

Do short sellers trade on private information or false information?

by

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We investigate whether short sellers contribute toward informational efficiency of market prices by trading on their private information or destabilize market prices by trading on rumors and false information. We do so by decomposing short-selling using contemporaneous insider trading - our proxy for the potential availability of private information. We find that short-selling activities are considerably informative about future stock returns when there is a higher likelihood of private information in stocks. Short-sellers also bring considerable additional information to the market, but only for smaller stocks, that is not fully captured by contemporaneous insider trading. Overall, these results suggest that on average short sellers bring informational efficiency to the market rather than destabilize them.

Keywords : Short selling, insider trading, price discovery, manipulation.

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1 Introduction

Short sellers can contribute to improved price discovery, price efficiency, liquidity, and better risk sharing (Miller, 1977; Diamond and Verrecchia, 1987; Jones and Lamont, 2002; and Lamont and Thaler, 2003). Opponents of short-selling, who are usually corporate executives or regulators, have argued that short-sellers can contribute to excessive volatility, panics, and excessive stock price declines by acting on false rumors or false information.¹ Indeed, to reduce the recent large stock price declines, especially in the financial services sector, the Securities and Exchange Commission (SEC) has issued various emergency orders either restricting or temporarily banning short selling.² In spite of the SEC's recent conviction regarding the effectiveness or deleterious effects of short-selling, academic literature to date has presented only a mixed picture on the information content of short-selling.³ In this paper, we propose a novel way to identify and understand the information content of short interest. Our goal is to understand whether, on average, short-sellers earn profits and whether these profits are due to private information, or false, manipulative information.

Our key insight is that we can use insider trading to decompose the information content of short-selling. Our argument is that insider trading provides an economically meaningful measure of the private information about a firm's future prospects (see Seyhun, 1986, 1992). If short-sellers make profits by trading in the same direction as the insiders, then this is likely to be due to private information. Furthermore, when there is no insider selling but short-selling exists, we test to see if short-sellers make money

¹See Allen and Gale (1992) for a discussion on information and trade based manipulation. They also provide some anecdotes on market manipulation using false information or rumors.

²See SEC Release no. 34-58166, July 15, 2008, 'Emergency Order Pursuant to Section 12(k)(2) of Securities and Exchange Act of 1934 Taking Temporary Action in Response to Market Developments', banning naked short-selling and all short-selling for 21 securities of 19 financial services firms. SEC Release no. 34-58248, July 29, 2008 'Order Extending Emergency Order Pursuant to Section 12(k)(2) of Securities and Exchange Act of 1934 Taking Temporary Action in Response to Market Developments,' extended this ban to August 12, 2008. More recently, SEC has banned short selling in 799 financial services firms. See SEC Release no. 34-58592, September 18, 2008.

³Similar restrictions on short-selling have been announced in U.K., Australia, Taiwan, and Netherlands. Australia banned short selling of any stock, Taiwan has restricted short selling of the market's 150 top stocks and the Dutch regulator prohibited naked short selling of banks for three months. See Wall Street Journal, Short Sales Ban Spreads Around Globe, September 22, 2008.

and how they make money. If short sellers possess independent private information, then we would expect to see permanent price declines in reaction to short selling. If short sellers manipulate and make money, then we expect to find temporary price reactions to short-selling that are subsequently reversed (Allen and Gale, 1992). If short-selling in the absence of insider selling is due to hedging reasons, we would expect to see no systematic price movements.

Our unique approach also allows us to decompose the information content of insider trading. To this extent, we investigate whether insiders make money when there is no short-selling or when they disagree with short-sellers. If insiders have better access to private information, we expect them to earn abnormal profits regardless of short-selling activity. If short-sellers bring independent private information not possessed by insiders or they successfully manipulate prices, we would expect insiders to lose money when they oppose short-sellers.

By analyzing the interaction between short-selling and insider trading, we are able to identify the source of both insiders' and short-sellers' information. This, in turn, provides us with a sharp test of the informativeness of both insider trading and short-selling. We start our analysis by investigating the correlation between short-sellers and insiders. On average, we find a positive correlation between short-selling and contemporaneous insider-selling. The positive correlation, however, is present in smaller stocks (defined as below median market capitalization stocks) only. For large stocks, the correlation between insider trading and short-selling is statistically zero. This result shows that short-sellers seem to be considerably informed about inside information in small stocks. For large stocks, lack of correlation suggests that short-selling can be due to independent private information, hedging needs, or possibly manipulative motivation.

We find that the portfolio of firms with abnormally high short-interest ratio earns four-factor model adjusted abnormal return of -0.29% per month on equal-weighted basis. When we condition the short-interest portfolios on insider trading strategy, we observe a remarkable improvement in the return prediction ability. When insider trades are indicative of private negative signal, we find that the portfolio of highest short-selling

stocks earns -0.56% return per month on an equal weighted basis in the four-factor model. The abnormal return remains a significant -0.46% per month on the value weighted basis. Thus, when private information about the stock is likely to be negative, abnormally high levels of short-interest predicts significantly higher profitability for short-sellers. This finding also provides an economic interpretation of the earlier finding of the literature that shows that short-selling unconditionally predicts future returns for smaller stocks but not for large stocks (see Asquith, Pathak, and Ritter, 2005). Since short-selling is positively correlated with insider selling for smaller stocks, but uncorrelated in large firms, short-selling activity is more informative in small firms. When we parse out the informative component of short-selling using insiders' private information, we find that short-selling activities predict returns even among large stocks.

When insider trades are indicative of positive private information, we find the reverse. In this group, abnormally low levels of short-interest (short covering) predict large positive returns over the next month. The four-factor equal-weighted return to the short-covering portfolio within positive insider trading group is a significant 1.29% per month. The return is positive, but only marginally significant, 0.49% per month on a value-weighted basis. These results indicate that short-sales have considerable information content for forecasting next month's stock return. A trading strategy that buys the extreme portfolio of short-covering among insider-buying group, and sells short the other extreme of high short-interest stocks within insider-selling group earns a 1.85% return per month on equal-weighted basis and 0.94% per month on value-weighted basis. These are economically large returns and unlikely to be explained away by transaction costs. We show that by following joint signals, there are significant gains in trading returns as compared to returns from trading strategies that only follow insider trading signals.

Our analysis allows us to critically examine the informativeness of short-selling when it does not agree with the insiders. Private information and manipulation hypotheses both suggest short-sellers should be able to make money even when there is no insider trading or when there is insider buying. We find that when short-selling is increased while insiders are buying, stock returns are abnormally positive and the shorts actually lose money. Our

evidence suggests that short-sellers increase their positions due to hedging reasons rather than information reasons and end up losing money when they find themselves opposing insiders. This finding is also inconsistent with the manipulation hypothesis.

When there is no insider trading, we find strikingly different results across large and small firms. On a value weighted basis we do not find any predictability in the next month's return based on short-selling activities in this group. On an equal weighted basis, however, we find that short-selling strategy remains profitable in this group as well. In other words, we show that short-selling activities are predictive of future returns even during the periods of low private information among small stocks. This can be either due to private information that is not possessed by insiders or due to manipulative activities. We further test these hypotheses by analyzing whether there is a permanent impact or a temporary price impact of the short-selling trades that are subsequently reversed. We find that there is no reversal in prices for these portfolios over the next three or six months. Hence, our evidence suggests that within small stocks, short sellers are able to bring additional value-relevant information that is not yet captured by insider trades.

Our study also allows us to shed light on the informativeness of insider trades. We find that conditioning on short-selling activities does not help explain the information content of insider trading. Instead, insider trading is profitable regardless of what short-sellers are doing. This evidence indicates that insiders possess private information not available to short-sellers.

We also examine short selling and insider trading on a daily basis, which corroborates our monthly evidence. With insider selling and increased short selling, daily abnormal returns start at -6 basis points and rise to about -70 basis points by day 30. With insider buying and low short selling, abnormal returns start at 15 basis points and rise to about 100 basis points by day 30. Once again, shorts trade profitably then they agree with insiders and lose when they disagree with insiders. There are no daily reversal patterns in abnormal returns.

Our study provides first empirical evidence on the joint trading behavior that helps us

decompose the information content of short-selling activity using insider trading. These are arguably the two most informed agents in stock markets - (a) insiders by virtue of their access to the company's private information and (b) short-sellers due to the incentives generated by potentially unbounded losses from their trades. We find that knowing the direction of insider trading can help distinguish between information-based, hedging-based, or manipulated-motivated short selling activity. On average, we find no evidence of manipulative practices by short-sellers. We also find that short-selling in the absence of insider trading is typically done for hedging reasons. In contrast, conditioning on short-selling does not help decompose insider trading. Insider trading is profitable regardless of the magnitude of short-selling.

It is worth mentioning that our study is not designed to specifically rule out episodic instances of manipulative short-selling. We instead document the role of short-sellers as systematic contributors toward efficient prices *on average*, which is what should matter from an ex-ante policy perspective. These findings support the policy implication in Diamond and Verrecchia (1987), Jones and Lamont (2002), and Lamont and Thaler (2003) that restrictions on short-selling are deleterious to market efficiency. Our findings suggest that elimination of the up-tick rule will improve market efficiency while banning short-selling or reducing the number of stocks that can be sold short will reduce market efficiency.

The rest of the paper is organized as follows. In section 2, we survey the literature on the information content of short selling. Section 3 develops our key hypotheses. Section 4 presents the sample and data and Section 5 presents results. Section 6 concludes the paper.

2 Literature survey

A general theme in the literature has been to examine whether stocks with high levels of reported short interest earn lower returns in the future. However, establishing a link between short-selling activity and future stock returns is complicated by at least two

main reasons. First, some of the short-selling activity is motivated by the hedging needs of traders and, therefore, it is not solely driven by adverse information. For example, derivative traders typically short the underlying stock after they sell a put option, or market-makers, dealers, specialists, and block-positioners routinely short a stock following their block purchases to hedge their risk of price declines during the settlement period. Without the knowledge of this hedging component of short-selling, it is difficult to understand which shorts are informed, and therefore the link between informed short-selling and future stock returns becomes tenuous.

Second, short sellers might face significant impediments to shorting due to market frictions, such as the unavailability of shares to be borrowed, search costs involved in finding a stock lender, or lower rebate rates on the short-selling proceeds (Jones and Lamont (2002), D'Avolio (2002), Asquith, Pathak and Ritter (2005), Nagel (2005) among others). To investigate the information content of short sales, ideally we need a proxy for the demand for the shares to be shorted which is independent of these supply side frictions. As Chen, Hong, and Stein (2001) point out, a low recorded level of short interest may proxy for unavailability of the company's shares for lending. D'Avolio (2002) shows that institutions are main suppliers of shares in the stock loan market. He also shows that stocks with low institutional ownership are more expensive to borrow. As such, stocks with low short interest may simply reflect the fact that they are difficult to short; and not that short sellers have less adverse information about these stocks.

