MIT Sloan School of Management

MIT Sloan School Working Paper 4706-08
6/3/2008

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This Draft: June 2008

Abstract
We find evidence of significant increases in short sales immediately *prior* to large insider sales, consistent with information leakage and front-running. We examine a number of alternative explanations that the increase in short sales is driven by public information about the firm or about the impending insider sale, but the evidence is inconsistent with these explanations. The result has implications for the enforcement of insider information regulations, and for timely disclosure of short sales information by stock exchanges.

JEL Classification Code: G10, G14, G18, G30
Keywords: Short Selling; Insider Sales; Front Running; Information Leakage.

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We gratefully acknowledge helpful comments from David Aboody, Paul Asquith, Sabrina Buti, Jeff Callen, David Goldreich, Jack Hughes, Derek Johnson, Lynn Li, Atul Rai, Gordon Richardson, Konstantin Rozanov, Brett Trueman, Kevin Wang, Ross Watts, Joe Weber, Franco Wong and seminar participants at MIT, UCLA and Wichita State.

1. Introduction

We investigate whether front-running of insider sales occurs through short sales. Front-running refers to trading by some parties in advance of large trades by other parties, in anticipation of profiting from the price movement that follows the large trade. The price impact is expected to occur because of liquidity effects generated by the large trade or because of information about future firm prospects.[1] Front-running can occur when, for example, some parties are tipped off about an impending large sale or a brokerage trades on its own account prior to executing a client's large trade.

The motivation for this research stems from two sources. The first motivation is that the existence of front-running has long been alleged on Wall Street, prompting the SEC to recently open an investigation into the practice.[2] We examine front-running of large insider sales, as opposed to large sales by blockholders or mutual funds for example, since large insider sales likely are informative about the firm's future prospects (e.g., Seyhun, 1998), and therefore are expected to move prices even if market microstructure frictions are modest. Another advantage of examining trading in advance of large insider sales is to mitigate attribution problems: since insiders are likely the most informed of traders, trading in advance of insiders is more likely in expectation to be front-running than to be due to information that is superior to that of insiders.[3]

The second motivation for this paper is to examine front-running through short sales because: (i) we expect that private or leaked information is more likely to be

[1] Another alternative is downward sloping (excess) demand curves for stocks (e.g., Shleifer, 1986).
[2] See for example "SEC is looking at stock trading," by Jenny Anderson, The New York Times, Feb 6, 2007.
[3] Consider two traders A and B. If A trades in advance of B, this could be because A has more information about the firm's prospects than B, or because news about B's impending trade is leaked in advance to A. However, if B is known to be the most informed trader, such as an insider, then the former explanation is unlikely almost by definition, and the latter explanation is more plausible.

exploited in the relatively opaque environment of the short sale market, where disclosure about short sales is limited; (ii) the ability to short stocks allows market participants other than a firm's current shareholders to seek and bring news to the market, thereby broadening the pool of people who can trade in advance of insider sales; (iii) front-running (of mutual fund trades) by hedge funds has been alleged in the popular press, and hedge funds engage in short selling as part of their investment strategy.

Short sales account for a substantial proportion of trading volume, with estimates ranging from 13% of NYSE volume during 2000-2004 (Boehmer, Jones and Zhang, 2007), to 24% of NYSE volume in 2005 (Diether, Lee and Werner, 2007). Despite the volume however, short sales transaction data (such as the number of shares shorted or outstanding short interest) is currently not publicly observable in real time as exchanges report the level of short interest once a month. In this reporting environment, traders with private information can engage in large short sales without the fear of immediate and full price impact, and thereby enhance profits.

A novel feature of our study is that we use historical intra-day short selling *transaction* data that has recently become publicly available. This data, disclosed (monthly, not in real time) by NYSE pursuant to Regulation SHO, is available from January 2005 to May 2007. In contrast, the prior literature has generally used *monthly* short interest data (total short interest at one point in time, not transaction data for the month), or in very few instances has used proprietary transaction data. By combining daily short selling with daily insider sales data, we are able to take advantage of the higher frequency data to conduct an event study of short sales around insider sales.

We document an increasing trend of daily short sales in the days leading up to (the first day of) a large insider sale, and peaking sharply on the (first) day of the large insider sale. We define a large insider sale as the top 30% of all insider sales as a proportion of firm value. For small insider sales (the bottom 30% of insider sales), short sales peak at least two days *after* (the first day of) the insider sale. The result is consistent with front-running of large insider sales.

Insiders are required to disclose their trades to the SEC on Form 4 within two business days of the trade, and the SEC makes Form 4 publicly available online in real time. We expect the SEC filing date is when the general public first becomes aware of the insider trade. When we examine short sales around the Form 4 filing date, we find that short sales peak prior to the filing date for large insider sales, but after the filing date for small insider sales. This too is consistent with front-running of large insider sales.

For large insider sales, short sales are significantly higher (relative to the benchmark window) starting seven days before the first day of the insider sale. The benchmark window is the [-60, -11] trading day window prior to the first day of the insider sale. In contrast to the pattern of short sales, the *cumulative* abnormal stock returns are *positive* and increasing until the first day after large insider sales, and then become constant (neither increasing nor decreasing) thereafter. This suggests stock prices do not reflect the impending insider sale, and that short selling is contrarian behavior with respect to public information in the pre- insider sale window. This pattern of contrarian short sales, leading up to a large insider sale, is consistent with the short sales reflecting private information about the impending large insider sale.

Front-running insider sales through short sales can occur in a number of ways. For example, the brokerage executing the insider sale might trade on its own account prior to or even on the first day of executing the insider sale. Alternatively, the brokerage employees might tip off a favored client, such as a large hedge fund, in order to curry favor. Another example is that insiders might tip off others in advance (see for example Cornell and Sirri, 1992, on tipping by insiders), or short sell stock illegally (see for example Meulbroek, 1992, and Fishe and Robe, 2004, on illegal insider trading) to 'double dip' (profit from both short sale and sale of holdings) or to lock in capital gains prior to the sale. The SEC recently charged two former Countrywide Financial Corp. executives with illegally shorting Countrywide shares before the firm announced a decline in earnings.[4] However, the data does not allow us to identify who is responsible for the front-running.

Front-running is not in itself illegal if it is based on public information. In other words, if the front-runner is able to use public information to accurately predict the timing of large trades, then the front-running is not illegal. Front running by brokers trading on their own account prior to executing a client's trade (dual trading), and front-running facilitated by leaked information (e.g., tipping off by brokerage employees or insiders in advance of the insider sale), are illegal (Harris, 2003).

We caution that information leakage and front-running are difficult to establish directly. Therefore, we examine a number of alternative explanations for short sales leading insider sales. These alternative hypotheses, described in detail in Section 4, revolve around the ideas that: (i) the advance short sales may be driven by public

[4] "Two former Countrywide executives settle on trading charges," by Ted Cornwell, National Mortgage News, March 6, 2006.

information that helps predict insider sales; (ii) the short sales may be driven by events associated with the insider sale rather than the insider sale itself (confounding events); (iii) the insider sales may be in response to the short sales (reverse causality). We find that the evidence is inconsistent with these alternative hypotheses.

It is clearly interesting to examine whether the front-running or leakage is profitable, but this is complicated by the fact that we do not have data on when the short sales are covered. In particular, it is unclear how many days to include in the holding period to be examined. Further, holding period returns are typically calculated using daily closing prices, but the short sale may be profitably covered at an unknown intraday price if the price pressure is very short lived or intraday. Therefore, to provide evidence on the profitability of front-running or information leakage: (i) we examine and find that intraday stock price volatility increases around the insider sale, suggesting elevated potential for profits; (ii) we sort the large insider sales into quintiles based on their ex post cumulative abnormal returns (CAR) in the [1, 20] trading day window after the insider sale. We find that for insider sales that are followed by the most negative CAR, short sales peak four days before the insider sale. In contrast, for insider sales that are followed by the most positive CAR, short sales peak on the day of the insider sale rather than in advance of the sale. This suggests information leakage is likely profitable.

