# Cluster Trading of Corporate Insiders*

Chang-Mo Kang, Donghyun Kim, Qinghai Wang†

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†Chang-Mo Kang: School of Banking and Finance, University of New South Wales, chang.kang@unsw.edu.au; Donghyun Kim: Lubar School of Business, University of Wisconsin, Milwaukee, kim236@uwm.edu, (414)229-5612; Qinghai Wang: College of Business Administration, University of Central Florida, Qinghai.Wang@ucf.edu, (407)823-6453.

# Cluster Trading of Corporate Insiders

Abstract

Over forty percent of insider trades are cluster trades where multiple corporate insiders trade in the same direction on the same day or over consecutive days. Cluster trades, particularly purchases, are more informative than other insider trades. Even though insiders within the same ranks are more likely to trade together, cross-rank cluster trades, those joined by top executives and directors for example, are more informative than within-rank cluster trades. We show that cluster trades are likely driven by shared access to information and contain strong information signals. Information asymmetries, both between insiders and outsiders and among insiders, are related to the probability and the profitability of cluster trading. Using Sarbanes-Oxley Act of 2002 (SOX) that speeded up insider trading disclosure as a natural experiment, we find that competition among informed insiders contributes to the clustering of their trades and expedites information aggregation.

**Keywords:** Insider Trading, Cluster Trades, Market Efficiency

**JEL Classification Number:** G11, G23, G32

# 1 Introduction

Corporate insiders, as a group, have preferential access to information about the company and may take advantage of their private information in their trading decisions. The extensive literature on insider trading has largely focused on the trading activities and the implications of the trading decisions of the *individual* insiders (See, e.g., Jaffe (1974), Seyhun (1986), Lakonishok and Lee (2001) and Jeng, Metrick, and Zeckhauser (2003), Cohen, Malloy, and Pomorski (2012), among others). These papers show that insiders are informed and their trades, particularly purchases, earn abnormal returns.

In this paper, we study the cluster trading activities of corporate insiders. We define "cluster trading" as the trading pattern in which multiple insiders engage in the same directional trades on the same day or over consecutive days.[1] Corporate insiders are likely to have shared access to important firm information and may trade based on the same information. However, depending on the information and organization structure within a firm, information sharing could differ systematically cross firms and different types of insiders, executives and directors for example, may have differential access to firm information. Studying cluster trading, specifically whether and how the different types of corporate insiders trade together as well as the informativeness of their trades, allows us to examine the information asymmetry both between insiders and outsiders and among the insiders themselves.

Because multiple corporate insiders could have access to common firm specific information, studying their trading decisions as a group further allows us to examine how insiders trade strategically in the presence of other informed traders. Existing studies of insider trading, by focusing on the trading decisions of individual insiders, generally view corporate insiders as monopolistic informed traders – à la Kyle (1985). Holden and Subramanyam (1993) and subsequent studies show that the trading strategy of informed traders is affected by the presence of other informed

[1]The term "cluster trading" is similarly used by practitioners to refer to trading of multiple insiders within a short period of time. In the empirical analysis, we use alternative specifications for cluster trading to ensure the robustness of the results.

traders and, furthermore, the competition between informed traders accelerates the stock price adjustment to their private information. When multiple insiders are informed, the trading decisions of individual insiders not only reflect the information they possess, but also represent strategies in anticipation of or in response to the trades of other informed insiders. Studying how corporate insiders trade, both individually and as a group, helps us to answer important questions on the trading strategies of multiple informed insiders, the informativeness of their trades, and the effects of those trades on stock prices.

Several findings stand out in our empirical analysis of the insider cluster trades over the sample period of 1986-2016. First, corporate insiders often trade together. On average, over forty percent of insider trades (38% of insider purchases and 46% of insider sales based on the number of trades) are cluster trades where multiple insiders trade in the same direction within a short window. Executives are slightly more likely to trade in clusters than directors (41.4% vs. 33.9% for purchases). In cluster trading, insiders trade both within and across their ranks. For top executives, 67% of their cluster purchases include other top executives and 79% are joined by other executives or directors. But executives and directors overall are both more likely to trade with other insiders of the same ranks than across ranks. For the overall executive cluster purchases, 56% only include other executives and 12% only include directors but no other executives. For cluster purchases of directors, 50% are joined only by other directors while 14% include only executives but no other directors.

Second, cluster trades, particularly purchases, are more profitable than other insider trades. Over holding horizons ranging from 5 to 90 days, the abnormal returns earned by cluster purchases are almost twice as high as those of non-cluster trades. The results hold for trades of both corporate executives and directors, but the differences are more pronounced for director trades. We also find that, while insider sales are much less informative than insider purchases, insider cluster sales are more informative than non-cluster sales after controlling for firm fixed effects. We verify the robustness of the results based on an alternative classification of trading clusters that includes a one-day interval between insider trades. We also obtain similar results based on monthly aggregation of cluster and non-cluster trades.

Third, even though insiders within the same ranks are more likely to trade together, cluster trades on average are more profitable when joined by insiders of different ranks. For the full sample of cluster trades over all three holding horizons, cross-rank cluster trades are more informative than within-rank cluster trades, but there are important differences across insider types and the investment horizons. Regardless of the holding horizons, the higher returns of directors' cluster purchases are almost all earned by their trades in clusters with executives. For top executives, their cluster trades joined by other executives or directors are much more profitable than their trades with other top executives over long holding horizons (90-day), but are less profitable over the short 5-day holding horizon.

Why do insiders trade together and earn higher returns when trading in a cluster? Furthermore, what explains the differences of cross-rank cluster trades and within-rank cluster trades? On the informativeness of cluster trades, one possibility is that while insiders trade for both information and liquidity reasons, cluster trading or correlated trading by insiders is more likely to be driven by information reasons rather than common liquidity needs. Related to this point, it is further possible that insiders could have common access to significant corporate information and stronger information signals may motivate trading by multiple investors in the same direction. We conduct several tests to examine such possibilities.