Some recent studies have used clever identification techniques to overcome some of these difficulties and understand the informativeness of short-selling activities.⁴ These techniques can be broadly summarized into four groups. The first group posits that the short-selling activities are more likely to predict negative returns when there is a high divergence of opinion about the true value of stock. Rooted in Miller's (1977) argument, these studies explore the link between proxies for divergence of opinion and future stock returns (see Diether et al. (2002), Gopalan (2003) and Boehme, Danielson, and Sorescu

⁴See the recent papers by Asquith, Pathak, and Ritter (2005) and Nagel (2005) for more comprehensive literature review.

(2004)).

The second group approaches the problem by analyzing detailed, and often proprietary, information on shorting activities of a set of stocks over some short time period. Geczy, Musto, and Reed (2002) analyze a database from a single stock lender and conclude that short-sale constraints are unable to explain anomalous pattern in stock returns. Jones and Lamont (2002) examine an interesting dataset of rebate rates on stocks during 1926-1933, when there was a public stock loan market. They show that the newly listed stocks in the public stock loan market underperform in subsequent period.

The third group exploits the variation in the supply of loanable shares to investigate this relation. Assuming that institutional shareholding is a good proxy for the inverse of short-sell constraints, these studies show that higher short interest predicts negative returns in those groups that have high institutional holdings. Nagel (2005) argues that short-sale constraints are more likely to bind for stocks with low institutional holdings. Building on this argument, he finds that the cross-sectional return predictability based on variables such as market-to-book ratio, analyst dispersion, turnover, or volatility is most pronounced among stocks with low institutional ownership. Therefore, he concludes that the short-sale constraints help explain cross-sectional return anomalies. Asquith, Pathak, and Ritter (2005) use institutional holdings as a proxy for the supply of shares and observed short-interest as a proxy for the demand of shares to short. In their detailed analysis, they show that short-sale constrained stocks underperform significantly on an equal-weighted basis, but only weakly on a value-weighted basis. Earlier contributions by Senchack and Starks (1993), Aitken et al. (1998) and Angel, Christophe, and Ferri (2003) analyze the effect of short-sell announcement on short-term stock returns. Finally, in a recent paper, Boehmer, Jones, and Zhang (2008) investigate a long series of daily proprietary data of short sales for NYSE stocks. During 2000-2004, they find that heavily shorted stocks underperform lightly shorted stocks by 1.16% over the following 20 days on a value-weighted basis, which is remarkably close to our results based on publicly available information as well. The advantage of their dataset is that they are able to identify whether the short position was initiated by institutions or individuals as well as

whether they are as a part of program trade or not.

We propose a novel approach for assessing the informational efficiency of short-sellers. By projecting short-selling on insider trading, we help decompose the motivations for the short-selling activity. Similarly, to understand the motivations for insider trading activity, we decompose it using short-selling activity. Our novel approach helps us understand the profitability of both insider trading and short-selling.

To improve the information content, we modify the short-selling measure to account for the supply-side frictions. Rather than comparing the recorded level of short-interest as a measure of adverse information, we construct a measure of short-interest that accounts for the historical average level of short-interest in the company's stock. Every month, we compute a standardized measure of short-interest defined as recorded short-interest minus the up-to-then historical average of short-interest normalized by the up-to-then historical standard deviation of this variable. By construction, this measure is based on the innovation in the short-interest of a company in a given month and it is in the spirit of Diamond and Verrecchia's theoretical argument that "an unexpected increase on the short-interest of a stock is shown to be bad news." This measure is also insensitive to cross-sectional differences in levels of short-interest. As long as the level of short-sell restrictions does not change significantly across time for a given stock, this measure has the ability to capture the demand side of short sales, and therefore it has the ability to capture the extent of adverse information-motivated trades more precisely. We find remarkable improvements in return predictability of short-interest using this measure, as compared to the recorded levels of short interest.

3 Hypotheses

Many countries have some restrictions on short-selling. As late as 1990, only about 20 of 80 countries with stock exchanges have allowed short-selling (Charoenruek and Daouk, 2005). Most regulators worry about the destabilizing effects of short-selling and the SEC is no exception. The SEC adopted Rule 10-1a to regulate short-selling activities after

conducting an inquiry into the effects of concentrated short-selling during the market break of 1937.⁵ This rule prohibited investors from short-selling on down-ticks. The SEC adopted this up-tick rule with a purpose to “preventing short selling at successively lower prices, thus eliminating short-selling as a tool for driving market down; and preventing short-sellers from accelerating a declining market by exhausting all remaining bids at one price level, causing excessively lower prices to be established by long sellers”.⁶ The SEC stated that they adopted these rules “to prevent short selling that could manipulate or depress the market of a security”. Thus, the initial justification behind the up-tick rule was the destabilizing role of short-selling.

There was a significant change in the up-tick rule on July 6, 2007 when the SEC eliminated this rule for all stocks.⁷ This was preceded by a one-year pilot program temporarily suspending the up-tick rule for certain securities on July 28, 2004. The SEC stated that the “Commission should remove price test restrictions because they modestly reduce liquidity and do not appear necessary to prevent manipulation”. This seems to indicate that the SEC’s rule was motivated by the informational efficiency role played by the short-sellers.

Recent turmoil in the financial market has once again brought short-selling activities under closer scrutiny of the regulators. Some investors who lose money typically argue that short-sellers create panic and ‘undue’ negative pressure on stocks to destabilize the markets and profit from the price declines.⁸ On July 15, 2008, the SEC banned short-selling activities in 19 financial stocks to restore stability to the stock markets. On September 18, 2008, the SEC banned short-selling in 799 financial services stocks.

⁵See http://www.sec.gov/rules/concept/34-42037.htm#P49_9887 for the SEC’s regulations on short-selling.

⁶See securities Exchange Act Release No. 13091 (December 21, 1976), 41 FR 56530 (1976 Release).

⁷See <http://www.sec.gov/rules/final/2007/34-55970.pdf>.

⁸Executives of failed companies typically also blame short-sellers for their firms’ troubles. For instance, Richard Fuld, the former chief executive of Lehman Brothers, blamed short-sellers for the demise of Lehman Brothers in his testimony to a Congressional Committee. See Financial Times, ‘Ex-Lehman Chief Blames Short Sellers’, October 7, 2008. Similarly, Enron’s founder, Kenneth Lay, blamed an attack by short-sellers for the failure of Enron during his criminal trial testimony. Prosecutors countered by showing that Lay’s son was also short-selling Enron stock. See International Herald Tribune, ‘Lay Blames Enron Failure on Attack of Short-Sellers’, April 26, 2006.

These decisions reflect the earlier view that short-sellers create excessive volatility and unwarranted downward pressure on stocks by their speculative trading that necessitated the imposition of up-tick rule in 1930s. In contrast, the SEC's actions during the 2004-2007 period were motivated by the competing view that short-sellers contribute toward the informational efficiency of market prices by trading on their private information and thus contribute toward market efficiency. Under this view, short-sellers are an important part of financial markets and they play a vital role in price discovery process. A ban on short-selling, therefore, may not be socially desirable.

It is clear from the above discussion that understanding the roles played by the short-sellers is an important task from both an academic as well as policy viewpoint. In Figure 1, we plot the stock market performance of 19 financial stocks around the SEC's announcement of the ban on short-selling of their stocks in July 2008. As expected, we find almost 20% abnormal increase in stock prices of these stocks just after the announcement of the ban. While not shown here, analysis also shows an abnormal decline of about 10% in the trading volume of these 19 stocks.⁹ Was this stock-price increase and trading-volume decrease due to the removal of destabilizing short trades from the market? Or was it due to the removal of informed short-sellers with adverse information from the market? While the increase in stock prices and decline in trading volume can be consistent with either of the two scenarios, it has fundamentally different implications from the viewpoint of the efficiency of the regulation. Under the first hypothesis (destabilizing role) a temporary ban on short-selling is desirable, whereas under the second it is not. Thus, it is important to understand what role short-sellers play in the financial markets. To distinguish between these two alternative hypotheses, we design our empirical tests using insider trading information.

There are three important premises behind our tests. First, we take insider trades as indicative of the availability of private information in the financial markets that is not yet reflected in stock prices. Insiders are arguably the most informed agents for

⁹We ran a market model in natural logs of number of shares traded for each firm from January 1, 2008 to May 30, 2008. Abnormal volume was from June 1, 2008 to October 1, 2008 computed from this market model.

their own company's stocks. There is a large literature documenting evidence in support of this assumption (see Jaffe (1974), Finnerty (1976), Seyhun (1986, 1992, 1998), and Lakonishok and Lee (2001)).

Second, insider trades are likely to be free from destabilizing manipulative practices due to the regulatory requirements. Some manipulative strategies (information-based) involve short-selling the stock, starting false rumors to drive the price down and then buying the stock cheaply.¹⁰ These manipulative strategies require that agents reverse the direction of their trading fairly rapidly before fundamental information is released and prices reverse course. However, Section 16(b) of the Securities and Exchange Act of 1934 prohibits short-swing profits for insiders within six months and in effect makes it very difficult for insiders to manipulate the stock prices (John and Narayanan, 1997). Empirical evidence is consistent with this assertion. Stock prices do not reverse course following insiders' trades.¹¹ Instead, insiders tend to focus on long-lived private information that is not likely to be disclosed by the firm quickly. Thus, by projecting short-selling activities on insider trades, we hope to separate the informational-motivated trades of short-sellers from their hedging-motivated and possibly manipulation-motivated trades.

Third, manipulation can result in profits both when it agrees with or it opposes fundamental information. A manipulative agent who receives positive information when other market participants also expect high likelihood of positive information can make even more profits by initially selling the stock publicly instead of buying it, driving the price down, and then buying the stock privately (John and Narayanan, 1997; Allen and Gale, 1992). Similarly, a manipulative agent who receives negative private information when other market participants also expect high likelihood of negative information can make even more profits by initially buying the stock publicly instead of selling it, driving the price up, and then selling the stock privately. Hence, in our empirical tests we pay careful attention to the fact that there is a possibility of manipulative trades across all portfolios of insider trading and short-selling strategies.

¹⁰Spreading false rumors is illegal in the U.S.

¹¹See Jaffe (1974), Finnerty (1976), Seyhun (1986, 1992, 1998) and Lakonishok and Lee (2001).

In our tests we first separate stocks into positive, neutral, and negative groups based on the insider trading signals and then evaluate the performance of high, medium, and low levels of short-selling activities within each group. This allows us to control for the extent of private information in the stock and then evaluate the effectiveness of short-selling activities on future stock returns. The informational efficiency hypothesis predicts that short-sellers earn most of their profits during the periods of high private information as indicated by the direction of insider trading, and by trading in the direction of insiders' information. The manipulation or market destabilization hypothesis predicts that short-sellers earn profit even while opposing insiders or during the periods of no private information. Further, manipulative trades are likely to result in price reversal in subsequent periods rather than leave a permanent price impact on the stocks. We describe our methodology in detail after describing sample and data below.

