b_8	b_9	b_{10}	b_{11}
Prediction	?	—	+	+	?	?	+	—	+	?	?	?
Book-to-market ($N = 576,640$, adj. R^2 17.50%)												
Coefficient	−1.613*	1.429*	0.805*	0.085	−0.088*	7.018*	−0.160	−0.191*	−0.065	0.313	−0.033	0.813
t -statistic	[−10.14]	[13.40]	[12.18]	[0.10]	[−2.84]	[15.42]	[−0.79]	[−3.27]	[−0.67]	[0.39]	[−1.06]	[1.42]
Earnings yield ($N = 576,640$, adj. R^2 16.99%)												
Coefficient	−1.682*	0.742*	0.607*	−0.573	−0.014	6.901*	−0.242	0.05	−0.058	0.873	−0.03	0.849
t -statistic	[−9.78]	[6.97]	[9.38]	[−0.64]	[−0.46]	[15.19]	[−1.21]	[0.82]	[−0.61]	[1.02]	[−0.96]	[1.49]
Value-to-price ($N = 576,640$, adj. R^2 17.81%)												
Coefficient	−1.846*	1.623*	0.786*	0.579	−0.047	7.047*	−0.162	−0.103	−0.06	−0.076	−0.037	0.823
t -statistic	[−11.3]	[16.55]	[11.91]	[0.72]	[−1.59]	[15.68]	[−0.76]	[−1.67]	[−0.63]	[−0.10]	[−1.25]	[1.45]
Accruals ($N = 576,640$, adj. R^2 16.95%)												
Coefficient	−1.58*	0.686*	0.648*	−0.684	−0.036	6.885*	−0.192	−0.091	−0.05	0.967	−0.036	0.851
t -statistic	[−10.4]	[7.82]	[9.60]	[−0.74]	[−1.16]	[15.08]	[−0.96]	[−1.69]	[−0.51]	[1.10]	[−1.15]	[1.47]
Asset growth ($N = 576,640$, adj. R^2 17.81%)												
Coefficient	−1.639*	1.606*	0.600*	0.201	−0.055	6.805*	−0.195	−0.09	−0.036	0.25	−0.036	0.857
t -statistic	[−10.46]	[20.04]	[8.94]	[0.24]	[−1.83]	[15.10]	[−0.95]	[−1.43]	[−0.37]	[0.31]	[−1.17]	[1.50]

Notes. We define the dependent variable, SI_{it} , as the level of shares held short reported in month t divided by the CRSP shares outstanding in month t . We define the independent variable Overpriced_{it} as an indicator variable that equals 1 if the firm is in the lowest quintile of the monthly sorted book-to-market, earnings yield, or value-to-price ratios or the highest quintile of annually sorted accruals or asset growth, and 0 otherwise. The variable Decline_{it-12} is an indicator variable that equals 1 if the firm-specific buy-and-hold return over the past 12 months is negative, and 0 otherwise. We also include controls for the expected costs of short selling. We define DivP_{it} as the most recent annual dividend divided by price, SzRank_{it} as the within-sample rank of market value of equity at time t , and InstHold_{it} as the number of shares held by institutions divided by the number of shares outstanding. We include all firm-month observations from 1995 to 2011 with available data listed on the NASDAQ and NYSE/AMEX. We classify observations as *down* if the return on the S&P 500 index was less than or equal to 0, and *up* otherwise. There are 347,819 observations in the *up* state and 228,821 in the *down* state. We correct t -statistics (in brackets) for firm and time clustering (see Petersen 2009, Gow et al. 2010), and we include year fixed effects in all specifications.

* $p < 0.05$.

month under the “down” market state, and when the market return is positive, we include the observations in the “up” market state, where the market return is the monthly return on the CRSP value-weighted index). We find that the differences in the coefficients on both *Overpriced* and *Decline* are not statistically different at conventional levels between “down” and “up” markets, in almost all cases. The only exception is that in down markets, the price-to-book measure of overpricing is less targeted by short sellers. These results suggest that the targets of short sellers are economically similar in each of these market states.

5.4. Limitations and Caveats

Our results must be interpreted with the important caveat that many short positions are undertaken only for a brief period of time. 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. Instead, our focus is on whether short sellers appear to amplify sustained price declines or align

firms with fundamentals in the longer term. Because the alignment of price with fundamentals is generally considered to be a long-term process in the accounting and finance 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., Jegadeesh 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 are only applicable to longer-term short-selling positions.²²

Our main results are also limited by our choices of how to measure firm fundamentals. Consistent with Dechow et al. (2001), part of our analysis involves the use of the value-to-price ratio as a measure of overpricing. Although the residual income model has strong theoretical and empirical support in prior literature (Ohlson 1995, Frankel and Lee 1998, Lee et al.

²² For example, there is some evidence that intraday short selling is destabilizing during liquidity crises (Shkilko et al. 2012).

1999), the model is always implemented with error, and our results should be interpreted with this caveat in mind. To the extent that our other measures, such as accruals and asset growth, provide similar evidence, however, this concern is partially mitigated.

6. Conclusion

Our study is motivated by recent regulatory actions and ongoing debate surrounding short sellers' activities in firms with declining prices (e.g., Securities and Exchange Commission 2008, 2009; Financial Services Authority 2008). We address the question of whether short sellers take positions in firms with price declines to amplify price declines, or to reduce holding costs when targeting overpriced firms. Our study contributes evidence on the debate about whether short sellers target price decline firms on an unwarranted basis.

Our empirical results can be summarized as follows. First, although we find significant levels of short interest following price declines, it is concentrated in the firms that appear to be overpriced based on financial statement analysis such as low fundamentals-to-price ratios, high accruals, and high asset growth. Second, we find that short interest falls significantly for firms following a price decline, although significantly increasing in firms that become overpriced in the future. Third, for the firms most targeted by short sellers, abnormal returns following price declines are more negative for firms that appear overpriced based on financial statement analysis. Finally, we find that although short interest increases on average following marketwide price declines, there are generally no significant differences in the targets of short sellers, suggesting that short sellers continue to concentrate their positions in overpriced firms, even following marketwide declines.

Taken together, our results provide evidence on why short sellers target firms following price declines and following marketwide declines. Although these positions may appear to push prices below fundamental values on the surface, we find that the evidence suggests the opposite—that the positions of short sellers among firms with prior price declines are concentrated within overpriced firms on average. Thus, regulations restricting these actions may impede efficient price discovery for firms trading above their fundamental values. Given the ongoing regulatory interest in the actions of short sellers in firms with declining prices, future research could further examine the sources of public and private information on which short sellers appear to condition their trades. Ongoing research in this area is important given that the current regulatory framework relies on using price decline-based restrictions

as a method of identifying underpricing. Our study focuses on the role of price declines relative to annual accounting-based trading strategies. Although outside of the scope of our study, price declines may also aid short sellers in minimizing holding costs associated with targeting firms around corporate events such as earnings surprises (Bernard and Thomas 1990, Doyle et al. 2003), restatements (Desai et al. 2006, Efendi et al. 2005, Karpoff and Lou 2010), and press releases disclosing negative information (Engelberg et al. 2012). Future research could explore these possibilities.

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