In the first test, we examine how cluster trades are associated with the "opportunistic trades" and "routine trades" identified in Cohen, Malloy, and Pomorski (2012). Based on individual insider trading patterns over an extended period of time (three years), Cohen, Malloy, and Pomorski (2012) identify "opportunistic trades" as those insiders take that do not follow established trading schedule and show such trades to be more likely information driven. We find that frequency of clustering of "opportunistic trades" is not higher than other trades. Cluster trades provide strong return predictability in the presence of the identified "opportunistic trades". The results suggest that if both cluster trades and "opportunistic trades" capture informed trading by corporate insiders, the two measures are complements rather than substitutes. In the second set of tests, we examine the relation of cluster and non-cluster trades with subsequent corporate news and announcements. We

find that cluster trades are significantly related to subsequent corporate news in addition to the established relation between insider trading and corporate news. The results show cluster trades could contain stronger information signals than individual insider trades.

We investigate how insiders may share access to corporate information and how the shared access to information affects their trading strategies in the final section of the empirical analysis. We first examine whether various firm characteristics are associated with the probability and the profitability of cluster trading to assess the effects of information structure and governance structure of a firm on the frequency of cluster trading. We find that insiders are more likely to purchase in clusters in firms with greater information asymmetry between insiders and outsiders, such as in small firms and firms with greater return volatility. However, cluster trades also occur more frequently in firms with greater financial analyst coverage and higher institutional ownership, indicating the potential effects of competition between insiders and information intermediaries on the probability of cluster trading. We examine specifically how CEO power (CEO centrality) and board independence affect director's propensity to trade together with corporate executives. The results show that greater CEO power is related to lower frequency of executive-director cluster trades, and greater board independence reduces (negative) information sharing between corporate executives and the board of directors.

Shared access to information could lead to competition and strategic trading behavior of informed insiders. Holden and Subramanyam (1993) show that the optimal trading strategy of informed traders is affected by the presence of other informed traders. When insiders trade in a cluster over multiple days, their trades and the positions of their trades could be driven by information they have shared access to as well as their strategic incentives in the presence of multiple informed investors. We examine whether the trading profits of cluster trades are associated with their sequential position within a cluster. In a multi-day trading cluster, insiders earn higher returns from buying shares earlier than others. We find substantial early-mover advantage in insider purchases in multi-day trading clusters. However, when a group of insiders all trade on the same day, their trades earn substantially lower returns than those of multi-day cluster trades. The results

suggest that competition could affect the trading strategies of corporate insiders and influence how stock prices incorporate insider information from their trades.

We further examine the effects of competition among corporate insiders on their trading decisions. The Sarbanes-Oxley Act of 2002 (SOX), which speeded up insider trading disclosure, provided a natural experiment for studying such effects. In the pre-SOX period, insiders must disclose their trading activities within the first ten days of the month subsequent to the trading month. Post-SOX, insiders should file their trading activities within two days after the actual transaction. The shortened pre-disclosure period could speed up insider trading and may intensify competition among insiders (see, e.g., Huddart, Hughes, and Levine, 2001). Measured by the ratio of insider trades in clusters relative to all insider trades at the firm level, we observe an increase in cluster trades in the post-SOX period. The higher frequency of the cluster trades is mainly due to an increase in short-term clusters. We also find a stronger return predictability of cluster purchases, in particular, those placed within the first two trading days in a cluster, and greater price impacts of cluster trades in the post-SOX period.

This paper provides the first comprehensive empirical analysis on the activities and the informativeness of insider cluster trades. Because corporate insiders are likely to have shared access to important firm information, studying cluster trading provides important insights on the trading strategies of corporate insiders and the effects of their trades on stock prices. The extant literature on insider trading has largely focused on the trading activities and the implications of the trading decisions of the individual insiders. On the other end, several studies, such as Seyhun (1988, 1992) have examined the aggregate insider trading activities and the information content at the market level. Our paper filled a substantial yet overlooked gap in the insider trading literature.

The findings in the paper reveal that insider trading activities and their informativeness can be driven by both the information asymmetry between insiders and outsiders and the information asymmetry among the different types of insiders, as well as the competition of the insiders who share the information. For example, our findings show that much of the informativeness of directors' trading activities is explained by their trades in clusters with executives. Ravina and Sapienza

(2010) find that independent directors earn positive abnormal returns when they purchase their company stock, and the return difference from the same firm's executives is small. Our findings suggest that this is the case only when information is shared between executives and directors and when directors and executives trade together. Similarly, extant studies typically assume and confirm that the trades of top executives are more informative than other insiders' trades because they are more likely to have access to firm information. We find that cluster trades of top executives, not just with other top executives but with other executives and directors, are more informative than their individual trades.

Our findings suggest that studying and comparing the group and individual insider trading activities can provide insights that may not be available from studying individual insider trading activities alone. Similar to recent studies that employ trading gains of a specific group of insiders to infer their access to firm information (see, for example, Ravina and Sapienza (2010) on directors and Inci, Narayanan, and Seyhun (2017) on female executives), our method of identifying cluster trading of different types of insiders can offer a new approach to examining the information structure and information sharing within a firm.

The remainder of the paper is organized as follows. In the next section, we describes the data and our methodology of classifying cluster trading. Section 3 evaluates the informativeness of insider cluster trades and Section 4 investigates the possible reasons of the informativeness of cluster trading. Section 5 explore the causes and consequences of cluster trading, and the final section concludes.

## 2 Data and Variables

### 2.1 Data

We obtain information about insider stock trading of U.S corporate executives and directors from Thomson-Reuters Insider Filing (TRIF) database. TRIF collects the data from Forms 3, 4 and 5 that, in compliance with Section 16 of the Securities Exchange Act of 1934, corporate insiders file

with SEC to report their ownership of equity securities of companies. To reduce the measurement error, we include only the insider trading data verified by the data vendor (i.e., the data cleanse code R, H, or C) in our sample. Finally, we aggregate the same directional trades (i.e., purchases or sales) at an individual-stock-transaction date level. After filtering the data, the sample includes 457,539 insider purchases and 1,001,188 insider sales from 1986 to 2016.

We obtain stock price and firm characteristic information about the sample stocks from several data sources. Specifically, we obtain stock returns from the Center for Research in Security Prices (CRSP) database, financial/accounting variables from Compustat, board characteristics from Institutional Shareholders Services (ISS) database, corporate news from the RavenPack database, corporate earnings announcements and analyst earnings forecasts from the I/B/E/S database, and institutional ownership from Thomson-Reuters Institutional Holdings (13F) database. The details of sample construction and variable definitions are described in Appendix A.