4 Data and Sample

Our sample covers all firms on the NYSE/AMEX stock exchanges from September 1991 to December 2003. We start from September 1991 since this is the first month from which we have NYSE/AMEX short-interest data with the ticker name of the firm. NYSE/AMEX collects data on outstanding short interest from all member firms as of the 15th day of every month or the next business day if it is a holiday. It is reported to the press after a lag of few days. As Asquith, Pathak, and Ritter (2005) point out, this reporting can be as early as the 19th of the month or as late as the 1st day of the next month. We collect insider trading data for the corresponding time interval, i.e., we collect all insider trades from the 16th of the previous month to the 15th of the current month and take the net insider trade as the difference between buys and sells during the month. Insiders are defined as directors and top executives of the firms. Once we have the insider trading and short interest data as of the 15th of month t , we investigate its return starting from the beginning of month $t+1$. We prefer to start our portfolio formation from the beginning of the next month in order to account for the reporting delays in short interest and insider trades.

We obtain returns data for all NYSE/AMEX stocks (i.e., exchange codes 1 and 2) from the CRSP tapes. We limit our analysis to common shares (i.e., share codes 10, 11, and 12) only. All returns are measured on a monthly basis. Our key variables are the short-interest and net insider trades both scaled by the total shares outstanding of the firm. Since the stock exchange reported short sales are not always adjusted for stock splits, it presents a problem for our empirical work. To avoid any error due to split adjustment, we remove firm-month observations with stock splits. The month of stock split is obtained from the CRSP distribution file. This filter results in a loss of less than 1% of observations and doesn't change our results. We divide monthly short interest and net insider trading with shares outstanding as of the end of the month of reporting to create the scaled measures.

4.1 Measures of short interest and insider trading activity

At the beginning of month $t+1$, we consider all stocks in our sample and compute their month t innovation in short interest as follows. We compute the historical mean and standard deviation of scaled short-interest ratio based on the data availability up to the beginning of that year. We demean the scaled short-interest ratio and then divide the demeaned measure by standard deviation. Thus our measure denotes the deviation from the average level of shorting of a stock after accounting for its variance. We call this the standardized measures of shorting.

To compute historical average and standard deviation, on a stock by stock basis, we make use of all monthly data available till the beginning of the calendar year in which we form the portfolio. We skip years 1991 and 1992 to generate the initial distribution. We require at least 12 monthly observations to be available for a stock to compute its

mean and standard deviations.¹² Our standardized measure is given by the following:

$$\Delta SI_t = \frac{(\frac{SI}{SO})_t - \mu(\frac{SI}{SO})}{\sigma(\frac{SI}{SO})}$$

The standardized measure presents several economic as well as econometric advantages for our analysis. One advantage is that standardization isolates the innovation in short-selling activity and allows each stock to have a similar weight in overall results. Consider two stocks A and B. Assume that stock A has an average level of short-interest of 1% in a given month, whereas stock B's average short-interest ratio is 0.1% of its shares outstanding. Also assume for the time being that these levels remain constant from month 0 to t . In a cross-sectional portfolio regression, stock A will be classified into higher shorting group and B into lower group in each of these months. Now consider month $t+1$ where stock A's short interest remains at 1%, but stock B's short-interest jumps up to 0.5%. Cross-sectional portfolio regressions will continue to classify B as a low short-interest stock as compared to A even in this month. However, it is likely that this sudden upward shift in stock B's short-interest ratio represents higher adverse information available with the short-sellers. Our measure is able to capture such dynamic aspects of shorting activities. We scale it by the standard deviation of short-interest measure to account for the fact that a stock with large changes in short-interest on a month-to-month basis has less precise information about the innovation in the short-seller's signals as compared to stocks with lower changes.

For forming portfolios at the beginning of month $t+1$, we measure insider trading by the net insider buying during the 16th day of month $t-1$ to the 15th day of month t . If insiders are net buyers or net sellers during this period, we classify the firm into the *insider buying* or *insider selling* group, respectively. The remaining stocks are classified under *insider neutral* category.

¹²In unreported robustness check, we make use of all available information for a stock's short-selling activities including observations available after the portfolio formation date. Our results become stronger; however, to avoid any look-ahead bias we report our results with historical data based estimation of mean and standard deviation only.

4.2 Descriptive statistics

Table 1 presents the sample characteristics of key short-interest and insider-trading variables. We provide the distribution of short-interest and net insider trade measures (both scaled by the shares outstanding of the firm) as well their first differences. For every stock in our sample, we first compute the time-series mean, median, and other percentiles of the four measures and then report the median across all firms in this Table. We have more than 4,000 stocks in our sample entering and exiting the sample at different points in time.

For the median firm in our sample, the average net insider trade is -0.0073% of the shares outstanding of the firm. Thus, in our sample insiders on average have been sellers of their company's stocks. Consistent with the earlier studies, a majority of firm-month observations have no insider trading.¹³ However, there are significant activities in the top and bottom 10-percentiles, which are the months that provide us with interesting patterns in return predictability of insider trading.

The mean short-interest ratio as a percentage of shares outstanding in a given month is 0.8236% for the median firm in our sample. The median is even lower at 0.5192%. These low numbers are consistent with earlier studies such as Asquith, Pathak, and Ritter (2005). The level of shorting is generally low for the average stock; however, there are considerable variations across the decile portfolios.

When we investigate the monthly changes in insider trading and shorting activities, we find some interesting patterns in the data. While the median change in insider and short activities are zero, i.e., there are no changes on a month-to-month basis for the median firm-month in our sample, we find almost symmetric distributions on both tails. For the median firm, the net insider buying increased by 0.0341% or more for 10% of months, whereas it decreased by 0.0322% or more for the 10% of months. Similarly, shorting activity decreased by 0.2771% or more for 10% of the months, whereas it increased by

¹³For NYSE, AMEX, and NASDAQ firms from 1975 to 1995, Seyhun (1998), chapter 1 documents that insiders are active in approximately six months out of each year.

0.2996% or more for 10% of the months. This shows that there are significant changes occurring in the trades by insiders and short-sellers on a month-to-month basis, which we exploit as our identification strategy in formal portfolio returns tests.

5 Results

5.1 Trading patterns

We start our analysis by investigating the relation between insider trading and short-selling activities by analyzing their trading patterns. Our interest is in understanding whether short-sellers and insiders trade in similar direction at a given point in time. To do so, we regress short-selling activity on insider sales. Every month in the sample, we break stocks into three groups based on their standardized short interest ratio and assign them a rank of 1, 0, or -1 depending on whether they fall in top, middle, or bottom $1/3^{\text{rd}}$ of this distribution. We regress the ranked short-interest variable on a ranked insider sale variable that equals 1 for stocks with net insider selling, 0 for neutral insider trades, and -1 for stocks with net insider buying during the same period.

To investigate the trade correlations across large and small firms, we break stocks into large and small groups every month based on whether their market capitalization is above or below the sample median. We regress the ranked short-interest variable on insider sale variable, a dummy for large firm and their interactions. We present pooled as well as Fama-MacBeth regression results of this model in Table 2. We find that the relation between short-selling and insider-selling is positive and significant for smaller stocks as shown by the coefficient on ‘insider selling’ variable. However, the coefficient on the interaction term (‘large firms’ x ‘insider selling’) is negative and significant. To assess the effect of insider selling on short-interest for large firms, we sum the coefficient on insider selling and the interaction term. We find that the net effect of insider selling on short-interest is statistically zero for large firms.

Overall, we find that short-sellers trade in a correlated manner with the insiders of

small firms.¹⁴ For large firms, there is no meaningful relation between the trades of these two agents. One possibility is that there are considerable hedging-related shorting activity in the stocks of large firms, which in turn produces zero correlation between the insiders' and shorts' trading activities. However, there is significant heterogeneity in the trading behavior of short-sellers within the group of large firms as well. We exploit this heterogeneity by looking at the return predictability of short-sellers conditional on the direction of insider trades in subsequent sections.¹⁵

5.2 Raw returns

Every month starting with January 1993 we separate sample firms into three groups based on the direction of insider trading (buy, neutral, or sell) and three groups based on standardized short-interest. We classify stocks into three groups on each dimension and then analyze their subsequent returns. In Table 3, we provide raw returns of these portfolios over the next one-month, three-month and six-month period. We provide returns for both univariate sorting (Panel A) and two-way sorting (Panel B).

Panel AI presents returns based on insider trading signal. When insiders buy their firm's stocks, next month's average return is 1.92%. When they sell their firm's stocks, the return is a significantly lower 0.81%. The difference of 1.11% between insider buy and insider sell group is economically large and statistically significant at 1% level. The return difference remains large and positive even after six-months from the portfolio formation date. This indicates that insider trading has a permanent price impact.

The returns based on the short-selling signal are provided in Panel AII. The next month's raw return is 0.90% for stocks with increasing short interest (the top group),

¹⁴In this paper, we do not consider any actions that insiders might take to oppose short-sellers. See Lamont (2004) for an interesting analysis of this issue.

¹⁵We also consider some preliminary analysis on the lead-lag relation between the trading behavior of these two agents. We fit a vector auto-regression model on a stock-by-stock basis with insider trading and short-selling as the two dependent variables and their lags as right-hand-side variables. We find that both these trading activities are serially positively correlated. But apart from that, we do not find much meaningful lead-lag relation between the two variables for the average firm in our sample. Much of the correlation between the trading behavior of these agents is contemporaneous.

and 1.54% for stocks with decreasing short interest (the bottom group). The difference of 0.64% between the two groups is statistically significant at the 1% level. Also consider the medium group which has a mean monthly return of 1.16%, which is very similar to the unconditional mean monthly return in our sample. These results suggest that abnormal changes in short-selling activity predict future returns as would be expected. We conduct additional statistical tests using a calendar time portfolio regression approach and Fama-McBeth approach in the subsequent sections to see if the predictive ability of short-selling remains after taking into account additional risk-characteristics of these groups.

Panel B provides next month's return for portfolios formed on the basis of both signals. When insiders are selling, stocks with increased shorting earn a low 0.72% return, which is much lower than the unconditional mean return of 1.20% in our sample. When insiders are buying and shorts are covering, stocks experience a 2.19% return. The difference of 1.47% between the two extreme portfolios is significant. Hence, when the two signals agree, both insiders and shorts make abnormal profits. This finding is consistent with the private information hypothesis. We also show that the return differential between the two extreme portfolios remains persistent upto six months. In other words, the predictability of return based on these two signals is based on long-lived information, rather than short-term manipulative trades.