Illegal front-running and information leakage distort the playing field for market participants and can create adverse selection problems that limit market participation and inhibit efficient capital allocation (e.g., Harris, 2003). Leakage can be curtailed by regulatory enforcement action, or by 'shining light' through more timely disclosure of short sales by exchanges. Currently, exchanges are required to disclose the level of short

interest once a month, which only provides a snapshot. Disclosing higher frequency such as daily short sales activity will increase transparency and level the playing field by allowing broader market participants to exploit the information content of this data. However, regulators must also consider that short sellers will rationally respond to any new disclosure rule by altering their trading behavior to protect their private information advantage, thereby mitigating the value of simplistic disclosure rules.

The rest of this paper proceeds as follows. Section 2 discusses related literature. Section 3 describes the tests we conduct, the data and sample. Section 4 discusses the results, and describes tests of various alternative hypotheses. Section 5 concludes.

2. Related Literature

In this section we briefly discuss related literature to place the present study in context. In particular, we discuss front running, short selling, insider trading and price pressure.

Front-Running. Front-running is frequently alleged in practitioner circles, and was widely believed to have occurred around the Long Term Capital Management debacle of 1998. The empirical literature on front-running is relatively small, likely due to the difficulty of directly testing for front-running and the absence of relevant and publicly available data. Chen, Hanson, Hong and Stein (2007) present evidence suggesting that hedge funds engage in front-running of fire sales by distressed mutual funds. Chakravarty and Li (2003) use proprietary audit trail transaction data, and suggest that dual traders at the Chicago Mercantile Exchange do not engage in front-running.

The theoretical literature on dual trading examines the effects of front-running,

with conflicting conclusions. For example, DeLong, Shleifer, Summers and Waldmann (1990) suggest front-running increases price volatility and divergence from fundamental values. On the other hand, Grossman (1989) for example emphasizes the role of dual traders in enhancing liquidity and lowering trading costs.

Our objective in this paper is simply to provide empirical evidence on the existence of front-running of insider sales through short sales, rather than empirical evidence on the consequences of front-running.

Short Selling. Short selling dates back at least 400 years, and is fairly widely practiced across the world. A number of papers empirically examine whether short sellers are informed traders by using the distributional characteristics of returns as measures of price efficiency (e.g., Bris, Goetzman and Zhu, 2007; Wu, 2007) or using future abnormal return predictability as an indicator of information content (e.g., Brent, Morse and Stice, 1990; Desai, Ramesh, Thiagarajan and Balachandran, 2002; Asquith, Pathak and Ritter, 2005; Boehmer, Jones and Zhang, 2007; Diether, Lee and Werner, 2007). The evidence generally suggests short sellers are informed (though Brent et al., 1990, find no return predictability).

Other studies suggest short sellers anticipate adverse news in earnings announcements (Christophe, Ferri and Angel, 2004) and earnings restatements (Desai, Krishnamurthy and Venkataraman, 2006), consistent with short sellers being informed. However, Daske, Richardson and Tuna (2005) suggest short sellers do not anticipate bad news events and are therefore unlikely to be informed traders.

Evidence on whether short sellers are informed is important because it bears on: (i) some costs of short sales constraints. If short sellers are informed, their trades can

enhance informational efficiency and promote timely price discovery when short sales constraints are limited (e.g., Diamond and Verrecchia, 1987; Ofek and Richardson, 2003; Bai, Chang and Wang, 2006); (ii) the usefulness of higher frequency disclosures of short sales, such as transaction data (e.g., Aitken, Frino, McCorry and Swan, 1998; Christophe, Ferri and Angel, 2004).

Our study complements the literature discussed above in that we examine whether short sales lead insider sales. However, our study differs in that our focus is not so much on whether *'professional'* short *sellers* are informed, as on whether short *sales* contain information not yet impounded in prices. For example, a trader with adverse information may short sell on one occasion, though she is not a professional short seller. In other words, ours is a 'front-running or information leakage' story, not a 'superior information' story, where the former implies an unfair (illegal) and occasional advantage, while the latter implies a legal and consistent advantage based on information processing skills for example.

Insider Trading. There is an extensive literature on insider trading. One related branch is the literature on illegal insider trading, since front-running can occur when insiders tip off others about price-relevant information prior to trading themselves, or engage in illegal short selling prior to selling their stock. Cornell and Sirri (1992) investigate trading by insiders and their tippees in the 1982 Anheuser-Busch tender offer for Campbell Taggart. Meulbroek (1992) examines instances of illegal insider trading investigated by the SEC, and Fishe and Robe (2004) examine trading by brokers stemming from leaked information obtained in advance of the public. While these papers examine the impact of illegal insider trading (on for example market liquidity), our paper

differs in that we do not provide direct evidence on whether front-running is done by insiders or their tippees (i.e., whether the front-running is due to illegal insider trading), and our objective is not to examine the impact of illegal insider trading on stocks.

A second related branch is the literature on return predictability of insider sales. In order for information about a large upcoming insider sale to be exploited, insider sales should be *expected* to result in negative future returns. The evidence in Jaffe (1974), Finnerty (1976), Seyhun (1986, 1998), Damodaran and Liu (1993) and Jagolinzer (2007) suggests that insider sales precede negative abnormal returns,[5] and the evidence in Ke, Huddart and Petroni (2003) suggests that insider sales precede declines in firm performance.

Further, if large insider sales carry more information then front-running or information leakage is more likely for large insider sales. Seyhun (1986, 1998) shows that larger insider sales (as a proportion of firm value) result in more negative abnormal stock returns, while Datta and Iskandar-Datta (1996) show that the size of the insider sale is a signal used by bond traders in identifying information-motivated insider sales. For small insider sales, the potential cost of front-running or leaking information (for example, termination of employment or legal consequences) about the impending sale is the same as it is for leaking information about large insider sales, but the potential benefit of front running is smaller because of smaller expected price impact, thereby deterring front-running or leakage.

Therefore, it is reasonable to expect that leaked information about an impending large insider sale will be exploited and that traders will attempt to front-run large insider sales.

[5] However, Lakonishok and Lee (2001) do not find evidence that insider sales predict negative returns.

In a concurrent working paper, Purnanandam and Seyhun (2007) examine the return predictability of short sales conditioned on an insider trade. Our paper differs from theirs in several ways. First, our research objective is to examine potentially illegal behavior (front-running) by some market participants, rather than develop an implementable trading strategy. Second, we use daily short sale transaction data, while they use monthly short interest (which is a snapshot at a point in time). We are therefore able to conduct an event study (short window tests) around insider sales. Third, we examine whether information about the impending insider sale is leaked, and how the size of the insider sale relates to information leakage. The leakage story requires short window tests with daily data.

Price Pressure. Front-running is more likely when the trade being front-run is expected to move prices. Prices can be expected to move if the trade is informative with respect to the firm's future prospects as discussed above, if the trade generates price pressure due to liquidity effects or if there is a downward sloping (excess) demand curve for stocks.

The price pressure hypothesis suggests prices will dip temporarily if there is a large sale, while the downward sloping demand curve hypothesis suggests a permanent decrease in stock prices due to an increase in supply. There are a number of papers on price pressure and downward sloping demand. Kraus and Stoll (1972), Harris and Gurel (1986) and Coval and Stafford (2007) suggest the existence of price pressure, but Scholes (1972) and Mikkelson and Partch (1985) do not find evidence to support the price pressure story. Shleifer (1986) provides evidence consistent with downward sloping demand.