### 2.2 Insider cluster trades

Among all insider trades, we define *insider cluster trades* as the same directional trades placed by multiple insiders in the same stock on the same day or over consecutive trading days.[2] All the same directional cluster trades placed on the same day or over the consecutive trading days constitute a unique *trading cluster*. For instance, if three insiders purchase shares sequentially for three consecutive days, we classify all purchases into the same trading cluster. This methodology identifies 49,462 purchase clusters and 123,426 sales clusters in our sample.

We first characterize insider trading clusters based on the types of insiders who trade in the clusters. We classify corporate insiders into three groups: top executive, other executives and directors. Top executives include executives with titles of CEO, COO, CFO, President, or General Counsel, and directors are non-executive independent directors.[3] We construct three non-mutually exclusive subsamples based on the types of insiders. The sample of "Top Executive" clusters include

[2]In Section 3.2, we extend the definition of cluster trades to include the trades placed by multiple insiders over non-consecutive days (with one-day gap).

[3]We classify top executive, other executives and directors using the rolecode of the TRIF database. The details of classification method is described in Appendix A.

all identified trading clusters that contain at least one trade by a top executive and the sample of "Director" clusters include all clusters that contain at least one trade by a board director. The sample of "Executive" clusters include all identified trading clusters that contain at least one trade by a corporate executive, including trades by top executives. Note that one trading cluster could belong to all three sub-samples if it contains trades by top executives and directors.

We next create dummy variables to indicate whether insiders trade within or across their own ranks in a cluster. *Within cluster* contains trades from insiders within the same rank, and *Between cluster*contains trades from insiders of a different rank. Notice that *Within cluster* and *Between cluster* are not mutually exclusive as one trading cluster may contain trades of insiders from the same and different ranks. In this case, we designate a *Within&Between cluster* (or *W&B cluster* for short) for these clusters. The sub-samples based on insider types and the dummy variables jointly determine the characteristics of the trading clusters.

Table 1 presents the summary statistics of insider trades and trading clusters. The table shows that corporate insiders often trade in clusters. On average, based on the number of insider trades, over 40% of insider trades (38% of purchases and 46% of sales) are cluster trades. The size of cluster trades is also substantial. Cluster trades account for more than 36% of total value of insider purchases and 62% of sales, respectively. There are some differences across the insider types. Executives' trades (41% of purchases and 50% of sales) are more likely to be clustered than directors' trades (34% of purchases and 35% of sales). But the two insider groups do not significantly differ in their cluster trades based on the value transactions, implying that directors tend to execute relatively larger trades together with other insiders. For all three groups, insiders are more likely to trade in clusters for their sale transactions than for their purchase transactions.

The table further reveals that insiders trade both within and across ranks in their cluster trades, but there are some noticeable differences between executives and directors. Among executive purchase clusters, 88% (36.27% out of 41.44%) include trades by multiple executives, and 43% (17.95% out of 41.44%) of the executive purchase clusters also include trades by director(s). For director purchase clusters, 85% include trades by multiple directors, and 50% include trades by

elective(s). Excluding the *Within&Between* clusters, 56% of executives' (resp. 49% of directors') cluster purchases are only with other executives (resp. directors). Both executives and directors are more likely to trade with other insiders in the same group. For the top executive purchase clusters, 66% include trades by multiple top executives and 77% are joined other executives and/or directors.

Table 1 provides additional information on the characteristics of the trading clusters. For the full sample, more than half (56.7%) of purchase clusters are one-day clusters, but a much lower percentage of sale clusters (37.9%) are. Similar patterns hold for all three sub-samples. Most clusters (99% of purchases and 98% of sales) end in five trading days. A cluster on average includes 3.5 trades. Sales clusters include fewer directors' trades than purchase clusters, mainly because directors sell shares much less frequently than executives. Importantly, the identified trading clusters are rarely accompanied with trades in the opposite direction. Only 3% of purchase (resp. 2% of sales) clusters overlap with insider sales (resp. purchases).

# 3 Informativeness of Cluster Trades

In this section, we study the characteristics, and chiefly the informativeness of the cluster trades. We first examine the profitability of cluster trades relative to that of unclustered trades, and then investigate how the trading profits are associated with the characteristics of trading clusters. Finally, we conduct additional tests to assess the robustness of results.

## 3.1 Cluster trading profits

We first examine whether profits of cluster trades differ from those of unclustered trades. Following previous studies (e.g., Seyhun, 1986, Lakonishok and Lee, 1991, among many others), we compute insider trading profits using the abnormal returns after the transaction date. In the existing literature, trading profits are typically calculated at the insider-transaction date level for insider purchases and sales respectively. In the identified trading clusters, a substantial portion of cluster trades are placed on the same date by multiple insiders and thus yield the same abnormal holding

period returns. We report the average returns below by aggregating the same directional insider trades at a stock-transaction date level.[4]

Table 2 presents summary information on the average holding period returns of insider purchases (Panel A) and sales (Panel B) for cluster and non-cluster trades. In each panel, we report three holding period returns adjusted for the Daniel, Grinblatt, Titman, and Wermers (1997) characteristics benchmark returns (DGTW adjusted returns): (i) 5 trading-day cumulative abnormal returns (CAR), (ii) 21 trading-day buy-and-hold abnormal returns (BHAR), and (iii) 90 trading-day BHAR.

Panel A shows that cluster purchases earn higher returns than non-cluster purchases, although non-cluster purchases also predict significantly positive returns over all three holding periods. For the 5-day holding horizon, cluster and non-cluster purchases earn 2.1% and 1.1% abnormal returns on average, respectively. The return predictability of the two types of insider purchases is persistent, and their return gap gets wider over longer holding periods. Cluster purchases yield 3.8% and 6.4% abnormal returns over 21-day and 90-day horizons, respectively, while non-cluster purchases earn 2.0% and 4.0% during the corresponding holding periods. Overall, for the full sample, trading profits from cluster trades are almost double those of individual trades, and the differences are highly significant statistically and economically.

On average, purchases by executives earn higher returns than director purchases for both cluster and non-clustered trades. The trading profit difference between cluster and non-cluster purchases are observed in all ranks of insiders. But the difference between cluster and non-cluster director trades are more dramatic. For example, the clustered director trades earn more than twice the returns of individual director trades for the 5-day and 21-day holding periods (1.91% vs. 0.89% for 5-day and 3.45% vs. 1.61% for 10-day trading periods). Top executive purchases are also more profitable than other executives' trade, particularly in shorter holding horizons, but the difference between cluster trades and non-cluster trades are almost identical for the two groups.[5]

[4]In untabulated tests, we use the individual insider trade-transaction date level data and find results consistent with those based on the stock-transaction date level analysis.