When insiders are not trading, short selling appears to be still informative. An increase in shorting results in 0.88% return, while short covering results in 1.52% return. The difference of 0.64% is statistically different from zero. These findings can be consistent with both private information and manipulation hypotheses. Thus, we will examine these in more detail later.

When shorts are not active, insider trading is once again profitable. When insiders sell, stocks earn 0.72% returns over next month; when insiders buy, stocks earn 1.91% return. The difference between these two portfolios' return is significantly different from zero. These findings indicate that insiders possess private information that shorts do not have.

5.3 Calendar time regressions for one-way sorting

Our evidence so far did not control for risk. To take risk into account, Table 4 provides the four-factor model regression results for portfolios formed on the basis of insider trading and short interest. In Panel A, we provide the regression results for equally and value-weighted returns to three portfolios formed on the basis of net insider trading. On an equally weighted basis, we find that when insiders are buying, stocks earn positive four-factor model adjusted return of 0.95% per month, which is significant at 1% level. When insiders are selling, stocks earn -0.38% per month, also significant at 1%. The hedged portfolio that buys the insider-buying group and sells short the insider-selling group earns a significant 1.33% per month.

When we analyze the regression coefficients on other factors, we find that the insider-buying group has significantly negative loading on the momentum factor. This suggests that the insiders are more likely to buy stocks with poor performance in the recent past. This finding is consistent with the results from the insider trading literature (Seyhun, 1998).

Results based on value-weighted returns suggest that in the insider-selling group, there is -0.37% abnormal return which is significant at 1%. In the insider-buying group we find a positive but insignificant 0.16% return per month. Comparing the equally weighted and value-weighted returns, we conclude that insider trading is more informative for smaller stocks.

In Panel B, we find considerable return predictability among small stocks for portfolios based on short-interest alone. On an equally weighted basis, stocks with high short-interest earn a significant return of -0.29% per month whereas low short-interest portfolio earns a significant 0.49% per month. The four-factor model adjusted return of 0.78% on the hedged portfolio is highly significant. On a value-weighted basis, we do not find significant returns for either the high or the low short interest group.

Asquith, Pathak, and Ritter (2005) report that the return to highly shorted stocks, as defined by stocks with more than 2.5% short interest ratio or stocks in the top 5-10%

of the short-interest ratios, earn significant negative returns in the range of -0.65% to -1.46% per month in a four-factor model. They do not find significant returns to value-weighted trading strategy. Our results, on the value-weighted basis, are similar. But there are observable differences in our equal weighted returns. Note that we compute returns in the top 1/3rd of the standardized short interest ratio unlike focusing on very top percentiles. Our results show that our standardized measure is able to capture the negative return predictability of short activities for a much larger cross section of firms and that the short interest does have predictive ability even when it is not extremely high. Second, we also report the positive returns to short covering activities, a finding which is new to the literature. While the focus of the earlier literature has been on the negative information implicit in the high levels of short interest, by focusing on the standardized measure we show that when shorts are covering their position the returns are positive in the next month. Therefore, our results suggest that shorts are informed on both sides of the trade. This effect is, however, present only in the small stocks as evidenced by the fact that our value-weighted results are statistically weak.

5.4 Calendar time regressions for two-way sorting

We now analyze portfolio returns across high, medium, and low short interest within different insider trading groups. In Table 5, we provide calendar time portfolio regression results for nine portfolios formed on the basis of double sort on the standardized measures of short interest and the direction of insider trading. Within each of the three groups formed on the basis of insider trading activity, we investigate the returns across three short interest groups. We compute both an equal-weighted and a value-weighted measure of average return on each portfolio every month and then regress them on returns on four factors.

We first consider the cases when insider-trading and short-selling signals agree. In row I, when insiders sell and shorts increase their positions, stocks earn significantly low return on both equal-weighted (-0.56% per month) and value-weighted (-0.46% per month) basis. Similarly in row IX, when insiders buy and shorts cover their positions,

stocks earn a significant 1.29% per month on equal-weighted basis and a marginally significant 0.49% per month on value-weighted basis. On average, when insider trading and short-selling signals agree, both insiders and shorts make abnormal profits. This evidence is consistent with private information hypothesis.

A hedged portfolio formed on the basis of two extreme portfolios, i.e., long in the portfolio that has positive signals from both sets of investors (insider buy and shorts cover) and short in the portfolio that has negative signal from both sets of investors (insider sell and shorts increase) earns large four-factor adjusted return of 1.85% per month (t-statistics of 4.53) on equal-weighted and 0.94% (t-statistics of 2.54) on value-weighted basis. This is an economically large number as compared to returns from various investment strategies such as ‘value minus glamor investing’ or ‘small minus large stock investing’.

When insider-trading and short-selling signals conflict with each other, we do not find any profitability to the short-selling activity. In row III, when insiders sell while the shorts cover, abnormal returns are insignificant -0.09% per month for equally weighted and insignificant -0.22% for value-weighted portfolios. In row VII, when insiders buy while the shorts increase their positions, abnormal returns are significant 0.52% per month for equally weighted and insignificant 0.00% for value-weighted portfolios. Note that the equally weighted abnormal return is positive, which means that by increasing their short-position, short-sellers are actually losing money when they oppose insiders. This result is inconsistent with the manipulation hypothesis which predicts that manipulation can be profitable whether it agrees with or opposes fundamental information.¹⁶ In contrast,

¹⁶In unreported analysis, we analyze the returns to this sub-sample in greater details to detect any evidence of manipulation. If short-sellers increase their position to drive prices at abnormally low levels and then cover it in next period before the prices revert to their high fundamental value, then manipulation is a possibility. Based on this idea, we consider all stock at the beginning of month t in this sub-sample and consider a stock as a possible manipulation candidate if the following conditions are met: (a) In month t its market-adjusted return is negative; (b) In month $t + 1$ its market-adjusted return is positive, and (c) Short interest as of the beginning of month $t + 1$ is less than that as of the beginning of month t . Conditions (a) and (b) ensure price reversal, and condition (c) ensures that short-sellers are trading in a manner so that they benefit from this reversal. Only about 8% of firms in this sub-sample meet these conditions, which provides us with an upper limit on the likelihood of manipulation in this sub-sample. Since this sub-sample has less than one-ninth of the entire sample, these possible manipulation candidates amount to less than 1% of the entire sample.

insiders never lose to shorts when they disagree with shorts. Our evidence suggests that the source of profitability for these traders is private information. Moreover, short-sellers contribute toward price discovery by trading on private information.

Now we consider return predictability of short-selling activities when there is no insider trading. We find that the value-weighted return to all three sub-groups of short-selling activities is statistically insignificant in this group. Thus, when there is little or no private information in the market, short-selling doesn't predict future returns. In other words, short-selling activities do not generate returns solely based on their own trades when there is no private information available to insiders. This evidence is once again inconsistent with the view that i) short-sellers possess significant independent private information or ii) short-sellers are able to profit from price-destabilizing trades.¹⁷

When we analyze the equal-weighted returns to different short-selling groups within neutral insider trading portfolios, we find a remarkable difference in the results. In this group, high short-selling activity predicts significantly lower future returns (-0.31% per month), whereas short-covering activity predicts significantly positive future returns (0.46% per month). There are two alternative interpretations of this result: (i) short-sellers generate private-information that is independent of insiders in the small stocks; or (ii) short-sellers are able to profit from their price-destabilizing trades in small stocks even when there is no private information.

To tease out these explanations, we look at the long-run price impact of these trades. Our argument is that if short-sellers are acting on private information, then the price impact should be permanent. A transitory price impact, i.e., return reversal, will be consistent with manipulative practices as in Allen and Gale (1992). Motivated by this argument, we estimate Fama-MacBeth regression models with three-month ahead and six-month ahead returns as the dependent variables. We include the interaction of neutral insider trading with shorts increasing and covering as the explanatory variables. Thus the estimated coefficients compare the returns to these portfolios as compared to the

¹⁷One possibility is that our results come from a period with the up-tick rule in effect and therefore it is possible that up-tick rule imposes significant costs on the short-sellers and reduces their ability to search and profit from private information.

remaining stocks.¹⁸ In this regression, we control for the firm's market capitalization, market-to-book ratio, and last month's return to control for the well-known drivers of stock returns. We discuss further details of the Fama-MacBeth model in section 5.6. We find no evidence of return reversal as shown in Table 6. In other words, portfolios of high and low short-interest stocks, within the group of no insider trading, exhibit permanent price impact in the direction that suggests that short-sellers bring additional information to the market.

Overall, these findings together with trade correlation results suggest that short-sellers act on private information especially in small firms. Since their trading is positively correlated with insiders, short-selling strategy predicts returns among small stocks even on their own. For large stocks, when we condition short-selling trades on privately informed insiders, we again find that short-sellers predict future returns.

Our evidence also indicates that conditioning on short-selling does not much improve the information content of insider trading. Insider selling is informative even when there is medium level of short selling (row II). Similarly, insider buying is informative regardless of whether shorts increase their positions, hold their positions, or cover their positions (rows VII, VIII and IX). This evidence suggests that insiders possess information that is not available to short-sellers.

5.5 Incremental improvement in returns

A natural question arises regarding the magnitude of *additional* private information that short-sellers bring to the market over and above the insiders' private information. We analyze this issue in terms of the improvement in realizable trading profits to an investor who follows the combined signal from insiders and short-sellers over an investor who just follows insider trading signals. We do so by forming two hedged portfolios and then comparing their returns. The first portfolio buys stocks that insiders are buying and

¹⁸Our results are robust if we include all eight interaction terms formed with the interactions of various insider trading and short-selling groups. We focus on the insider neutral group since this is the group where we need to separate the two hypotheses mentioned above.

sells short stocks that they are selling. The combined portfolio strategy is simply the strategy that buys stocks with good signals from both agents and sells shorts stocks with negative signals to both agents. This is nothing but the hedged portfolio return that we presented in the previous section (presented under extreme portfolio of Table 5).

We provide the portfolio regressions in Table 7. For expositional clarity we first provide returns to the two hedged portfolio followed by the improvement in returns using combined signals. On the equal-weighted basis, the combined portfolio earns 0.52% higher return than the portfolio that is only based on insider trades. This difference is economically large as well as statistically significant. On value-weighted basis, the difference remains economically large at 0.42%, but it is no longer statistically significant. Overall, we document significant improvement in the realizable trading profits if an investor exploits the joint signal. The improvement is reliably large for small stocks, but not so for large stocks. This suggests that in addition to trading with insiders in a correlated manner, short-sellers also bring additional information to the market that is not yet captured by insider trades, especially within the set of small stocks.