Our objective in this paper is not to distinguish between these alternative explanations for price movements, but simply to suggest that front-running will occur if any of these mechanisms is *expected*.

3. Tests, Data and Sample

3.1. Tests

We examine daily short sales around the first day of an insider sale (sales may execute over multiple days in some cases). The particular insider we consider is the CEO. Our test window is the [-10, +10] trading day window around the insider sale (day 0), and the benchmark window (for the normal or expected level of daily short sales) is the [-60, -11] trading day window.

We ensure that the test window is free from events that are known to affect short sales. In particular, we ensure that there are no earnings announcements in the [-15, +15] trading day window for two reasons: (i) Bettis, Coles and Lemmon (2000) report that many firms restrict insiders to trading three to twelve trading days after earnings announcements, so that insider trades in this period are predictable once earnings are announced; (ii) Christophe et al. (2004) show that short sales increase prior to negative earnings announcement, so it is important to ensure that the increasing short sales we observe are in anticipation of the insider sale rather than in anticipation of the earnings announcement. Further, we examine abnormal stock returns in the test window to verify that there is no public information to which the short sales may be responding. Finally, we also exclude the earnings announcement week from the benchmark window, because our objective is to use the benchmark window to calculate 'normal' short sales.

We conduct the event study separately for large and small insider sales, where we define large (small) sales as the top (bottom) 30% of insider sales as a percent of firm market value. This is because larger sales are expected to carry more information and have larger price impact, so information leakage and front-running are more likely for the larger sales (e.g., Seyhun, 1986, 1998; Datta and Iskandar-Datta, 1996). We scale insider sales by firm market value given the evidence in Seyhun (1986). However, as we note in Section 4, the result is robust to scaling by normal daily trading volume (average daily trading volume in the benchmark window), and the correlation between insider sales scaled by firm market value or by trading volume is large (0.84). Further, the results are robust to defining large (small) insider sales as the top (bottom) quintile or decile.

It is possible that large insider sales are not informative for prices if informed insiders fragment their sales in order to mask its information content (e.g., Barclay and Warner, 1993) or to price discriminate (Harris, 2003). We expect this is unlikely to be an issue because: (i) we use the total sale, rather than transaction size, to identify large sales. A large sale may be fragmented into smaller transactions, but the sum of the sales from all transactions will be invariant; (ii) this biases against finding a result for large insider sales; (iii) other mechanisms such as price pressure from liquidity effects can allow large insider sales to move prices.

We examine daily short sales around both the insider sale date and the SEC filing date (which is presumably when the sale is known publicly). During our sample period from January 2005 to May 2007, insiders are required under Sarbanes-Oxley 2002 to report sales electronically on Form 4 within two business days of the sale, and the SEC makes Form 4 available online (through EDGAR) on the day of filing.

We also conduct multivariate tests by estimating event-specific regressions (where each insider sale is a separate event) and reporting the average coefficients (Schipper and Thompson, 1983; Campbell, Lo and MacKinlay, 1997). We regress daily short sales on an event dummy that is 1 in the [-5, 0] trading day window before the insider sale, and 0 in the [-60, -11] day benchmark window. Therefore, each regression has 56 observations (6 days from the event window and 50 days from the benchmark window). Other controls in the regression include the firm's contemporaneous and lagged daily stock returns, intraday stock price volatility and daily trading volume. These are included since short sales may be in response to speculation that the stock is temporarily overpriced (if daily return is high), in response to heightened intraday price volatility that affords greater opportunity for profit or in response to higher trading volume that affords an opportunity to earn a liquidity premium. The variable of interest is the event dummy, and we report mean coefficients and t-statistics for large insider sales and small insider sales.

Finally, we identify a number of alternative explanations for short sales leading insider sales. These alternative hypotheses revolve around the ideas that: (i) the advance short sales may be driven by public information that helps predict insider sales; (ii) the short sales may be driven by events associated with the insider sale rather than the insider sale itself (confounding events); (iii) the insider sales may be in response to the short sales (reverse causality). The alternative hypotheses are described in detail and tested in Section 4.

3.2. Data

We obtain daily returns, prices and shares outstanding from CRSP, and annual accounting data from Compustat. Intra-day short sales transactions data is obtained from the NYSE TAQ database that reports short sales on NYSE from January 2005 through May 2007. This data was reported by NYSE pursuant to Regulation SHO. We aggregate intraday data to obtain daily short sales data.

Size is the log of market value of equity, where market value is price (Compustat data199) times shares outstanding (data25) at the last fiscal year-end before the insider sale. The *market/book* ratio is market value of equity divided by book value of equity (data60). *Shares Outstanding* is the number of shares outstanding.

Event Date Short Transactions is the number of short sale transactions on the insider sale date. *Average Daily Short Transactions* is the average number of daily short sale transactions over the entire sample period. *Event Date Short Sales* is the number of shares shorted, as a percent of shares outstanding, on the insider sale date. *Average Daily Short Sales* is the mean daily number of shares shorted as a percent of shares outstanding, over the entire sample period. *Insider Sales* are the shares sold by the CEO as a percent of the firm's shares outstanding. *Frequency of Insider Sales* is the number of distinct insider sales per firm over the entire sample period. *Days between Transaction and Filing* is the number of days from the insider sale date to the SEC filing date.

3.3. Sample

Table 1 describes the sample selection procedure. We start with all open market insider sales as reported to the SEC in Table 1 of Form 4 (Seyhun, 1998; Ke, Huddart and

Petroni, 2003). We then delete insider trading records assigned a cleansing code of "A" or "S" by Thomson Financial (e.g., Narayanan and Seyhun, 2007).[6] After merging the different datasets, ensuring that we have a benchmark window for all insider sales events, eliminating insider sales events that have earnings announcements within 15 days, and eliminating insider sales that don't fall on the first day of the sale (recall that some insider sales are executed over multiple days, so we count sales on subsequent days as part of the sale on the first day rather than as independent sales), we are left with a final sample of 2,030 insider sales events.

Table 2, Panel A reports descriptive statistics for the full sample. Mean firm *size* of 7.84 implies a mean market value of about $2.5b, so the firms in our sample are large firms on average. The mean *market/book* is 3.85, suggesting the presence of some growth firms. The mean of *Average Daily Short Sales* is 0.18, while the mean *Event Date Short Sales* is 0.20%. This suggests short sales are higher on the insider sale date than on other days by about 0.02% of shares outstanding. To put this in some context, the mean number of shares outstanding is about 158 million, which would imply about an additional 32,000 shares being shorted on the insider sale date for the average firm. Multiplying 32,000 shares by 2,030 insider sales events, and then by an average share price of $50, suggests substantial abnormal short sales response to insider sales.

The mean of *Average Daily Short Transactions* is 478, while the mean *Event Date Short Transactions* is 538, suggesting the number of short sale transactions increases by about 13% on average on insider sale dates. The mean *Insider Sales* is 0.06% of shares

[6] According to Thomson Financial, these cleansing codes identify observations for which: (1) collection requirements were not met; (2) numerous data elements were missing or invalid; or (3) reasonable assumptions could not be made.

outstanding, but 8.13% of trading volume. Finally, the mean *Frequency of Insider Sales* is 3.2 distinct sales events per firm over the entire sample period.

Panel B (C) of Table 2 shows descriptive statistics for large (small) insider sales. While we measure the size of the insider sale based on first day sales, the results are robust if we base size on sales over up to five consecutive days. Further, the correlation between the size of the insider sale measured based on first day or multiple consecutive day sales is large (over 0.9). In Panels B and C, mean insider sales are 19.38% of normal daily trading volume for large sales but 1.24% of daily trading volume for small sales. Firm size and shares outstanding (market/book ratio) are smaller (is larger) for the large insider sale sample compared to the small insider sample, suggesting firms in the large insider sale sample are relatively smaller and have higher expected growth than firms in the small insider sale sample.