[5]The executive sub-sample contains the top-executive sub-sample, but the difference between the trading profits

Panel B presents evidence on return predictability of insider sales. Relative to purchases, insider sales have much weaker return predictability, consistent with the well-documented evidence in previous studies (See, e.g., Lakonishok and Lee, 2001). Furthermore, insiders do not earn higher profits from cluster sales. In fact, non-cluster sales seem to be slightly more informative than cluster sales over short holding horizons, and the pattern reverses for the 90-day holding horizon. Note however that insider trading clusters can differ across firm characteristics, so the univariate comparison of trading profits in this table should be treated with caution.

We next formally test the return predictability of cluster and non-cluster trades as well as the predictability of within- and between-group clusters. We control for year-month fixed effects in the regressions and further add firm fixed effects in separate specifications. As shown in Section 5, the propensity for cluster trading differs systematically across firms, and the firm characteristics could have important implications for insider trading profits in both cluster and non-cluster trades. By including firm fixed effects in the analysis, we control for the cross-firm differences in the profitability of insider trades and test whether the profitability of cluster and non-cluster trades significantly differs in the same firm. In the regression, we drop the trading clusters that last longer than 5 trading days to control for the price pressure of long-lasting sequential insider trades.[6]

Table 3 presents the regression results. In the regression, we use the DGTW-adjusted trading return of each insider trade and designate a "Cluster" dummy for insider trades that belong to a trading cluster. Panels A–C report return predictability of insider purchases for 5-day CAR, 21-day BHAR, and 90-day BHAR, respectively. For all three holding horizons, cluster purchases predict higher returns than non-cluster purchases. Column 1 of each panel shows that, after controlling for the year-month fixed effect, cluster purchases predict around 1% higher 5-day CAR and 2% higher 21-day and 90-day BHARs than non-cluster purchases. Column 3 of each panel confirms that the results are robust to controlling for the firm fixed effects.

We conduct subsample tests using the purchases of top executives (columns 5–8), all executives

of top executives and other executives can be obtained by comparing the two samples.

[6]In unreported analyses, we check that the estimation results are robust to the full sample specification and other sample censoring rules.

(columns 9–12), and directors (columns 13–16). We report results from the regressions both with and without firm fixed effects. All three groups of insiders earn higher returns from cluster trades and the magnitudes are similar across the sub-samples. Controlling firm fixed effects yields a stronger result for the cluster dummy in the regressions for all samples and for holding horizons.

We further compare trading profits between within- and cross-rank clusters in the regressions. We focus our discussions on the sub-sample results because the within- and between-clusters are clearly defined in the sub-samples and there are significant differences in the sub-sample results. For the executive purchase clusters, trading profits of the within- and cross-rank clusters are similar for the two short holding horizons. But for the long 90-day holding horizon, when executive trade together with directors (i.e., the between clusters), the trading profits are substantially lower than those of executive-only trading clusters (i.e., the within clusters). Patterns for director cluster trading profits are different. The cross-rank purchases earn much higher returns than the within-rank purchases of director cluster trades. For the long holding horizon, the profits of director cluster trades are almost exclusively derived from their trades along with corporate executives.

Cluster trades that involve top executives exhibit some distinctive patterns across the three holding horizons. For the very short, 5-day holding horizon, cluster purchases with other top executives earn higher returns than those trades with non-top executives or directors. There is very little difference in the trading profits for the 21-day holding horizon between the within-rank and cross-rank cluster trades. In contrast, for the long, 90-day holding horizon, top executive cluster purchases joined by other types of insiders are much more profitable than top executive-only trades. In untabulated tests, we find that the high long-horizon returns of cross-rank cluster purchases of top executives arise from the trades clustered with other executives rather than with directors.

Panels D–F present return predictability of insider sales for 5-day, 21-day, and 90-day holding horizons, respectively. Column 1 of each panel shows that the return predictability of cluster sales does not significantly differ from that of non-cluster sales after controlling for year-month fixed effect. Column 3 of each panel, however, shows that the return difference between the two types of sales becomes greater and statistically significant after controlling for the firm fixed effects. For the

90-day investment horizon (Panel F), cluster sales predict 1.5% lower returns than non-cluster sales after controlling for the firm fixed effects. The results suggest that insider sales, on average, are less informative in firms in which insiders are more likely to sell together. Similar to the analysis for insider purchases, we also conduct subsample tests using the sales of top executives (columns 5–8), all executives (columns 9–12), and directors (columns 13–16). For all three samples and across the three holding horizons, the return differences between cluster and non-cluster sales are significant after controlling for firm fixed effects. Different from the results for insider purchases, with- and cross-rank insider cluster sales do not exhibit notable differences in return predictability for any holding horizons in all three sub-samples.

### 3.2 Additional Evidence

We check the robustness of results on the informativeness of cluster trades in several additional tests. For the first test, we relax the requirement for "consecutive days" in our identification of cluster trades and use an alternative specification of trading cluster that could include an one-day interval between insider trades. Specifically, for each stock, we define *extended cluster trades* as the same directional trades placed by multiple insiders on the same day, over consecutive or non-consecutive trading days with at most one-day gap. All the same directional extended cluster trades placed during the period constitute an *extended trading cluster*. For instance, if three insiders purchase shares sequentially every other days, the three purchases form one extended trading cluster.

Table 4 presents the estimation results of year-month and firm fixed effect panel regressions. To conserve space, we only report results for 21-day BHAR of insider purchases (Panel A) and sales (Panel B). Overall, the results are consistent with the main analysis results in Table 3. In unreported analyses, we also run the panel regression without firm fixed effect as well as for other holding period returns, and find that the results are consistent with our main analysis results in Table 3.

In Panel A of Table 4, column 1 shows that the 20-day BHARs of insider cluster purchases are 2% higher than those of non-cluster purchases. In the subsample analysis of top executives

(column 3), all executives (column 5), and directors (column 7), we find similar results. For all three sub-samples, returns of cross-rank insider purchases are more profitable than within-rank cluster purchases. Panel B shows that the return predictability of extended cluster sales is still weaker than that of extended cluster purchases. On average, cluster sales predict only 33bp lower return than non-cluster sales (column 1). Compared with executives, directors earn higher profits from cluster sales relative to non-cluster sales. Again, there is little difference between with-rank and cross-rank cluster sales for all three sub-samples.