5.6 Fama-MacBeth regressions

As an alternative estimation approach, we run a cross-sectional regression every month and report the time-series coefficient and t-statistics as in Fama-MacBeth approach in Table 8. The dependent variable in this regression is the monthly excess return on a stock over the risk-free rate. To parallel our results with calendar time portfolio regressions, we create a series of dummy variables based on the interactions of insider trading and short-selling signals and include them as interaction terms on the right-hand-side of this regression model. These interaction terms are formed by intersecting insider buying, neutral, and selling indicator variables with shorts increasing, neutral, and covering variables. We omit the dummy variable *neutral insider x neutral short*, since this is the benchmark portfolio where both signals are neutral. Thus, the coefficient on dummy variables in this regression represents the difference in returns to a strategy that buys stocks with certain combination of insider trading and short-selling signals as compared

to a strategy that follows neutral signals on both accounts.

This methodology has three advantages. First, it confirms the robustness of our results to characteristics-based approach rather than covariance-based approach of Fama-French regression (see Daniel and Titman, 1997). Second, it allows us to include additional covariates/characteristics in the regression model to rule out some competing hypotheses that we describe below. Finally, in this approach we can easily compare the coefficient on different interaction terms to estimate the incremental power of short-selling signal within a given insider trading group.

Table 8 provides the results. In the first model, we regress excess return on dummy variables without any other controls. In the subsequent specification we control for the well-known drivers of stock returns, namely firm size, market-to-book ratio of equity, and prior month's stock-return. All variables are measured using only past information to remove any look-ahead bias from our analysis. Consistent with the calendar time approach, we find that highly shorted stocks when insider information is negative earn -0.43% to -0.46% return on a per month basis depending on the model specification, whereas their extreme counterpart (*insiders buying x shorts covering*) earn positive 0.99% to 1.04% returns on a monthly basis. Both these numbers are significant at 1% level and the difference between the returns to two portfolios is significant as well. Results from other control variables are broadly in line with earlier studies and as expected. More notably, consistent with prior findings we find the one-month reversal result in our data as well; last month's loser stocks earn higher return (Jegadeesh, 1990; Lehman, 1990).

Fama-MacBeth regression also allows us to compare the predictability of short-selling within a given insider trading group. We test for these differences and report the result at the bottom of Table 8. For every insider trading group, we find that the shorts-increasing subgroup under-performs the shorts-covering subgroup by substantial magnitude. We also note that within the insider selling group, the return difference between two extreme short-selling portfolios comes predominantly from the short-increasing subgroup. The reverse is true for the insider-buying group. Overall these results corroborate our finding that short-sellers make considerable profits when they trade on private information.

5.7 Semi-parametric model.

In this section, we use a semi-parametric approach to analyze the incremental information in short-interest. Unlike the purely non-parametric approach used for portfolio formation for the Fama-French regression model, we now project short-selling activities on insider selling using a regression model. Every month we regress standardized short-selling ratio on net insider selling (scaled by shares outstanding) and then use the residual from this regression as the component of short-selling that is orthogonal to insider trading. Our goal is to analyze if this residual component has any additional information in predicting future returns. This test provides us with an alternative model to assess the incremental information content of short-selling activities that is not explained by insider trades.

After obtaining the residual from this regression, we first consider all stocks where insiders are selling their stocks. We break all stocks in this group into three sub-groups based on the residual. Stocks falling into a high residual group represent firms where insiders' private information is negative and short-interest is abnormally high. Stocks falling into the low residual group represent firms where short-selling is abnormally low when insider signals suggest negative private information. We undertake a similar break-up within the insider buying group. In this group, low residual stocks represent firms with large amount of short-covering when insiders' private signal is positive. High residual group represents stock where short-sellers are increasing their position abnormally even though insider trades suggest positive signal.

We estimate Fama-MacBeth regression model with one month ahead excess return as the dependent variable. We include four interaction terms as explanatory variables on the right-hand-side. These variables are formed by interacting insider sell and insider buy groups with high (top $1/3^{rd}$) and low (bottom $1/3^{rd}$) residual short-interest. These interaction variables represent the groups of stocks where insiders have considerable negative (or positive) information and at the same time short-sellers have engaged in abnormally high levels of short selling (covering). Results are provided in table 9. We find large negative coefficient on the interaction of insider sell and high residual short interest. Stocks with abnormally high short interest, when private information is likely to be negative,

earn 0.59% to 0.51% lower return than stocks in the middle groups. Similarly within the set of insider buying group, stocks with abnormally high short-covering earn 0.76% to 0.78% higher returns than the middle group. All these returns are statistically significant at 1% level and they point toward the informational role of short sellers. When insiders are selling, yet shorts are covering their position, the return is statistically zero. When insiders are buying, but shorts are increasing their position, the return is positive 0.38% to 0.39%. This suggests that increasing short interest at a time of positive private signal from insiders is not a profitable strategy. These results are consistent with our earlier calendar time-based regressions.

We also test for the difference in returns across high and low residual short interest portfolios within insider buying and selling groups. We find that within the insider selling group, high residual short-interest stocks significantly underperform their low counterpart. In other words, when private information is likely to be negative, abnormally high short-interest predicts large negative returns in the next month. Within the insider buying group, the difference between the two groups is positive, but only marginally significant. Together, these results show that the abnormally high level of short-interest during periods of selling from insiders is the most informative piece of short-selling activity.

5.8 Daily Short Sales

In our analysis so far, we use monthly short interest data to separate the information discovery hypothesis from manipulation. If manipulation occurs within a shorter frequency then our monthly analysis might not have the power to detect it. To overcome this challenge, in this section we present an analysis based on a sample of daily short sales and insider trading data.

The short-sale transactions data come from NYSE TAQ dataset pursuant to Regulation SHO reporting. As per this regulation a pilot program was instituted to collect data on a set of securities from January 2005 to May 2007. Thus, this sample period is different from our monthly sample. The analysis in this section, therefore, can also be

taken as out-of-sample validity of our results in the rest of the paper. We obtain data on daily short sales from this dataset and match it with insider trading data on a daily basis. For each firm in the sample, we create a measure of abnormal short selling by subtracting the average short sales of the trailing last 60 days from the day's short sales and dividing it by the standard deviation of short sales measured over the same window. We assign stocks, everyday, into nine portfolios based on the activities of insiders and short sellers. Along the insider trading dimensions, we create three buckets based on whether insiders sell, do not trade, or buy their company's stock on a net basis on a given day. On the short selling dimension, we assign them into three buckets based on whether a given stock's abnormal short selling falls in top, middle, or bottom 1/3rd of the distribution.

In total we have data from 545 trading days (we miss 60 trading days in the beginning of the sample since we need data on historical mean and standard deviation). There are 1520 stocks in our portfolio on an average day giving us a total sample size of about 828,000 stock-days over this period. We have 33,697 stock-days (4.1% of the sample) in which insiders are net sellers and 4,850 stock-days (0.06%) in which insiders are net buyer. The average short sales is about 0.16% of the shares outstanding of the firm. We compute the average stock return for several holding periods, 1-day, 3-days, 15-days, and 30-days, after the portfolio formation. Using the Fama-MacBeth approach we regress average stock returns on eight dummy variables, representing the eight portfolio assignments. We leave out the portfolio with neutral signal from both insiders and short sellers as the baseline variable in the regression model. The time series mean and t-statistics, after Newey-West correction to account for overlapping return days, are presented in Table 10.

Our results show that when both signals are negative (insiders selling and shorts increasing their position), the next day's returns is -0.06% which is significant. On the other extreme when both agents act in the positive direction, the next day's return is a large 0.15% which is also significant at the 1% level. In fact our results, across the subgroups, are very similar to the results obtained with monthly portfolio formation.

More important, we do not find any evidence of return reversal 3,15 or 30 days out in future, after the daily portfolio formation. In other words, the price impact of these trades seems to reflect permanent information and not any short-lived manipulative pressure on the stock price. Overall these results mitigate possible concerns with our monthly analysis, and also provide an out-of-sample test of our results.

5.9 Returns based on alternative sorting techniques

In this section we analyze the returns to portfolios formed on the basis of some alternative measures of short-interest, including replication of the key findings of some of the earlier papers.

5.9.1 Portfolios based on levels of short-interest ratios

Following Asquith, Pathak, and Ritter (2005), we investigate the returns to a portfolio of stock that has short-interest (as a percentage of shares outstanding) of 2.5% or more. This allows us to compare our sample and results in the context of their analysis. In Panel A of Table 10 we provide the four-factor regression results for this portfolio. On an equal weighted basis, this portfolio earns -0.55% per month which is statistically significant. This result is very close to the findings of Asquith, Pathak, and Ritter (2005) for NYSE/AMEX firms for a slightly different sample period. Consistent with their findings, the value-weighted returns are much weaker in our unreported analysis as well. Overall, our sample and results based on raw short-interest measures are very similar to earlier studies.

5.9.2 Portfolio formation based on insider signal and raw short-interest ratio

As a further robustness, we consider stocks with positive net insider trades as stocks with positive news and stocks with negative net insider trades as stocks with negative news. Then, we consider stocks with more than 2.5% short-interest ratio as highly shorted

stocks and stocks with less than 0.1% short-interest ratio as low short group. The cut-off of 0.1% roughly corresponds to bottom 10% of months for the median stock (see Table 1). We estimate a four-factor model for four portfolios based on this two-by-two sorting. In Table 10, Panel B we report the regression results for two portfolios of interest. When insiders are selling, the portfolio of high short-interest stocks earn negative -0.41% per month, which is marginally significant on an equal weighted basis. The value weighted return to this portfolio is -0.26% per month, which is not significant. The return to the low short-interest portfolio when insider signal is positive is 0.59% on equal-weighted basis and 0.68% on value-weighted basis. Both these numbers are statistically significant.

5.9.3 Portfolio formation based on insider signal and monthly innovation in short-interest ratio

Finally, as in the previous section we consider stocks with positive net insider trades as stocks with positive news and stocks with negative net insider trades as stocks with negative news. But now we form short-interest portfolios based on their monthly innovation. If the short-interest increases from the previous month, we classify the stock in “shorts increasing” group; if it decreases, we classify it into “shorts decreasing” group. This measure is slightly closer to our base measure and is in the spirit of abnormal shorting activities in a given month.

We estimate a four-factor model for four portfolios based on this two-by-two sorting. In Table 10, Panel C we report the regression results for two portfolios of interest. When insiders are selling, the portfolio of high short-interest stocks earn negative -0.16% per month, which is not significant on an equal-weighted basis. The value-weighted return to this portfolio is -0.21% per month, which is also not significant. The return to the low short-interest portfolio when insider signal is positive is significant 0.56% on equal-weighted basis and an insignificant 0.17% on value-weighted basis.