Table 3, Panel A (Panel B) shows the distribution of *Average Short Sales* and *Insider Sales* by calendar month (by industry). As Panel A shows, neither short sales nor insider sales appear concentrated in any month, which suggests an absence of any calendar time-based explanation (e.g., tax) for the pattern of shorts leading insiders that we document in the next section. In addition, Panel B suggests that the sample is not dominated by any particular industry.

4. Results

Short Sales Leading Insider Sales. Figure 1, Panels A and B, show demeaned daily short sales, as a percent of shares outstanding, in the [-10, +10] trading day window around the event which occurs on day 0. The mean daily short sales is calculated over

the benchmark [-60, -11] trading day window. The event in Panel A is the insider sale date, which is the first day of the sale. The event in Panel B is the SEC Form 4 filing date. The figure shows full sample results.

Figure 1, Panel A shows that short sales increase before the insider sale and peak on the day of the sale. Panel B shows that short sales increase and peak prior to the SEC filing date. Short sales rise sharply two days before, and peak one day before, the SEC filing date which is presumably when the insider sale becomes publicly known. This is the first suggestion that information about the insider sale is leaked in advance.

If the largest insider sales are more likely to have adverse price impact, we would expect the patterns in Figure 1 to be more pronounced for large insider sales. Table 4 show daily demeaned short sales, and t-statistics, in the [-10, +10] day window around large and small insider sales, while Figure 2, Panel A provides a graphical depiction of the same result for convenience. Figure 2, Panel A shows that short sales begin to increase seven days before a large insider sale, and show a pronounced peak on the day of the large insider sale. In contrast, there does not appear to be a relation between short sales and small insider sales in the pre-event window, but short sales on day +2 following a small insider sale are significantly higher than in the benchmark window. In Figure 2, Panel B, day 0 is the SEC Form 4 filing date. Panel B shows the same pattern as Panel A, except that short sales show a pronounced increase two days before the SEC filing date, and peak one day before the SEC filing date, for large insider sales.

The pattern of the short sales around large insider sales, contrasted with short sales around small insider sales in Figure 2, Panels A and B, is consistent with leakage of information in advance of large insider sales (that presumably have the largest price or

price volatility impact), or advance private exploitation of information about the impending insider sale.

Regression-based Tests. Table 5 shows the results of multiple regressions run for each insider sale event in the large insider sale sample and also in the small insider sale sample, as described in Section 3.1. Each regression has 56 observations as described previously, and 608 (609) regressions are run in the large (small) insider sale sample. The table shows mean coefficients from these regressions, and t-statistics based on the standard error of the mean coefficient across the regressions. The coefficient of interest is the event dummy. The table shows a significant event dummy for the large insider sales sample, but not for the small insider sales sample. This suggests that for large insider sales, short sales are significantly higher in the [-5, 0] day window than in the benchmark [-60, -11] day window, where day 0 is the insider sale date.

We verify that the result is robust to: (i) excluding day 0 and defining the event dummy as 1 in the [-5, -1] day window, in order to ensure that the significant event dummy for large insider sales is not driven by the heightened short sales on day 0; (ii) defining the event dummy as 1 in the [-3, -1] day window; (iii) scaling insider sales by normal daily trading volume (rather than shares outstanding); (iv) defining large and small insider sales as the extreme quintiles or deciles (rather than extreme 30%); and (v) measuring the size of the insider sale based on multiple consecutive day sales (rather than first day sales only). Finally, when we define the event dummy as 1 in the window [-10, -6], we obtain an insignificant coefficient on this dummy, suggesting short sales on days -6 to -10 are not abnormally high.

To further assess the robustness of the result in Table 5 we conduct randomization tests as follows: (i) recall that for a given insider sale event we have fifty-six days associated with the event, fifty days in the benchmark window and six days in the event window. We start by *redefining* the event dummy as 1 for six randomly selected days out of the original benchmark window of fifty days, and 0 for all other days (including the true event days); (ii) we do the same for all insider sale events, and then run 608 regressions, one for each of the 608 large insider sale events; (iii) we compute the mean of the 608 event dummy coefficients, and the t-statistic based on the standard error of the 608 coefficients. This yields one t-statistic that we can compare to the t-statistic of 2.82 reported in Table 5; (iv) we repeat this procedure 1000 times, to obtain 1000 t-statistics.

In the 1000 trials, we find that a t-statistic of 2.82 has a zero probability, and the probability of obtaining a t-statistic greater than 1.64 is 0.015. This suggests the significant mean event dummy coefficient reported in Table 5 is due to a strong 'treatment effect' rather than simply chance.

Overall, the regression result is consistent with front-running of large insider sales based on leaked information.

Abnormal Stock Returns Before the Insider Sale. Table 6 shows daily abnormal (or market adjusted) stock returns, and their t-statistics, in the [-10, +10] trading day window around large and small insider sales. The table shows that abnormal returns are non-negative (either significantly positive or zero) before the insider sale, suggesting an absence of adverse public information about the firm in that window. This implies that short sales in the pre- insider sale window are reacting to something other than adverse public information about the firm.

Figure 3 provides a graphical depiction of cumulative (rather than daily) abnormal stock returns, in the [-10, +10] trading day window around large and small insider sales. The figure shows that CAR_VW (value-weighted cumulative abnormal return) increases before all insider sales, and then levels off after the sale, but the increase in CAR is most pronounced for large insider sales.[7]

The flat CAR plot in the post- insider sale window in Figure 3, and the non-negative daily abnormal returns in the same window in Table 6, seem to suggest that perhaps short selling ahead of insider sales is not profitable. However, we argue against this interpretation because we do not observe when the short sales are covered. In particular, it is unclear what holding period to examine (i.e., it is unclear how many days these short sellers maintain their position). Further, holding period returns are typically calculated using closing prices, but the short sales may be covered at an unknown intraday price if the price pressure generated by the large sale is very short-lived or intraday.

Two results provide some evidence on the profitability of leakage. First, in unreported tests we find that intraday stock price volatility in the pre- insider sale window is higher for large insider sales, and peaks on the day of the insider sale. Higher price volatility affords greater opportunity to cover shorts profitably, and is consistent with short-lived or intraday price pressure.

Second, we sort the large insider sales into quintiles based on their ex post CAR in the [1, 20] day window after the insider sale. Quintile 1 (Quintile 5) contains the observations with the most negative (positive) CAR following the insider sale, and is therefore the most (least) profitable for advance short sales. Table 7 shows daily short

[7] Figure 3 is unchanged if we use equal-weighted CAR.

sales and daily abnormal stock returns for Quintiles 1 and 5 in the [-10, +10] trading day window around the insider sale. The table shows that for quintile 1 (the most ex post profitable for advance short sales), short sales peak four days before the insider sale (day -4). In contrast, for quintile 5 (the least ex post profitable for short sales), short sales peak on the day of the insider sale (day 0) rather than in advance of the sale. This suggests that leakage is likely profitable.

In summary, the results in this section suggest large insider sales are front-run by short sales. The front-running is not due to public information as reflected in stock returns, suggesting information about large insider sales is leaked in advance of the sale.

4.1. *Alternative Hypotheses*

In this section we examine a number of alternative hypotheses (to the information leakage and front running hypothesis) that could potentially explain short sales leading large insider sales. As described below, we find the evidence is inconsistent with these alternative hypotheses.