Next, we test the informativeness of cluster trades using the firm-month level data. The stock-transaction date level analysis may overestimate the informativeness of cluster trades because, by construction, cluster trades are concentrated over certain time periods. We address this concern by running the firm-month level analysis.[7] Specifically, we first identify the firm-months in which cluster purchases (resp. cluster sales) are placed, and then test whether the returns of the following calendar months are higher (resp. lower) than other monthly returns. For each directional trade, we create two dummy variables, namely, *Insider trade dummy* that indicate firm-months having insider trades and *Cluster trade dummy* that indicates firm-months having cluster trades.[8] Our sample consists of 2,494,847 firm-months. Among them, insiders purchase shares in 127,547 (5.1%) firm-months, and place cluster purchases in 27,232 (1.1%) firm-months. They also sell shares in 198,663 (8.0%) firm-months, and place cluster sales in 56,255 (2.3%) firm-months.

We run a panel regression as follows: for each stock $i$ and year-month $t$,

$$\begin{aligned} r_{i,t+1} = \alpha + \beta_1 \left(\text{Insider trade dummy}\right)_{i,t} + \beta_2 \left(\text{Cluster trade dummy}\right)_{i,t} \\ + \left(\text{Controls}\right)_{i,t} \cdot \Gamma + \varepsilon_{i,t+1}, \end{aligned} \tag{1}$$

where $r_{i,t+1}$ is the monthly return of stock $i$ in month $t+1$, and control variables include log market capitalization, book-to-market ratio, past one-month stock return, momentum (past 11 months stock returns), and year-month fixed effects.[9] The details of variable definitions used in

[7] See Lakonishok and Lee (1991) for a similar approach.

[8] To be consistent with the insider trade-level analysis, we only consider the clusters covering five trading days or shorter.

[9] Standard errors are clustered by time. Petersen (2009) shows that the Fama-MacBeth standard errors are close

the regression are described in Appendix A.

Table 5 presents the estimation results of the monthly return predictability of insider purchases (columns 1–4) and sales (columns 5–8). As we use monthly return predictability, the results here can be best compared with the 21-day holding period returns in Table 3. However, one important difference is that, here we use the one-month return subsequent to the month of insider trading, not the day of insider trading.

Column 1 shows that the monthly returns are, on average, 1% higher in a month following insider purchases. Cluster purchases are more informative. The monthly returns following cluster purchases are on average 65bp point higher than the monthly returns after non-cluster purchases. Insider sales and cluster sales, on the other hand, do not predict returns of the following month. In column 5, the coefficient estimates of insider sales dummy and cluster sales dummy are statistically and economically insignificant, although their signs are negative. Columns 2 and 6 show the return predictability of cluster purchases and sales are robust after controlling for the firm fixed effects. Overall, the results are consistent with the individual trade-level analysis in Table 3, while the economic magnitude of return predictability of cluster trades is smaller. The weaker return predictability in firm-month level analysis is not surprising. While, as shown in Table 3, cluster trades have significant predictability for returns over short horizons, e.g., the following five trading days, the firm-month level analysis excludes the insider trading returns from the transaction date to the calendar-month end.

We also examine whether the informativeness of cluster trades depend on whether the clusters contain both executives' and directors' trades or contain the trades of one type of insiders. Different from the individual trade-level analysis in the sub-samples, the classification here is less refined. Overall, for insider purchases, cross-rank clusters and within-rank clusters seem to be equally informative, and neither types are informative at the monthly return level for insider sales.

To sum up, the results in this section show that cluster trades, particularly purchases, are more profitable than other insider trades. Even though insiders within the same ranks are more likely

to the standard errors cluster by time in the stock return regression where a significant time effect is present.

to trade together, cluster trades on average are more profitable when joined by insiders of different ranks. However, there are important differences across insider types and the investment horizons. Regardless of the holding horizons, the higher returns of directors' cluster purchases are almost all earned by their trades in clusters with executives. For top executives, their cluster trades joined by other executives or directors are more profitable than their trades with other top executives over long holding horizon.

# 4 Why are Cluster Trades More Informative?

In this section, we investigate why cluster trades are more informative than individual insider trades. One possible reason is that, while insiders trade for both information and liquidity reasons, cluster trades by insiders could be more likely driven by information reasons rather than common liquidity shocks. In this case, the average profitability of cluster trading is higher because it largely excludes the less informative liquidity trading. Another possibility is that insiders could have common access to more significant corporate information and the stronger information signals may motivate trading by multiple investors in the same direction. We examine the these two non-mutually exclusive possibilities in this section and leave investigations on other potential explanations related to firm and insider characteristics to the next section. In the first test, we examine how cluster trades are associated with the "opportunistic trades" and "routine trades" identified in Cohen, Malloy, and Pomorski (2012). In the second test, we investigate the relation of cluster and non-cluster trades with subsequent corporate news announcements.

## 4.1 Cluster trades and "opportunistic trades"

We examine the relation between cluster trading and the information driven trading identified in Cohen, Malloy, and Pomorski (2012). Cohen, Malloy, and Pomorski (2012) propose that "opportunistic trades", i.e., trades by insiders who do not follow an established trading routine are likely information-driven trades. Following Cohen, Malloy, and Pomorski (2012), we first identify routine traders and opportunistic traders using the sample of insiders who have ever traded shares

for three consecutive years, and define the trades of each type of insiders as routine trades and opportunistic trades, respectively. Specifically, the routine traders are defined as the insiders who trade shares in the same calendar month for at least three consecutive years, and the opportunistic traders are defined as those with trading history but without such discernible pattern. The trades of non-routine and non-opportunistic insiders remain unclassified. The details of routine trade identification procedure are described in Appendix A.

We first compare the frequency of cluster trading in "opportunistic trades" and "routine trades". Table 1 shows in the full sample of insider trades that 38% of purchases and 46% of sales are cluster trades. We find in the classified sample that the fraction of cluster purchases does not differ between "opportunistic trades" and "routine trades": 38% of opportunistic trades and 39% of routine trades belong to trading clusters and the ratios are almost identical to the full sample ratio. The ratios for cluster sales are also similar: 42% of opportunistic trades and 41% of routine trades are cluster trades. These results show that cluster trades are not simply an aggregation of trades by "opportunistic insiders", but are equally likely to contain trades by opportunistic insiders and routine insiders.