The results from these alternative ways of sorting stocks into portfolios of informed high and low short-interest groups show that these simple measures also provide us with directionally similar results as in the base case that we provide in the paper. But the

statistical significance, and in many cases the economic magnitude as well, is much weaker as compared to the base case. Therefore, our standardized measure brings a remarkable improvement in the return predictability of short trades. We argue that this is because our standardized measure (a) is able to remove the “noise” associated with supply side frictions in shorting and (b) is able to capture the information content more precisely in conjunction with the informed insider trades.

6 Conclusion

We examine the return prediction ability of short-sellers. A large body of academic literature assumes that short-sellers are informed market participants, who help bring adverse information into the market and thus improve the information efficiency of the market. On the other hand, short-sellers are often blamed for manipulative practices and destabilizing trades. Therefore, it is an important task, both from academic and policy viewpoint, to understand whether short-sellers act on private information that can contribute toward market efficiency or on false information that may lead to market destabilization.

In this paper, we use the insider trading signal as an instrument for periods of high or low private information in a stock and use that to assess the trading behavior and return predictability of short-sellers. We argue that if short sellers make profits when they trade in the same direction as the privately informed insiders, then it is likely that they trade on value-relevant private information. If they make profits during periods of low insider trade or by opposing insider trades, then there are two possibilities: Either they have better/additional value-relevant information that insiders do not have or they are successfully manipulating the stock prices. We tease out these competing hypotheses by analyzing whether their trades leave a permanent price impact or only a transitory effect that reverses in the next period. A permanent price impact is taken as evidence consistent with additional information argument, whereas price-reversal is consistent with manipulative practices.

We show that short-selling activity is positively correlated with insider selling among small stocks, but uncorrelated with insider selling among large stocks. When private information is likely to be negative, i.e., when insiders are selling, an increase in short-interest predicts negative returns both on an equal-weighted and a value-weighted basis. The economic magnitude of the returns is large. In an almost symmetric fashion, when private information is likely to be positive, i.e., when insiders are buying, short-interest covering predicts positive returns both on an equal-weighted and a value-weighted basis. When short-sellers oppose the insiders, they do not earn any profits. Finally, during periods of no insider trading, short-sellers bring considerable informational efficiency to the market by trading on their private information, especially among smaller stocks.

Overall, we provide empirical evidence in support of the key hypothesis of numerous models in economics and finance that short-sellers are informed about fundamental information that relates to future stock returns. We do not find evidence that suggests that short-sellers trade on false information and manipulate stock prices. Our evidence has important policy implications as well. Based on our findings, we conclude that increasing the costs for short-sellers, either by way of up-tick rules or by banning short-selling altogether and forcing shorts into costly synthetic strategies, would reduce market efficiency.

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Figure 1: Performance of 19 financial stocks with short-selling restrictions
The following figure plots the cumulative abnormal return of 19 financial stocks for which short-selling was banned on July 15, 2008. All returns are equal weighted across stocks and computed with respect to the price on July 15, 2008.

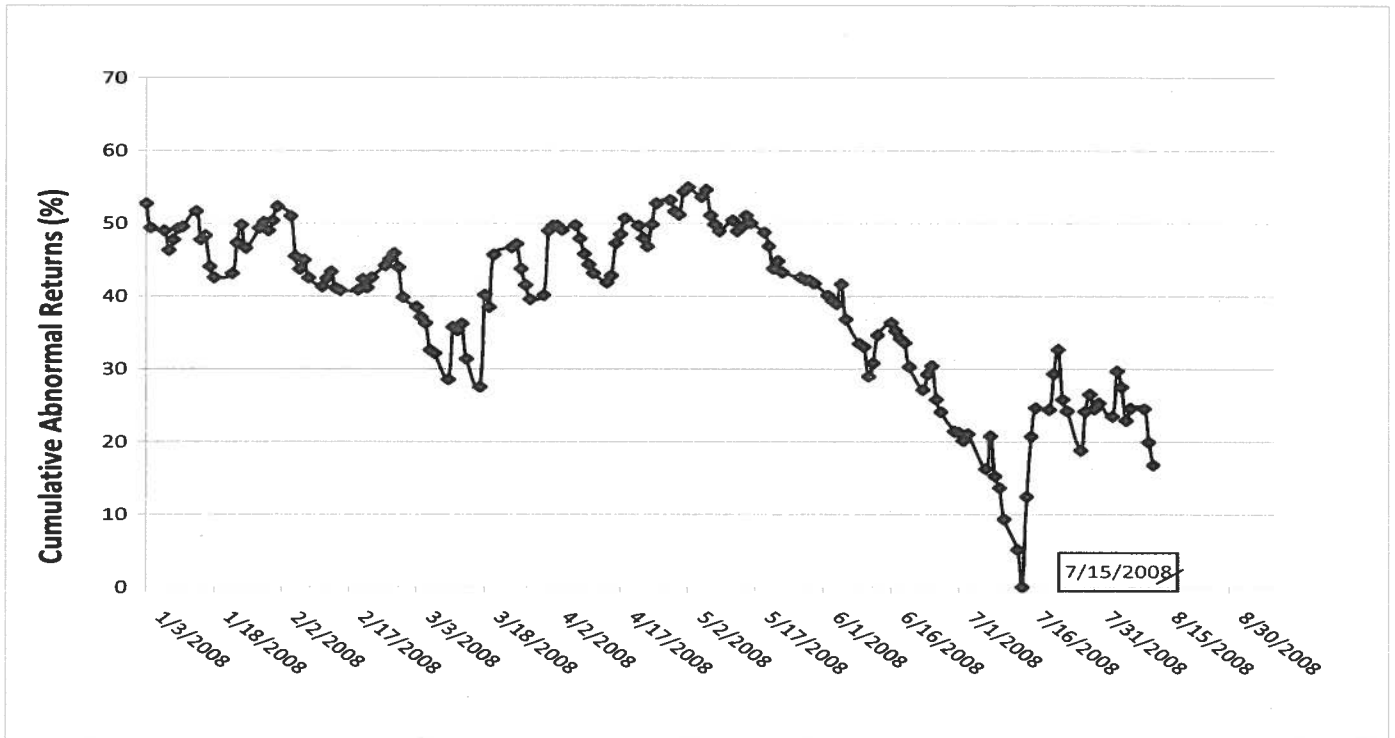


Table 1: **Descriptive statistics**

This table provides descriptive statistics of short-interest and insider trading variables. We first compute the mean, maximum and 25th, 50th, 75th, 90th, 95th and 99th percentiles for every firm in the NYSE/AMEX during our sample period and then report the median across firms in this table. Net/SO represents net insider trading (buy minus sales) during the month scaled by shares outstanding. SI/SO represents short interest scaled by shares outstanding. Δ Net/SO represent the change in Net/SO ratio from previous month to the current month so that a positive number represents an increase in the net insider buying activity. Δ SI/SO represents current month's short-interest ratio (SI/SO) minus the previous month's short-interest ratio. Number of observations (firms) used to compute the medians are presented under column NOBS.

Variable	Mean	P10	P25	P50	P75	P90	P95	P99	Max	NOBS
Net/SO	-0.0073	-0.0095	0.0000	0.0000	0.0000	0.0000	0.0048	0.0497	0.0719	4065
SI/SO	0.8236	0.0933	0.2271	0.5192	1.0511	1.7374	2.1543	2.9777	3.1143	4065
Δ Net/SO	0.0000	-0.0322	0.0000	0.0000	0.0000	0.0314	0.1060	0.4305	0.5542	4028
Δ SI/SO	0.0022	-0.2771	-0.0904	0.0000	0.0951	0.2996	0.5122	1.0575	1.1955	4028

Table 2: **Relation between insider-trading and short-interest**

We regress monthly short-interest on contemporaneous insider trading activities and present the regression results in this table. The dependent variable is the standardized short-interest group that takes a value of -1,0 or 1, with -1 representing the lowest short-interest group and 1 the highest. The explanatory variable is an ordered insider selling variable that takes a value of 1 for firm-months with net insider selling, 0 for firm-months with no insider trading and -1 for firm-months with net insider buying. *Large firm* is a dummy variable that equals one for firms with above median market capitalization as of the beginning of the month and zero otherwise. In the pooled regression, we include year fixed effects and all standard errors are clustered at firm-level. In Fama-MacBeth model we estimate the model on monthly basis and present the time-series average and t-statistics based on these numbers.

Dependent variable: Short Interest Group	Pooled		Fama-MacBeth	
	beta (t)	beta (t)	beta (t)	beta (t)
Insider Selling	0.062 (6.87)	0.064 (9.50)		
Large Firm	0.300 (20.62)	0.303 (50.42)		
Large Firm x Insider Selling	-0.064 (-5.45)	-0.067 (-8.26)		
Year Fixed Effects	Yes	Yes	No	No
Clustering	Firm	Firm	No	No

Table 3: **Raw returns**

This table provides raw returns for portfolios based on the direction of insider trading and standardized short-interest. In Panel A, we form monthly portfolio based on one-way sorting on either insider-trading (Panel AI) or short-interest (Panel AII). At the beginning of every month t , in Panel AI we classify stocks into three groups based on the insiders' trades from the 15th day of month $t - 2$ to the 15th day of month $t - 1$. We classify them into *sell*, *neutral*, and *buy* group if insiders are net sellers, neutral or net buyers during the month. In Panel AII, we classify stocks into three groups depending on standardized short-interest. The top group is labeled as *shorts increasing*, the middle group as *shorts neutral*, and the bottom group as *shorts covering*. 1-month return is the average portfolio return measured for month t , 3-month return represents the sum of three monthly returns (t , $t+1$ and $t+2$) and similarly for the six-month return. *NOBS* gives the median number of firms in each portfolio per month. Panel B provides the raw returns based on the combination of these two strategies. These estimates are based on 132 monthly observations starting from January, 1993 to December, 2003. We skip 1991 and 1992 to form initial distribution of net buy and short-interest measure. *Hedged returns* measure the difference in extreme signals. ***, **, and * denote significance at 1%, 5% and 10% respectively.