Reverse causality. Under this story, short sales do not increase in response to insider sales, but rather, insiders sell in response to increases in short sales. However, this story does not explain the evidence because: (i) short sales transactions are not publicly observable by managers. Even the transaction data we use was made available once a month. Therefore, insiders can not sell in response to unobservable increases in short sales; (ii) short sales increase and peak two days after small insider sales, so short sales appear to respond to insider sales rather than vice versa, in this case. It is therefore reasonable to expect short sales to increase in response to news of large insider sales,

which would be consistent with early response (pre- insider sale) if information about the insider sale is leaked. Therefore, the evidence appears more consistent with the information leakage story than with the reverse causality story.

Liquidity Provision or Speculation by Contrarian Short Sellers. Figure 3 shows that cumulative abnormal returns are positive and increasing prior to all insider sales, and especially so for the large insider sales. Therefore it is possible that short sellers are speculating that the stock is temporarily overpriced, or are attempting to earn a premium for providing liquidity if there is temporary buying pressure on the stock. The entirety of the evidence is inconsistent with these explanations for two reasons: (a) these two stories do not predict that (or explain why) insiders sell a few days later, since insiders are unlikely to trade to exploit temporary mispricing or to provide temporary liquidity (Seyhun, 1998); (b) the two stories don't explain the differential response of short sales to the size of the insider sale, that is, they don't explain why (i) short sales do not lead small insider sales even though abnormal returns are increasing and positive before small insider sales, or (ii) why short sales increase two days after small insider sales when abnormal returns are non-positive and there is presumably less buying pressure.

In addition, the regression tests in Table 5 show that, in the large insider sale sample, short sales are significantly higher in the pre-insider sale window after controlling for contemporaneous and lagged stock returns, trading volume and price volatility (proxies for the speculation and liquidity provision motives). Therefore, the contrarian short sale (for large insider sales) in the pre-insider sale window is more consistent with anticipation of the impending large insider sale based on leaked information.

IPO Lockup Expiration. If the insider sale occurs at an IPO lockup expiration then it may be anticipated by short sellers if the lockup period is publicly known. For this explanation to be viable, our sample would have to be dominated by firms less than one year old. We find however that for firms with large insider sales, the median firm age is 12 years and the first quartile of firm age is 7 years. Further, we find that short sales lead insider sales after excluding firms with only six months of listing history on CRSP (six months is the typical lockup period). Therefore, the IPO lockup expiration story does not explain the evidence.

Mergers and Acquisitions (M&A). If the insider sale follows a publicly announced merger, and the shorted firm is the acquirer as in standard merger arbitrage (Baker and Savasoglu, 2002; Geczy, Musto and Reed, 2002), then short sales may not be attributable to foreknowledge of insider sales. However, this story does not explain: (i) why acquirer insiders make large sales following the announcement of an acquisition, especially since this could be interpreted by the market as an unfavorable signal; (ii) the differential response of short sales to the size of the insider sale, that is, why short sales increase and peak before large insider sales but not small insider sales; (iii) why abnormal stock returns are positive and increasing before the insider sale, if the shorted firm is the acquirer. Typically, acquirers experience non-positive stock returns when the acquisition is announced. Nevertheless, we use Compustat footnote code 1 to identify firms involved in M&A in the year of the insider sale (e.g., Hribar and Collins, 2002), and then exclude these firms from the sample. M&A firms accounted for 16.3% of the large insider sales sample. We find in unreported tests that short sales lead large insider sales after eliminating M&A firms, suggesting the M&A story does not explain the evidence.

Insider Sales Resulting from Vested Options. Under this story, the executive option vesting schedule is publicly known (for example, grant dates may be known from SEC filings and vesting dates would likely be on grant date anniversaries), and short sellers are hoping to exploit the adverse effect of temporary selling pressure on stock prices when managers make large sales. Note that this explanation requires that managers sell on the vesting date or in the very few days immediately after vesting. Insider sales on an arbitrary date after vesting are not predictable. We therefore exclude the 31 insider sales events with option vesting dates in the five trading day window prior to the insider sale, and then examine whether short sales lead large insider sales. The result, not reported, is robust, suggesting the option vesting story does not explain the evidence.

Insider Sales Resulting from Exercised Options. If the CEO exercises a large number of options, and this is publicly known, it may also be anticipated that she will fairly quickly sell these shares for diversification or liquidity. In this case, the short sales may be a reaction to option exercise rather than due to foreknowledge of the insider sale. This explanation requires that the CEO sell immediately after option exercise, since sale on an arbitrary date after exercise is not predictable. We therefore exclude the 34 insider sales events (out of 2,030) with options exercise in the five trading day window prior to the insider sale, and then examine whether short sales lead large insider sales. Unreported tests show the results are robust, suggesting the option exercise story does not explain the evidence.

Earnings Announcements. Under this story short sales do not anticipate the insider sale, but rather, anticipate earnings announcements (Christophe, Ferri and Angel,

2004), and that insider sales follow earnings announcements because insiders are prohibited by firm policy from selling until two days after an earnings announcement (Bettis, Coles and Lemmon, 2000). However, we conduct all tests after excluding earnings announcements in the [-15, +15] trading window around the insider sale, thereby ruling out this explanation.

Sales by Other Insiders. To ensure that short sales are not responding to sales by insiders other than the CEO, who sell just before the CEO, we exclude the 148 large CEO sales events with sales by other insiders (the top 5 executives) in the previous five trading days. Unreported tests show that short sales lead large insider sales in the remaining sample (they are significantly higher starting two days before the large insider sale).

In summary, the evidence appears inconsistent with the alternative hypotheses described above, and appears more consistent with information leakage and front-running.

5. Conclusion

We examine front-running of large insider sales through short sales since large (as opposed to small) insider sales are expected to have greater short-term price impact or to carry more information about the firm's future prospects. Consistent with information leakage and front-running, we find that short sales are significantly higher than average in the days leading up to *large* insider sales, and peak on the day of *large* insider sales (day 0). In addition, short sales increase and peak one day before the large insider sale is reported to the SEC (and therefore before the insider sale becomes publicly known). In contrast, this result does not hold for *small* insider sales. We identify and test a number

of alternative explanations (to information leakage and front-running) for the pattern of short sales leading insider sales, but the evidence is inconsistent with these explanations.

A novel feature of our evidence is that we use newly public high frequency data on short sales transactions. Prior studies have used monthly short interest data, or proprietary high frequency data in a very few cases, to explore the return predictability of short sales (though no prior paper has studied whether short sales front-run insider sales).

The results in this paper have implications for the enforcement of insider information regulations and for timely disclosure of short sales information by exchanges. Information leakage distorts the playing field for market participants, and can lead to adverse selection problems that limit market participation and inhibit efficient capital allocation. Information leakage can be curtailed through regulatory enforcement action, or by 'shining light' through more timely disclosure of short sales by exchanges. Currently, exchanges are required to disclose the level of short interest once a month, which only provides a snapshot. Disclosing higher frequency such as daily short sales activity will increase transparency and level the playing field by allowing broader market participants to exploit the information content of this data.