We next examine jointly the informativeness of cluster trades and opportunistic trades. Table 6 presents the panel estimation results. Using the sample of daily individual insider purchases (Panel A) and sales (Panel B), we regress 21-day BHARs on the opportunistic trade dummy, the cluster trade dummy, and an unclassified trade dummy (for trades that cannot be classified as opportunistic or routine based on Cohen, Malloy, and Pomorski, 2012). We control for year-month fixed effects in all specifications, and report results with and without firm fixed-effects. Panel A shows that cluster purchases predict significantly positive returns after controlling for the opportunistic trades.[10] For the full sample, column 1 shows cluster trades yield 1.2% higher abnormal returns than non-cluster trades over the 21-day window while opportunistic purchases yield 1.5% higher returns than routine purchases. The results hold for the executive and director samples, but not for the top executive sub-sample. Cohen, Malloy, and Pomorski (2012) show that

[10]In unreported analysis, we use only the unclassified trades sample and find a strong return predictability of the clustered trades.

trades of senior opportunistic insiders are less informative than nonsenior opportunistic insiders. The results here confirm that the opportunistic trades of top-executives ar not more information. But, when top executives trade with other insiders, their trades are still highly informative.

There are also significant differences in the results for specifications with and without firm fixed effects. For the full sample and all three sub-samples, the estimated coefficients of the opportunistic trade dummy lose significance or change sign after controlling for firm fixed effects, while the significance of the cluster trade dummy remains unaffected. Because the opportunistic trades are defined at the firm-insider level, controlling for firm fixed effects could reduce the significance of the opportunistic trade dummy. The difference in the results could also reveal that there are significant variations in the identified opportunistic trades across firms. The results with firm fixed effects nevertheless suggest that in the same firm and with the same insiders, their trades are more informative when they trade together.

Panel B shows that both opportunistic sales and cluster sales have much weaker return predictability than the corresponding purchases. Opportunistic trades do not predict returns significantly better than routine trades in any specifications. Cluster trades, on the other hand, predict lower returns after controlling for firm fixed effects. These results hold for all groups of insiders. The somewhat surprising results of positive return predictability of opportunistic sales after controlling for firm fixed effects are also related to the reasons discussed in the previous paragraph.

Our classification of opportunistic and routine trades follows the main approach of Cohen, Malloy, and Pomorski (2012) in which an insiders is first identified as either an opportunistic or a routine trader and the trades then are classified accordingly. We also use an alternative specification suggested in Cohen, Malloy, and Pomorski (2012) that is solely based on trade-level classification. The results based on this different classification approach are largely similar to those reported here.

Overall, the results suggest that cluster trades and opportunistic trades represent very different patterns of informed insider trading. Clearly, cluster trades are not simply congregations of opportunistic trades. Individually, opportunistic trades are more informative than routine trades.

But when opportunistic insiders trade as a group, or trade with routine insiders, such trades are more informative than their individual trades. The identification of cluster trading differs from and complements the identification strategy of Cohen, Malloy, and Pomorski (2012).

### 4.2 Cluster trades and corporate news

We now study whether insiders tend to trade together when they have common access to significant information about the firm. Specifically, we test whether cluster trades significantly predict corporate announcements of material information beyond the predictability from individual insider trades. We use the Event Sentiment Score (ESS) of RavenPack News Analytics as a proxy for the positivity of the news.[11] ESS is normalized to a score of 50 for neutral tone, and, thus, we define positive (resp. negative) news as those of which ESS is above (resp. below) 50. By aggregating news at the firm-month level, we create two dummy variables, namely, *positive news month* that indicates a firm-month with more positive news than negative news, and the reverse for the *negative news month*. Notice that we consider both news-tone dummy variables because many firm-months do not have any news.

Table 7 presents the panel estimation results for the news predictability of cluster purchases (columns 1–4) and sales (columns 5–8). We employ the panel estimation model in (1) and use the news-tone dummy variables as dependent variables. While insider purchases predicts positive news announcement in the following month, cluster purchases exhibit even stronger news predictability. After controlling for firm characteristics and year-month fixed effects, the probability to be positive news month is 2.2% point higher in the month following non-cluster purchases and 5.2% point higher in the month following cluster purchases (column 1). Likewise, the probability to be negative news month is 2.3% point lower after non-cluster purchases and 4.2% point lower after cluster purchases (column 3). Cluster sales also predict negative news very strongly. Columns 5 and 7 show that, relative to the month following non-cluster sales, the month following cluster trades is more likely

[11] To ensure the relevance and reduce duplication of corporate news, we restrict the news source to Dow Jones Newswire and exclude the news of which relevance score is below 80. The details about ESS measure is provided in Appendix A.

to be negative news month (7.5% point higher) and less likely to be positive news month (4.4% point lower), respectively. In the estimations of even-numbered columns, we control for the firm fixed effects and find qualitatively consistent results. In sum, cluster trades predicts corporate news more precisely than non-cluster trades, suggesting that cluster trades actually contain important corporate information which is not publicly available.

Next, we examine whether cluster trades predict earnings surprises. We consider the cluster trades placed during the four-week prior to the announcement date. We measure the earnings surprise using the market reaction to the earnings announcement. Specifically, we use two measures, CAR$(0, 5)$ and CAR$(0, 21)$, which correspond to the cumulative DGTW benchmark-adjusted returns during the five trading days and the 21 trading days after the announcement date, respectively. Table 8 presents the estimation results for the earnings surprise predictability of cluster purchases (column 1–4) and sales (columns 5–8). We regress the earnings surprise measures on the insider trade dummy, cluster trade dummy, and controls used in (1). Cluster purchases predict positive earning surprise. While non-cluster purchases predict 40 bp higher 5-day returns and 81bp higher 21-day returns, cluster purchases predict 89 bp higher 5-day returns and 1.4% point higher 21-day returns (columns 1 and 3). The return gap between the two types of insider purchases are statistically significant. The results are robust to controlling for the firm fixed effect (columns 2 and 4). Cluster sales, on the other hand, do not predict earnings surprises better than non-cluster sales. Overall, our results suggest that cluster purchases near the earnings announcement contain positive information about the fiscal quarter's earnings that have not been released to the public.