Panel A: Returns based on one-way sorting

	1-month	3-months	6-months	NOBS	1-month	3-months	6-months	NOBS
	Panel AI: Insider Trading				Panel AII: Short Interest			
Sell	0.81%	2.83%	6.31%	339	Increasing	0.90%	2.77%	5.64%
Neutral	1.20%	3.64%	4.71%	1140	Neutral	1.16%	3.50%	6.85%
Buy	1.92%	4.71%	8.35%	196	Covering	1.54%	4.51%	8.81%
Hedged	1.11%***	1.88%***	2.04%**		Hedged	0.64%***	1.74%***	3.17%***

Panel B: Returns based on two-way sorting

	1-month return			3-month return			6-month return		
	Insider			Insider			Insider		
	Sell	Neutral	Buy	Sell	Neutral	Buy	Sell	Neutral	Buy
Shorts Increasing	0.72%	0.88%	1.56%	0.85%	2.36%	2.74%	3.71%	1.35%	5.61%
Shorts Neutral	0.72%	1.17%	1.91%	1.19%	2.75%	3.62%	4.54%	1.79%	6.08%
Shorts Covering	1.07%	1.52%	2.19%	1.12%	3.59%	4.52%	5.68%	2.09%	7.58%
Hedged	-0.35%	-0.64%	-0.63%	-1.23%	-1.78%	-1.97%	-1.97%	-3.39%	-3.27%

Table 4: **Fama-French regression**

This table provides results from Fama-French calendar time portfolio return regressions for trading strategies based on different combinations of standardized short interest and insider trading measures. In Panel A, we form monthly portfolios based on insider trading strategy depending on whether insiders are net sellers, neutral or net buyers of their firm's stocks in the preceding month. In Panel B, we form three portfolios based on standardized measure of short-interest. In this table we provide portfolio regression results for the six portfolios based on individual signals from insider trading and short interest. *Hedged* corresponds to a portfolio that buys stocks with extreme signals. For each portfolio, we regress mean portfolio return (equal and value-weighted) in excess of risk-free rate on excess return on the market along with SMB, HML and UMD factors. We estimate the regression models with 132 monthly observations from January 1993 till December 2003. Robust t-statistics are provided in the brackets.

	Equal-Weighted Returns						Value-Weighted Returns					
	Alpha Market	SMB	HML	UMD	R ²	Alpha Market	SMB	HML	UMD	R ²		
Panel A: Insider Trading Strategy												
Selling (I)	-0.38 (-2.87)	0.96 (21.56)	0.37 (7.65)	0.54 (10.84)	-0.06 (-2.17)	86.85%	-0.37 (-3.80)	0.85 (27.18)	-0.17 (-5.16)	0.19 (4.50)	0.00 (0.09)	89.50%
Neutral (II)	0.10 (0.88)	0.96 (28.87)	0.53 (12.67)	0.60 (14.68)	-0.21 (-7.33)	93.25%	0.13 (1.49)	0.99 (32.01)	-0.12 (-5.13)	0.27 (6.61)	-0.05 (-3.19)	94.80%
Buying (III)	0.95 (3.72)	0.95 (15.16)	0.55 (7.56)	0.63 (8.62)	-0.35 (-4.02)	85.04%	0.16 (0.83)	1.00 (16.71)	-0.28 (-5.14)	0.30 (4.20)	-0.18 (-4.23)	82.44%
Hedged (III-I)	1.33 (5.11)	-0.01 (-0.16)	0.18 (3.31)	0.09 (1.20)	-0.29 (-3.43)	44.13%	0.53 (2.52)	0.15 (2.33)	-0.10 (-1.54)	0.11 (1.38)	-0.18 (-4.12)	26.50%
Panel B: Shorts Trading Strategy												
Increasing (I)	-0.29 (-2.56)	1.04 (26.71)	0.48 (10.24)	0.65 (12.27)	-0.18 (-7.25)	92.02%	-0.09 (-0.57)	0.94 (23.92)	-0.04 (-1.22)	0.30 (5.98)	-0.04 (-0.82)	89.50%
Neutral (II)	0.09 (0.74)	0.93 (25.99)	0.45 (11.03)	0.58 (14.09)	-0.20 (-6.67)	91.98%	-0.07 (-0.61)	0.95 (29.56)	-0.20 (-7.32)	0.27 (6.93)	-0.04 (-1.96)	92.16%
Covering (III)	0.49 (3.33)	0.91 (20.77)	0.56 (10.10)	0.56 (10.94)	-0.22 (-4.97)	89.06%	0.18 (1.26)	0.96 (23.50)	-0.20 (-6.03)	0.13 (2.97)	-0.10 (-2.37)	91.06%
Hedged (III-I)	0.78 (5.69)	-0.13 (-3.41)	0.08 (1.82)	-0.09 (-1.73)	-0.04 (-0.93)	13.71%	0.26 (-1.03)	0.02 (-0.32)	-0.16 (2.70)	-0.17 (2.11)	-0.06 (0.68)	10.22%

Table 5: **Fama-French regressions: Interactions strategies**

This table provides results from Fama-French calendar time portfolio return regressions for trading strategies based on different combinations of short interest and insider trading signals. We classify stocks into insider selling, insider neutral, or insider buying group depending on the direction of insider trading in the preceding month. We independently sort stocks into three groups based on standardized short-interest measure as well. In this table we provide portfolio regression results for the nine combination portfolios formed on the basis of these two signals. *Hedged* corresponds to a portfolio that buys stocks with positive signals from both agents (insiders buying and shorts covering) and sells stocks with negative signals from both agents (insiders selling and shorts increasing). For each portfolio, we regress the mean portfolio return in excess of risk-free rate on excess return on market along with SMB, HML, and UMD factors. We estimate the regression models with 132 monthly observations from January 1993 till December 2003. Robust t-statistics are provided in the brackets.

	Equal-Weighted Returns					Value-Weighted Returns						
	Alpha	Market	SMB	HML	UMD	R ²	Alpha	Market	SMB	HML	UMD	R ²
	Insider Selling											
SI H (I)	-0.56 (-3.37)	1.03 (22.69)	0.42 (8.53)	0.58 (10.03)	-0.04 (-1.10)	85.02%	-0.46 (-2.14)	0.85 (13.71)	-0.08 (-1.09)	0.18 (2.51)	0.06 (0.94)	70.84%
SI M (II)	-0.41 (-2.46)	0.93 (16.57)	0.34 (6.35)	0.55 (9.84)	-0.09 (-2.48)	82.05%	-0.44 (-2.75)	0.89 (21.90)	-0.21 (-4.63)	0.28 (4.31)	0.00 (0.12)	80.62%
SI L (III)	-0.09 (-0.51)	0.92 (17.66)	0.33 (4.77)	0.49 (6.99)	-0.03 (-0.79)	77.36%	-0.22 (-1.18)	0.85 (16.05)	-0.20 (-3.51)	0.07 (0.88)	-0.04 (-0.78)	75.48%
	Insider Neutral											
SI H (IV)	-0.31 (-2.79)	1.04 (27.19)	0.52 (10.53)	0.66 (12.27)	-0.19 (-6.87)	92.08%	-0.02 (-0.18)	1.01 (20.92)	0.03 (0.64)	0.40 (5.17)	-0.04 (-0.78)	86.79%
SI M (V)	0.11 (0.97)	0.93 (28.89)	0.48 (12.73)	0.58 (14.73)	-0.22 (-7.75)	92.35%	0.14 (1.04)	0.96 (26.51)	-0.17 (-4.69)	0.24 (4.58)	-0.05 (-1.88)	88.63%
SI L (VI)	0.46 (3.17)	0.91 (20.60)	0.59 (11.11)	0.57 (10.11)	-0.22 (-5.75)	88.47%	0.34 (1.63)	1.00 (15.23)	-0.17 (-2.96)	0.16 (2.10)	-0.11 (-1.91)	85.09%
	Insider Buying											
SI H (VII)	0.52 (2.01)	1.06 (14.27)	0.48 (5.81)	0.69 (7.26)	-0.37 (-4.83)	81.72%	0.00 (-0.01)	0.99 (10.58)	-0.06 (-0.59)	0.42 (2.64)	-0.29 (-3.22)	64.12%
SI M (VIII)	0.91 (3.26)	0.94 (13.85)	0.51 (6.69)	0.62 (6.91)	-0.30 (-3.59)	77.75%	0.11 (0.38)	1.01 (13.68)	-0.25 (-3.22)	0.43 (5.13)	-0.17 (-2.42)	68.54%
SI L (IX)	1.29 (3.77)	0.87 (10.54)	0.64 (7.08)	0.58 (6.65)	-0.37 (-3.17)	75.59%	0.49 (1.67)	0.98 (11.16)	-0.28 (-2.94)	0.28 (2.43)	-0.19 (-2.98)	64.54%
Extreme (IX-I)	1.85 (4.53)	-0.16 (-1.80)	0.22 (2.57)	0.00 (-0.04)	-0.33 (-2.34)	23.99%	0.94 (2.54)	0.13 (1.04)	-0.20 (-1.46)	0.10 (0.80)	-0.25 (-2.67)	16.19%

Table 6: Persistence of returns

This table provides estimation results from Fama-MacBeth regression model for 1, 3, and 6 months return (over the risk-free rate) as the dependent variable. *Insider Neutral x Shorts Increasing* is a variable that equals one if insiders are neutral (neither net buyers or sellers) and standardized short-interest falls in the top 1/3rd of monthly distributions, zero otherwise. *Insider Neutral x Shorts Covering* is defined similarly. MCAP stands for market capitalization at the beginning of the month, M/B denotes market to book value of equity. Last month's return measures the raw return of previous months. To remove skewness bias, MCAP, M/B, and Last Month's Returns are all ranked between zero to one on a monthly basis and we use these ranks in the regressions. We estimate this cross-sectional regression on a monthly basis for 132 months and then report the time-series means and t-statistics based on these estimates. For 3- and 6-month return regressions, t-statistics are based on Newey-West correction with 2 and 5 lags, respectively.

	1-month	3-months	6-months
	beta (t)	beta (t)	beta (t)
Insider Neutral x Shorts Increasing	-0.26% (-3.17)	-0.80% (-4.91)	-1.45% (-4.51)
Insider Neutral x Shorts Covering	0.20% (2.08)	0.76% (4.19)	1.48% (4.03)
MCAP	0.08% (0.15)	0.07% (0.06)	-0.33% (-0.11)
M/B	-0.74% (-1.59)	-1.52% (-1.45)	-3.35% (-1.48)
Last Month's Return	-1.30% (-3.34)	-0.82% (-1.31)	0.29% (0.39)

Table 7: Improvement in realizable returns

This table provides results from Fama-French calendar time portfolio return regressions for trading strategies based on (i) a strategy that forms portfolio based purely on insider trading signals, and (ii) a strategy that combines the two signals (combined strategy). For the insider-trading strategy, the portfolio buys stocks in the insider-buying group and sells shorts stocks in insider-selling group. For the combined strategy the investor buys stocks that have positive signals from both sources (insider buying and shorts covering) and sells shorts stocks that have negative signals from both (insider selling and shorts increasing). For each portfolio, we regress the mean portfolio return in excess of risk-free rate on excess return on market along with SMB, HML, and UMD factors. We estimate the regression models with 132 monthly observations from January 1993 till December 2003. Robust t-statistics are provided in the brackets.