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TABLE 1
Sample Selection Procedure

	Number of Observations
(1) # of CEO stock sales transactions in Thomson Financial Insider database from Jan 1, 2005 to May 31, 2007	212,050
(2) Excluding cleansing code "A' and "S" and eliminating observations with missing ticker symbol	210,503
(3) Aggregating transactions by day	23,301
(4) Merging with NYSE SHO short sales data by ticker symbol and transaction date	7,836
(5) Merging with CRSP by CUSIP and transaction date	7,743
(6) Keeping transaction dates in the window March 1, 2005 to May 15, 2007	7,100
(7) Excluding earnings announcements within 15 days of insider sale	3,642
(8) Keeping only the first day of insider sales as a distinct sale	2,030
Final Sample:	2,030

TABLE 2

Descriptive Statistics

Panel A reports descriptive statistics for the full sample of 2,030 insider sales events; Panel B (C) reports descriptive statistics for Large (Small) insider sales, defined as the top (bottom) 30% of *Insider Sales*. *Event Date Short Transactions* is the number of short sale transactions on the insider sale date; *Event Date Short Sales* is the number of shorted shares as a percent of shares outstanding, on the insider sale date; *Insider Sales* are the shares sold by the CEO as a percent of the firm's shares outstanding (/Shares Outstanding) or as a percent of normal daily trading volume (/Trading Volume); *Firm Size* is the logarithm of firm market value at the last fiscal year-end prior to the insider sale; *Shares Outstanding* is the number of shares outstanding, in thousands; *Market/Book* is the ratio of market value divided by book value of equity at the end of the last fiscal year prior to the insider sale; *Days between Transaction and Filing* are the number of days from the first day of the insider sale to the SEC Form 4 filing date; *Average Daily Short Transactions* is the average number of daily short sale transactions over the sample period of March 2005 to May 2007; *Average Daily Short Sales* is the average daily number of shares shorted as a percentage of shares outstanding, over the sample period; *Frequency of Insider Sales* is the number of distinct Insider Sales in the sample period.

Panel A: Full Sample

	Mean	Q1	Median	Q3	StdDev
Event Date Short Transactions	538	169	351	697	590
Event Date Short Sales (%)	0.20	0.07	0.13	0.25	0.23
Insider Sales/Shares Outstanding (%)	0.06	0.01	0.03	0.06	0.20
Insider Sales/Trading Volume (%)	8.13	1.44	3.94	9.33	12.59
Firm Size	7.84	6.89	7.67	8.64	1.32
Shares Outstanding	157,787	31,999	60,691	134,121	374,194
Market/Book	3.85	1.82	2.53	3.78	6.72
Days between Transaction and Filing	3.09	1.00	2.00	2.00	17.26
Average Daily Short Transactions	478	143	301	627	513
Average Daily Short Sales (%)	0.18	0.06	0.12	0.22	0.23
Frequency of Insider Sales	3.2	1	2	4	3.95

Panel B. Large Insider Sales Sample

	Mean	Q1	Median	Q3	StdDev
Event Date Short Transactions	473	171	308	613	506
Event Date Short Sales (%)	0.27	0.10	0.18	0.32	0.27
Insider Sales/Shares Outstanding (%)	0.17	0.08	0.11	0.17	0.35
Insider Sales/Trading Volume (%)	19.38	7.89	13.35	22.81	17.93
Firm Size	7.29	6.64	7.14	7.84	1.04
Shares Outstanding	71,276	29,205	45,115	70,740	96,291
Market/Book	4.11	1.82	2.55	3.50	8.00
Days between Transaction and Filing	3.90	1.00	2.00	3.00	19.29

Panel C. Small Insider Sales Sample

	Mean	Q1	Median	Q3	StdDev
Event Date Short Transactions	737	249	531	985	728
Event Date Short Sales (%)	0.18	0.06	0.11	0.23	0.20
Insider Sales/Shares Outstanding (%)	0.01	0.00	0.01	0.01	0.00
Insider Sales/Trading Volume (%)	1.24	0.39	0.84	1.59	1.44
Firm Size	8.55	7.57	8.34	9.56	1.38
Shares Outstanding	297,870	54,699	101,636	375,620	574,280
Market/Book	3.54	1.81	2.47	3.84	5.29
Days between Transaction and Filing	3.60	1.00	1.00	2.00	24.30

TABLE 3

This table shows the Monthly and Industry Distribution of Short Sales and Insider Sales over the sample period of March 2005 to May 2007. *Average Daily Short Sales* is the daily number of shares shorted as a percentage of shares outstanding. *Insider Sales* is the shares sold by the insider as a percent of the firm's shares outstanding.

Panel A: Monthly Distribution

	Number of firms	Average Daily Short Sales (%)	Num. of Insider Transactions	Insider Sales (%)
January	123	0.193	173	0.123
February	59	0.167	111	0.108
March	135	0.185	304	0.139
April	37	0.168	143	0.105
May	44	0.203	134	0.087
June	60	0.182	217	0.083
July	15	0.157	110	0.071
August	26	0.170	119	0.107
September	39	0.191	229	0.086
October	4	0.105	78	0.048
November	39	0.193	145	0.089
December	48	0.162	267	0.121

Panel B: Industry Distribution

Sector code	Industry Description	Number of Firms	Average Daily Short Sales (%)	Num. of Insider Transactions	Insider Sales (%)
01	Finance	128	0.136	356	0.106
02	Healthcare	51	0.157	220	0.062
03	Consumer Non-Durable	31	0.163	120	0.087
04	Consumer Services	104	0.181	320	0.173
05	Consumer Durables	20	0.353	47	0.088
06	Energy	61	0.297	183	0.120
07	Transportation	11	0.215	40	0.061
08	Technology	53	0.176	265	0.062
09	Basic Industries	55	0.218	181	0.074
10	Capital Goods	79	0.164	183	0.164
11	Public Utilities	34	0.100	103	0.028
99	Unclassified	2	0.048	12	0.107
	Total Number of Firms or Insider Transactions	629		2,030	

Table 4

This table reports demeaned daily short sales, as a percent of shares outstanding, in the [-10, +10] day window around the insider sale (day 0). The mean is calculated in the [-60, -11] day window excluding the earnings announcement week. *, **, *** denotes two-tailed statistical significance of difference from 0 at 10%, 5%, and 1%, respectively. Number of OBS is the number of insider sales events for the category of insider sales. Insider Sales are the shares sold by the insider as a percent of the firm's shares outstanding. Large (Small) insider sales are the top (bottom) three deciles of insider sales in the full sample.

	Large Insider Sales Sample		Small Insider Sales Sample	
Event Day	Daily Short Sales	t-stat	Daily Short Sales	t-stat
-10	0.0065	0.97	0.0042	0.82
-9	0.0031	0.46	0.0022	0.43
-8	-0.0003	-0.05	-0.0019	-0.38
-7	0.0193***	2.88	0.0026	0.52
-6	0.0166**	2.48	-0.0029	-0.57
-5	0.0177***	2.65	-0.0064	-1.26
-4	0.0220***	3.28	0.0063	1.24
-3	0.0186***	2.77	0.0012	0.24
-2	0.0133**	1.99	-0.0036	-0.70
-1	0.0280***	4.19	-0.0010	-0.19
0	0.0564***	8.41	0.0056	1.09
1	0.0295***	4.40	-0.0003	-0.07
2	0.0154**	2.30	0.0137***	2.69
3	0.0178***	2.65	0.0014	0.28
4	0.0108	1.61	0.0004	0.08
5	0.0119*	1.77	-0.0016	-0.32
6	0.0137**	2.04	0.0029	0.57
7	0.0147**	2.20	0.0081	1.58
8	0.0082	1.23	0.0104**	2.03
9	0.0156**	2.32	0.0058	1.14
10	0.0181***	2.69	0.0099*	1.92
Number of OBS:	609		609	

Table 5

This table reports mean coefficients from event-level regressions of daily short sales (as a percentage of shares outstanding) on the independent variables listed. A separate regression is run for each insider sale event. There are 608 (609) insider sales events in the Large (Small) insider sales sample. Large (Small) insider sales are the top (bottom) three deciles of insider sales in the full sample. Insider Sales are the shares sold by the insider as a percent of the firm's shares outstanding. *Event* is an indicator variable that is "1" if the day is in the event window [-5,0], and "0" if the day is in the benchmark window [-60,-11], where day 0 is the insider trading date; RET_t is the firm's daily stock return, and RET_{t-1} is the one-day-lagged RET; $HILO_t$, or intraday price volatility, is the difference between the highest and lowest intraday price, scaled by the average of the highest and lowest price; $HILO_{t-1}$ is the one-day-lagged HILO; VOL_t is the daily trading volume, excluding short sales; VOL_{t-1} is the one-day-lagged VOL. *, **, *** denotes two-tailed statistical significance of difference from 0 at 10%, 5%, and 1%, respectively. Number of OBS is the number of regressions in the sample. Each regression has 56 observations (6 days from the event window and 50 days from the benchmark window).