The news and earnings surprise predictability of cluster trades complements our return predictability analysis in Section 3. Short-term return predictability of cluster trades can be due to the price impact of sizable insider trades or overreaction of outside investors. While the long-term return predictability, e.g., 90 trading days return, is unlikely driven by price impact or overreaction as suggested by informative long-term returns, we further address the concern by investigating the predictability of cluster trades for the corporate news and for the earnings surprises. The results overall support the notion that cluster trades are associated with stronger informational signals

than individual insider trades.

# 5 Information Sharing, Competition, and Cluster Trades

In this section, we study the effects of firm information structure and competition among insiders on the probability and profitability of cluster trading. We first examine whether cluster trades are associated with information asymmetry between corporate insiders and investors and then examine whether information asymmetries among insiders affect cluster trading. We further investigate the effects of competition among informed insiders on their trading strategies based on the positions and profits of their trades within a trading cluster. We use the 2002 Sarbanes-Oxley Act (SOX) that mandates insiders to disclose their trades more quickly to study whether and how the Act affected trading cluster formation, trading strategy and trading profits. The analyses in this section allow us to determine differences in cluster trading across firms and and how cluster trading affects stock prices.

## 5.1 Firm information structure and cluster trades

We first examine differences in cluster trading across firms, with a particular focus on the association between a firm's information structure and the frequency of cluster trading. Aboody and Lev (2000) and Huddart and Ke (2006) find that measures of firm information symmetry are associated with both insider trading activity and insider trading gains. A firm's information environment can affect overall insider trading activities as well as the probability of cluster trading among insider trades. If insiders as a group enjoy substantial information advantages over outside investors, it is more likely that these insiders could trade together to take advantages of their information.

Following the existing literature, we use various firm characteristic variables such as firm size, book-to-market ratio, return volatility, R&D and liquidity as proxies for information asymmetry. We also include financial analyst coverage and institutional ownership to measure information production by information intermediary and investors. Greater information production by other market participants could reduce the information advantages of insider. Finally, we consider the

effect of firm governance structure on firm transparency and information structure. We classify firms based on two governance measures: E-index and classified board. E-index is the management entrenchment index from Bebchuk et al. (2009). We define a "Good E-Index" dummy as 1 if E-index is less than 3. E-index and classified board data are available in the subperiod of 1990-2006 and restricted to the largest 1500 firms. This set of variables largely captures the level of information asymmetry between corporate insiders and outside investors.

In order to isolate the effect of firm information environment on cluster trading rather than overall insider trading activity, we use a cluster ratio in the empirical analysis. Cluster ratio is the fraction of cluster purchases (resp. sales) out of total insider purchases (resp. sales) at the firm-year level.[12] We run the following panel regression to relate firm characteristics to the probability of cluster trading: for each stock $i$ and year $t$,

$$\text{Cluster ratio}_{i,t+1} = \alpha + \beta \left(\text{Firm characteristics}\right)_{i,t} + \left(\text{Controls}\right)_{i,t} \cdot \Gamma + \varepsilon_{i,t+1}, \tag{2}$$

where Cluster ratio$_{i,t+1}$ is a cluster ratio of stock $i$ in year $t+1$. In addition to the variables we specified above, we include logarithm of number of insider trades over the past one year in the firm and past one-year stock return as control variables. We also include industry fixed effects and year fixed effects in the regressions.

Table 9 Panel A presents the results of the panel regressions. Different from previous tables, we do not include firm fixed effects in the regression since firm characteristics do not vary greatly over time. We include year fixed effect and industry fixed effect and the standard errors are clustered by firm level. Columns 1–4 examine cross-sectional determinants of cluster purchases and columns 5–8 examine determinants of cluster sales. The results differ for cluster purchases and cluster sales. As our earlier results show that cluster purchases are much more informative than cluster sales, our discussion here focuses on cluster purchases. But we also highlight some differences between purchases and sales.

Several proxies of information asymmetry are positively associated with cluster purchase ratio.

[12] We define cluster ratio at the firm-months level and find consistent results.

For example, the cluster purchase ratio is higher for smaller firms and higher for firm with higher stock return volatility. Insiders also tend to trade together in their purchases in stocks with low liquidity. Stock liquidity is associated with price impacts of informed trading and can directly affect the expected profits of insider trading. Insiders have an incentive to trade promptly after receiving information, thus illiquidity leads to greater propensity of cluster trading. Notable differences for cluster sales are that, insiders of larger firms are more likely to sell their stocks together and liquidity does not seem to affect the cluster sale ratio. Additionally, when insiders are more active trades, they are also more likely to trade together, for both their purchases and sales.

External information production by financial analysts and institutional investors also affects the propensity of cluster trading. Column 2 shows that, for purchases, insiders are more likely to trade together when there is greater analyst coverage of the firm and when the overall institutional ownership of the firm is high, after controlling for the various firm characteristics. For sales, institutional ownership increases the likelihood of cluster trade but financial analyst coverage does not. Financial analysts and institutional investors could reduce the level of firm information asymmetry through their activities, and at the same time, they could infer information from insider trades. Consequently, they could compete with corporate insiders to speed up information diffusion in the financial market. The results suggest that insiders are more likely to trade together when facing greater competition from other market participants.

Columns 3 and 7 investigate how the governance structure of companies is associated with the probability of cluster trades. Because of the requirement of the governance index and board information, the sample in the two models is much smaller than the full sample. The results show the E-index and staggered board dummies are not significantly related to the cluster trading ratio. In columns 4 and 8, we examine the determinants of cluster trades including all specified variables in the previous models. The results largely remain though the sample again is only one fifth of the full sample. Overall, firm information asymmetry and transaction costs are positively associated with cluster trading.

Table 9 Panel B provides a sharper test on the relation between firm information structure

and the probability of cluster trading. Here, the dependent variable is the "between cluster ratio" of cluster trades of board directors: the fraction of directors' cluster purchases (resp. sales) with executives out of total directors' purchases (resp. sales) at the firm-year level. We intend to examine the relation between the information asymmetry within a firm and the likelihood that directors trade together with executives. In addition to the firm characteristics variables in Panel A, we add two new variables in the regressions to capture information sharing and information flow between executives and directors. The first variable, CEO centrality, is defined as the ratio of CEO's compensation to the sum of compensation of top five executives (Bebchuck et al., 2011). CEO centrality can serve as a proxy for the concentration of power of corporate executives. The second variable is the fraction of non-co-opted independent directors. An independent board provides a counterbalance to executive power. We use the percentage of non-co-opted independent directors as a measure of board independence as many of the independent directors are co-opted, and the simple ratio of independent directors may be less informative.[13] A higher level of executive power could imply greater information concentration and less information sharing between executives and directors. The effect of board independence on information sharing, however, could be ambiguous. It is possible that a more independent board is a more informed board because an independent board may demand greater information sharing and is a more effective monitor. It is also possible that executives may be less likely to share information with the directors when the board is more independent.