	EW Return					VW returns						
	Alpha	Market	SMB	HML	UMD	R ²	Alpha	Market	SMB	HML	UMD	R ²
Insider Only	1.33 (5.11)	-0.01 (-0.16)	0.18 (3.31)	0.09 (1.20)	-0.29 (-3.43)	44.13%	0.53 (2.52)	0.15 (2.33)	-0.10 (-1.54)	0.11 (1.38)	-0.18 (-4.12)	26.50%
Combined	1.85 (4.53)	-0.16 (-1.80)	0.22 (2.57)	0.00 (-0.04)	-0.33 (-2.34)	23.99%	0.94 (2.54)	0.13 (1.04)	-0.20 (-1.46)	0.10 (0.80)	-0.25 (-2.67)	16.19%
Difference	0.52 (2.39)	-0.15 (-2.66)	0.04 (0.69)	-0.09 (-1.47)	-0.04 (-0.43)	5.21%	0.42 (1.30)	-0.02 (-0.20)	-0.10 (-0.91)	-0.01 (-0.07)	-0.07 (-0.79)	0.00%

Table 8: Fama-MacBeth regression

This table provides results from Fama-McBeth regression estimates. The dependent variable is the one-month stock return in excess of risk-free rate. *'Insider Buying x Shorts Covering'* is a variable that equals one if insiders are net buyers in the preceding month and the stock's standardized short-interest at the beginning of the month falls in bottom $1/3^{rd}$, zero otherwise. *'Insider Selling x Shorts Increasing'* is a variable that equals one if insiders are net sellers and standardized short-interest falls in top $1/3^{rd}$, zero otherwise. Other interaction variables are defined similarly. MCAP stands for market capitalization at the beginning of the month, M/B denotes market to book value of equity. Last month's return measures the raw return of previous months. To remove skewness bias, MCAP, M/B, and Last Month's Returns are all ranked between zero to one on a monthly basis and we use these ranks in the regressions. We estimate this cross-sectional regression on a monthly basis for 132 months and then report the time-series means and robust t-statistics based on these estimates. We provide the statistical test for the difference in coefficients across shorts increasing and shorts covering group within each insider trading group at the bottom of the table.

		beta	beta
		(t)	(t)
I	Insider Selling x Shorts Increasing	-0.46%	-0.43%
		(-2.87)	(-3.88)
II	Insider Selling x Shorts neutral	-0.42%	-0.35%
		(-2.99)	(-3.06)
III	Insider Selling x Shorts Covering	-0.06%	-0.06%
		(-0.37)	(-0.42)
IV	Insider Neutral x Shorts Increasing	-0.27%	-0.21%
		(-2.96)	(-2.41)
V	Insider Neutral x Shorts Covering	0.37%	0.27%
		(3.39)	(2.95)
VI	Insider Buying x Shorts Increasing	0.40%	0.39%
		(2.05)	(2.07)
VII	Insider Buying x Shorts Neutral	0.75%	0.68%
		(4.24)	(3.93)
VIII	Insider Buying x Shorts Covering	1.04%	0.99%
		(4.80)	(5.63)
	MCAP		0.20%
			(0.36)
	M/B		-0.62%
			(-1.35)
	Last Month's Return		-1.33%
			(-3.41)
Test for difference in coefficient			
	III-I	0.39%	0.36%
		(2.21)	(2.11)
	V-IV	0.63%	0.49%
		(4.60)	(4.04)
	VIII-VI	0.64%	0.60%
		(2.48)	(2.63)

Table 9: **Incremental information in short-interest**

We first estimate a model of short-interest by regressing standardized short-interest on the extent of insider selling (net insider sales scaled by shares outstanding) in the same month. We collect the residual from this regression and label it as *residual short*. Now we consider stocks that fall in *insider selling* group and sort them into three groups based on *residual short*. The top group is called the *high residual short*, and the bottom group is called the *low residual short*. We perform similar exercise for stocks that fall in the *insider buying* group. Interaction variables are based on the combinations of insider trading and residual short interest signals. We regress next month's return on these indicator variables along with controls. MCAP stands for market capitalization at the beginning of the month, M/B denotes market to book value of equity. Last month's return measures the raw return of previous months. To remove skewness bias, MCAP, M/B, and Last Month's Returns are all ranked between zero to one on a monthly basis and we use these ranks in the regressions. We estimate this cross-sectional regression on a monthly basis for 132 months and then report the time-series means and robust t-statistics based on these estimates. We provide the statistical test for the difference in coefficients across high and low residual shorts within each insider trading group at the bottom of the table.

	beta	beta
	(t)	(t)
I Insider Sell x High Residual Short	-0.59%	-0.51%
	(-3.66)	(-4.82)
II Insider Sell x Low Residual Short	-0.02%	-0.03%
	(-0.14)	(-0.19)
III Insider Buy x High Residual Short	0.39%	0.38%
	(2.11)	(2.17)
IV Insider Buy x Low Residual Short	0.78%	0.76%
	(3.65)	(4.39)
MCAP		0.07%
		(0.12)
M/B		-0.69%
		(-1.51)
Last Month's Return		-1.31%
		(-3.39)
Test for difference in coefficient		
I-II	-0.57%	-0.48%
	(-3.14)	(-2.83)
IV-III	0.39%	0.38%
	(1.55)	(1.72)

Table 10: **Fama-MacBeth regression with Daily Data**

This table provides results from Fama-MacBeth regression results. The dependent variable is the average one-day stock return (in percentage) for different holding periods after the portfolio formation. *'Insider Buying x Shorts Covering'* is a variable that equals one if insiders are net buyers in the preceding day and the stock's standardized short-interest at the end of the preceding day falls in bottom $1/3^{rd}$, zero otherwise. *'Insider Selling x Shorts Increasing'* is a variable that equals one if insiders are net sellers and standardized short-interest falls in top $1/3^{rd}$, zero otherwise. Other interaction variables are defined similarly. We estimate this cross-sectional regression on a daily basis for 545 days and then report the time-series means and Newey-West corrected t-statistics based on these estimates.

Holding Period:	1-day	3-day	15-day	30-day
Dependent Var: % daily return	beta	beta	beta	beta
	(t-stat)	(t-stat)	(t-stat)	(t-stat)
I Low Insider x High Shorts	-0.0589 (-3.17)	-0.0460 (-3.82)	-0.0279 (-3.87)	-0.0230 (-3.58)
II Low Insider x Medium Shorts	0.0014 (0.07)	-0.0194 (-1.63)	-0.0219 (-2.62)	-0.0193 (-2.42)
III Low Insider x Low Shorts	0.0125 (0.60)	-0.0059 (-0.47)	-0.0082 (-1.03)	-0.0090 (-1.44)
IV Medium Insider x High Shorts	-0.0056 (-0.88)	-0.0051 (-1.21)	-0.0058 (-2.25)	-0.0056 (-3.29)
V Medium Insider x Low Shorts	0.0042 (0.69)	0.0042 (1.14)	-0.0014 (-0.61)	-0.0001 (-0.03)
VI High Insider x High Shorts	0.3980 (6.50)	0.3593 (11.69)	0.1315 (8.17)	0.0812 (5.43)
VII High Insider x Medium Shorts	0.2994 (5.60)	0.2437 (7.82)	0.0665 (4.27)	0.0395 (3.22)
VIII High Insider x Low Shorts	0.1526 (3.25)	0.1878 (5.45)	0.0622 (3.31)	0.0328 (2.08)

Table 11: **Robustness tests**

This table provides results from Fama-French calendar time portfolio return regressions for alternative ways of forming portfolios. In Panel A, we form monthly portfolio based on the level of short-interest (scaled by shares outstanding) in the spirit of Asquith, Pathak and Ritter (2005). If a stock's short-interest ratio is equal to or more than 2.5% we classify it into highly shorted group and provide the four factor regression estimates for the equally weighted return of this group in the table below. This replicates Asquith, Pathak and Ritter's results relevant to our study. In Panel B, we form two-by-two portfolio based on this measure of short interest interacted with whether insider's net buying has increased or decreased in a given month as compared to the previous month. We compute the net buy (buy minus sale) of company insider and the level of short-interest outstanding for each company from the 16th day of a month till the 15th day of the next month (both measures scaled by shares outstanding). If the net buy increases from month $t-2$ (i.e., from the 16th of month $t-3$ till 15th of month $t-2$) to month $t-1$ (i.e., from the 16th of month $t-2$ till 15th of month $t-1$), then we assign that stock to 'Insiders Buying' portfolio at the beginning of month t . If this measure decreases then we allocate the stock to 'Insider Selling' group. In Panel C, we use the innovation in short-interest ratio to form portfolios. If short interest (scaled by shares outstanding) comes down from month $t-2$ to $t-1$, then at the beginning of month t we assign the stock to 'Shorts Covering' portfolio, otherwise we assign it to 'Shorts Increasing' portfolio. Insider Buying and Selling portfolios are formed the same way as in Panel B. For each portfolio, we regress the mean (equal or value weighted) portfolio return in excess of risk-free rate on excess return on market along with SMB, HML and UMD factors. We estimate the regression models with 148 monthly observations from September, 1991 till December, 2003. Robust t-statistics are provided in the brackets.

	Alpha	Market	SMB	HML	UMD	R-2
Panel A: Based on Raw Short Interest Ratio						
SI/SO>2.5%	-0.55 (-3.12)	1.15 (22.67)	0.64 (9.19)	0.55 (8.57)	-0.24 (-5.88)	85.19%
Panel B: Based on Insider Signal and Raw Short Interest Ratio						
Equal Weighted Returns						
Insiders Selling, SI/SO>2.5%	-0.41 (-1.80)	1.15 (17.71)	0.60 (7.23)	0.52 (6.20)	-0.26 (-4.83)	78.44%
Insiders Buying, SI/SO<0.1%	0.59 (1.91)	0.72 (7.80)	0.70 (6.87)	0.44 (3.97)	-0.20 (-2.08)	60.46%
Value Weighted Returns						
Insiders Selling, SI>2.5%	-0.26 (-1.04)	1.14 (22.69)	0.16 (1.74)	0.26 (3.25)	-0.02 (-0.41)	69.96%
Insiders Buying, SI<0.1%	0.68 (2.36)	0.61 (7.89)	0.31 (3.24)	0.30 (2.62)	-0.06 (-1.04)	36.47%
Panel C: Insiders Signal and Monthly Innovation in Shorting Activity						
Equal Weighted Returns						
Insiders Selling, Shorts Increasing	-0.16 (-1.22)	1.01 (23.73)	0.46 (10.31)	0.59 (12.88)	-0.15 (-5.40)	88.29%
Insiders Buying, Shorts Covering	0.56 (3.30)	0.96 (19.78)	0.44 (7.15)	0.52 (8.94)	-0.21 (-4.12)	84.65%
Value Weighted Returns						
Insiders Selling, Shorts Increasing	-0.21 (-1.22)	0.90 (19.45)	-0.17 (-4.28)	0.23 (3.44)	-0.03 (-0.79)	79.27%
Insiders Buying, Shorts Covering	0.17 (1.11)	0.99 (21.69)	-0.28 (-6.75)	0.19 (3.43)	0.01 (0.22)	82.70%