Indep. Variables	Large Insider Sales Sample		Small Insider Sales Sample	
	Coefficient	t-statistic	Coefficient	t-statistic
Intercept	0.012***	3.18	0.015***	5.55
Event	0.011***	2.82	-0.001	-0.31
RET_t	1.657***	4.31	1.181***	18.83
RET_{t-1}	0.713***	8.73	0.743***	17.10
$HILO_t$	2.440***	7.98	2.574***	23.29
$HILO_{t-1}$	0.468***	6.33	0.299***	4.44
VOL_t	12.69***	30.75	12.43***	36.42
VOL_{t-1}	0.368*	1.87	0.339*	1.90
Number of OBS	608		609	

Table 6

This table reports value-weighted daily abnormal returns in the [-10, +10] day window around the insider sale (day 0). *, **, *** denotes two-tailed statistical significance of difference from 0 at 10%, 5%, and 1%, respectively. Large (Small) insider sales are the top (bottom) three deciles of insider sales in the full sample.

	Large Insider Sales Sample		Small Insider Sales Sample	
Event Day	Daily Abnormal Returns	t-stat	Daily Abnormal Returns	t-stat
-10	0.0012	1.65*	-0.0002	-0.35
-9	0.0004	0.58	-0.0004	-0.68
-8	0.0014	1.89*	0.0003	0.41
-7	0.0027	3.63***	0.0013	2.08*
-6	0.0019	2.55***	0.0010	1.54
-5	0.0025	3.33***	0.0001	0.17
-4	0.0026	3.45***	0.0012	1.95*
-3	0.0022	2.93***	0.0005	0.79
-2	0.0023	3.08***	0.0005	0.80
-1	0.0038	5.09***	0.0022	3.56**
0	0.0016	2.10**	0.0018	2.83**
1	0.0012	1.66*	-0.0005	-0.77
2	-0.0008	-1.05	-0.0003	-0.54
3	0.0001	0.15	-0.0001	-0.10
4	0.0005	0.62	0.0006	0.93
5	0.0000	-0.02	-0.0009	-1.39
6	-0.0009	-1.21	-0.0007	-1.08
7	-0.0003	-0.34	-0.0001	-0.15
8	-0.0005	-0.66	-0.0008	-1.35
9	0.0006	0.80	0.0006	0.91
10	0.0013	1.68*	0.0009	1.38
Number of OBS:	609		609	

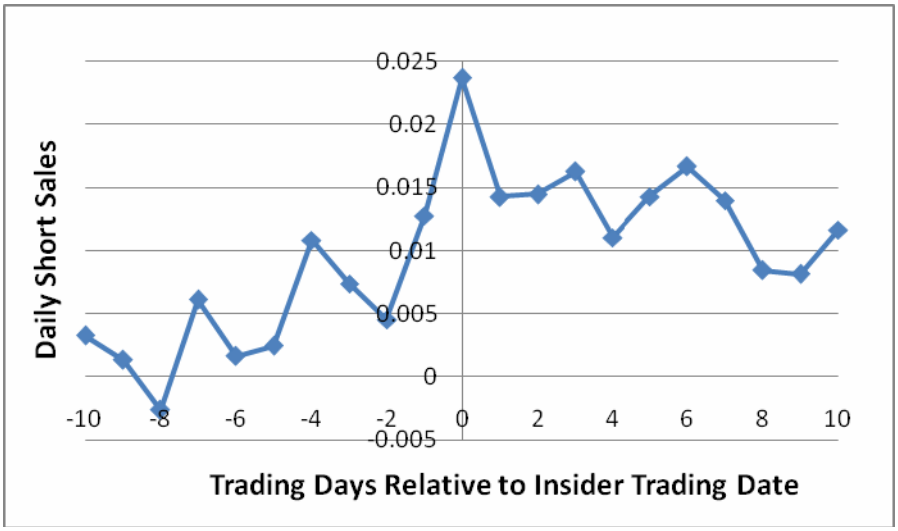
Table 7

This table reports demeaned daily short sales, and daily abnormal returns, for the top and bottom ex post return quintiles of *Large Insider Sales*. We start with the 609 large insider sales (the top 30% of insider sales in the full sample), and sort these into quintiles based on cumulative abnormal returns (CAR) in the [1, 20] day window after the insider sale. For quintile 1 (most negative CAR) and quintile 5 (most positive CAR), we report the daily short sales and daily abnormal returns in the [-10, +10] day window around the insider sale. *, **, *** denotes two-tailed statistical significance of difference from 0 at 10%, 5%, and 1%, respectively. The table shows that for quintile 1, short sales are significantly higher than average and peak four days *before* the insider sale. For quintile 5, short sales peak on the day of the insider sale (day 0).

	Quintile 1 (most negative) of CAR [1,20]				Quintile 5 (most positive) of CAR [1,20]			
Event Day	Daily Short Sales	t-stat	Daily Abnormal Returns	t-stat	Daily Short Sales	t-stat	Daily Abnormal Returns	t-stat
-10	0.0149	0.82	0.0027	1.62	0.0083	0.50	0.0007	0.32
-9	0.0300	1.65*	-0.0006	-0.38	-0.0110	-0.67	-0.0005	-0.24
-8	0.0227	1.25	0.0019	1.15	-0.0005	-0.03	0.0011	0.53
-7	0.0323	1.78*	0.0056	3.35***	0.0078	0.48	0.0019	0.94
-6	0.0114	0.63	0.0003	0.15	0.0180	1.10	0.0036	1.79*
-5	0.0264	1.46	0.0048	2.86***	0.0151	0.92	0.0031	1.54
-4	0.0501	2.76***	0.0001	0.07	0.0311	1.89*	0.0027	1.33
-3	0.0492	2.71***	0.0007	0.40	0.0100	0.61	0.0035	1.76*
-2	0.0216	1.19	0.0038	2.29**	0.0181	1.10	0.0012	0.60
-1	0.0258	1.42	0.0018	1.09	0.0125	0.76	0.0025	1.24
0	0.0458	2.53**	0.0029	1.76*	0.0711	4.33***	0.0009	0.45
1	0.0256	1.41	-0.0053	-3.22***	0.0507	3.09***	0.0089	4.46***
2	0.0224	1.23	-0.0077	-4.69***	0.0471	2.87***	0.0041	2.07**
3	0.0273	1.51	-0.0026	-1.60	0.0224	1.36	0.0011	0.55
4	0.0128	0.70	-0.0036	-2.21**	0.0292	1.78**	0.0061	3.04***
5	0.0113	0.62	-0.0009	-0.56	0.0258	1.57	0.0037	1.84**
6	0.0310	1.71*	-0.0093	-5.61***	0.0376	2.29**	0.0036	1.80*
7	0.0413	2.28**	-0.0026	-1.57	0.0371	2.26**	0.0027	1.34
8	0.0075	0.41	-0.0054	-3.30***	0.0502	3.05***	0.0035	1.74*
9	0.0194	1.07	-0.0028	-1.72*	0.0236	1.44	0.0033	1.64*
10	0.0427	2.36**	-0.0009	-0.52	0.0422	2.57***	0.0059	2.94***
Num. of obs.	120				120			

Fig. 1.

Panel A.



Panel B.

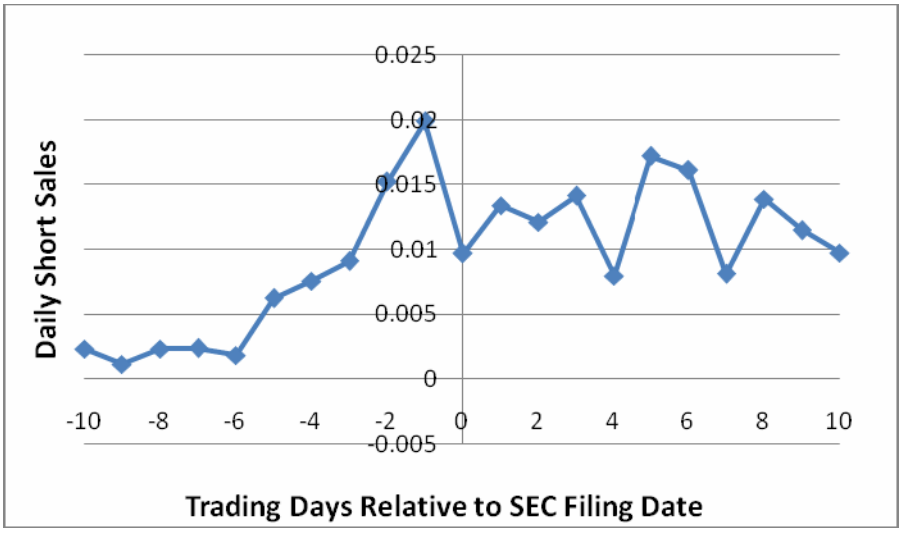
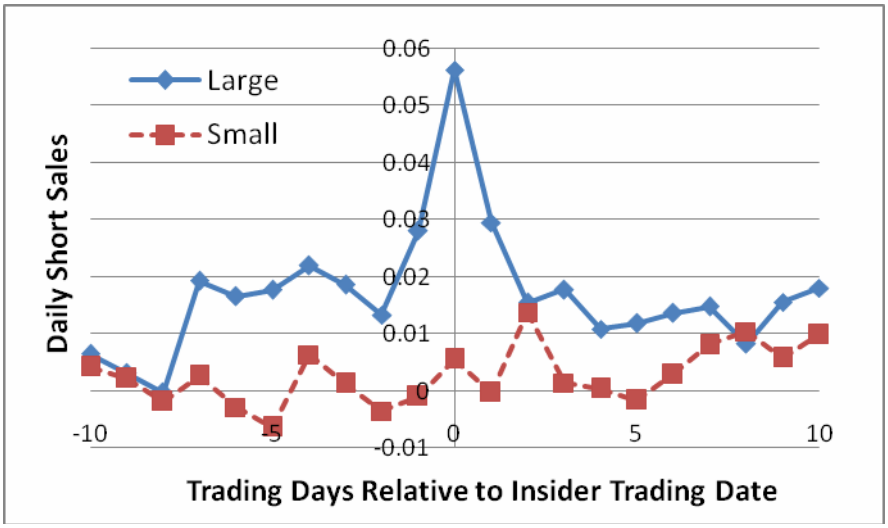


Figure 1 shows demeaned daily short sales, as a percent of shares outstanding, for the full sample. The mean daily short sales is calculated over the [-60, -11] trading day window, excluding the week with an earnings announcement. Day 0 is either the insider sale date (Panel A) or the SEC Form filing date (Panel B). Panel A shows the results for each day relative to the insider trading date, and Panel B shows the results for each day relative to the SEC Form 4 filing date. For Panel B, we use the 1,998 insider sale observations for which the SEC Form 4 is filed within 10 days after the insider sale.

Fig. 2.

Panel A:



Panel B:

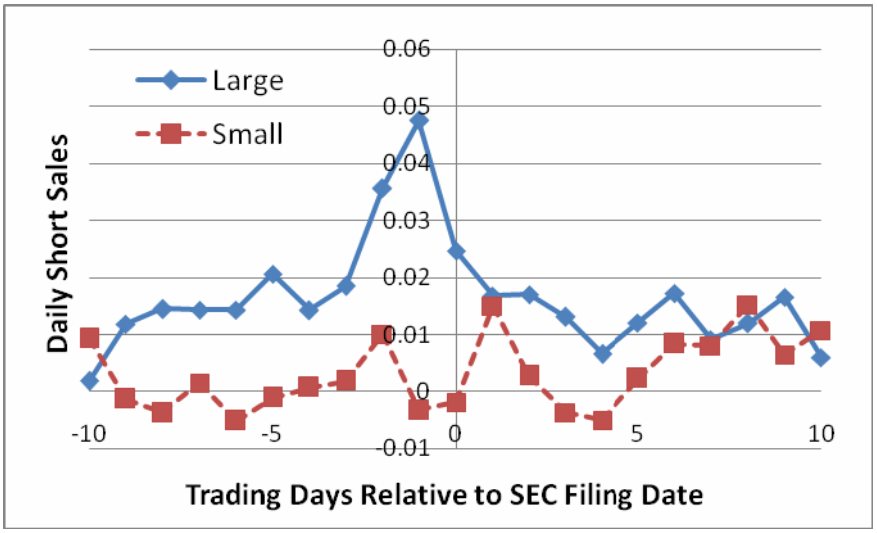


Figure 2 shows demeaned daily short sales, as a percent of shares outstanding, in the [-10, +10] trading day window. The mean is calculated in the [-60, -11] trading-day window, excluding the week with an earnings announcement. Day 0 is either the insider sale date (Panel A) or the SEC Form filing date (Panel B). Panel A shows the results for each day relative to the insider trading date, and Panel B shows the results for each day relative to the SEC Form 4 filing date. The figures show demeaned daily short sales by size of the insider sale. Insider Sales are the shares sold by the insider as a percent of the firm's shares outstanding. Large (Small) insider sales are the top (bottom) three deciles of insider sales in the full sample. Statistical significance is reported in Table 4.

Fig 3.

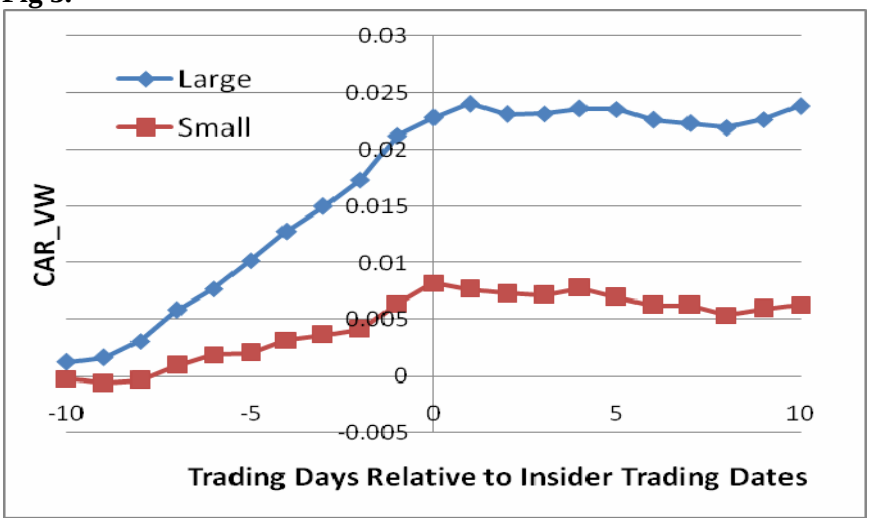


Figure 3 shows CAR_VW, value-weighted cumulative abnormal returns in the [-10, +10] trading day window around the insider sale date (day 0). Abnormal returns are market-adjusted returns. The figure shows CAR for Large and Small insider sales. Insider Sales are the shares sold by the insider as a percent of the firm's shares outstanding. Large (Small) insider sales are the top (bottom) three deciles of insider sales in the full sample.