Panel B presents the regression results on the ratio of between-cluster director trades. CEO centrality is negatively related to the between-cluster ratio for both purchases and sales. The results suggest that directors trade less with executives when CEOs have greater concentration of power and when there is likely less information sharing between executives and directors. The effects of board independence on director-executive cluster trading differ for purchases and sales. The fraction of non-co-opted independent directors is associated positively with between-cluster purchases, but negatively with between-cluster sales. For purchases, directors are more likely to

[13]We obtain the fraction of co-opted directors from Coles et al. (2014).

trade with corporate executives. The sales results however show that directors are less likely to trade together with executives based on negative information in firms with a higher percentage of non-co-opted independent directors. As greater board independence is associated with less concentrated executive power within a firm, the evidence suggests that executives are less likely to share negative information with the directors when the board is more independent. In sum, the results in Panel B reveal that information asymmetry within a firm affects insider cluster trading. Furthermore, the evidence suggests one may be able to use insider trading patterns such as the cluster trading ratio to infer information flows within a firm.

### 5.2 Profitability of trades within clusters

We now study how competition among informed insiders affects cluster trading. Cluster trades may arise as a consequence of strategic trading of multiple insiders who have access to common information. A single informed insider could choose to time and camouflage his trades to minimize price impact and maximize overall trading profit (see Kyle, 1985 and Admati and Peiderer, 1988). When there are multiple informed insiders, one insider's trade affects the trading profits of other informed insiders. Holden and Subrahmanyam (1993, 1995) show that the competition among informed investors makes them trade aggressively and, thus, their common private information is quickly incorporated into stock prices. Their models suggest that, if cluster trades and patterns of cluster trading are affected by competition among informed insiders, the positions and profits of trades within a cluster will reflect both the information flow across the insiders and the competition among the informed insiders.

Before studying the relation between trading position and trading profits with a cluster, we first examine the composition of a trading cluster, and specifically the types of insiders who are more likely to be front runners in *Between cluster trades*. To identify the sequential positions of individual cluster trades, we create four dummy variables: (i) *one day* that indicates a cluster ending in one day when multiple insiders execute their trades on a single day, (ii) *first day* that indicates the first trading day of a cluster that expands over multiple days, (iii) *last day* that indicates the last

trading day of a cluster that expands over multiple days, and (iv) *middle days* that indicates all the rest trading days of a cluster. Two-day cluster only include the *first day* and *last day* dummies.

Table 10 Panel A reports the estimation results of linear probability models that regress the indicator of *one day* or *first day* on two insider rank indicators *top executives* and *other executives*. Models 1 and 2 for purchases (and models 4 and 5 for sales) include all one-day and multi-day between cluster trades while model 3 (and 6) only include multi-day between cluster trades. Columns (1)–(3) show that, relative to directors, top executives are more likely to trade on the first day in a purchase cluster, while other executives are less likely to do so. By contrast, columns (4)–(6) show that, in the case of *Between cluster sales*, both the top and other executives are less likely to place their trades on the first day than directors. Given that top executives earn higher insider trading profits, particularly from purchases than other ranks of insiders, the results suggest that the insiders who have better access to information tend to trade earlier within a cluster.

We next examine how insider trading profits are associated with the sequential positions of cluster trades. Table 10 Panel B presents the year-month and firm fixed effect panel estimation results. Using the entire insider trading sample, we regress 21-day BHAR of insider purchases (columns 1–4) and sales (columns 5–8) on the aforementioned four dummy variables that indicate the sequential positions of clustered trades. We report the 21-day trading profit results to conserve space. We run the analysis using other holding period returns and find qualitatively consistent results. Notice that we include both cluster and non-cluster trades in the regression and the coefficient estimate of each dummy variable presents the average return difference between the corresponding position of cluster trades and the non-cluster trades.

Column 1 shows that insiders earn higher returns from buying shares earlier than other insiders in multi-day trading cluster. Relative to non-cluster purchases, the first-day trades of cluster purchases generate 2.8% higher 21-day BHAR while the last trades generate only 1.3% higher return. The trades in the middle of a cluster (this is possible only for clusters with three or more trading days) earn returns that are similar to first day returns. The results suggest that early purchases are more profitable. The results hold for all three groups of insiders. In comparison,

when multiple insiders trade on the same day, their trading profits, while still higher than non-cluster trades, are much lower than the first-day trades from multi-day clusters. In fact, one-day cluster purchase profits are lower than all trades except for the last-day top-executive trades in multi-day clusters.

On the other hand, results based on cluster sales are the opposite of those of cluster purchases regarding the relationship between trading positions and trading gains. Column 5 shows that, for the full sample, relative to non-cluster sales, the first-day sales of clusters predict 11bp lower returns while the last-day sales predict 46bp lower returns. The early sales of multi-day clusters are less profitable than later-day sales. We also run the subsample analysis using the trades of top executives (column 6), all executives (column 7), and directors (column 8), last-day trades again earn substantially lower returns for all three groups of insiders. Part of the results may reflect the fact insider sales are less informative, but the results also seem to suggest that insiders do not rush to sell their shares even when their trades are (negative) information driven.

### 5.3 Cluster trades in Pre- and Post-SOX periods

The previous section shows that competition among insiders affects both cluster trading patterns and trading profits. We further examine the competition effects, as well as the relation between cluster trading and information efficiency of stock prices based on sub-samples of insider trades before and after SOX. SOX regulation provides a natural experiment to the research questions, as it requires the prompt disclosure of insider trading activity, thus intensify the competition of the informed insiders. We can investigate whether the heightened competition among insiders after SOX affects the probability of cluster trades. In the post-SOX period, insider trading should be filed within two days after the actual insider transaction, and therefore, the public can acquire information more quickly from insider trade records. Insiders need to consider not only competition against other insiders in the same company but also competition against the public investors. Informed insiders would trade more aggressively within a short period before the information revealed to the public, and thus, cluster trades are more likely to occur after SOX.

We employ a panel regression with a firm fixed effect using cluster ratio as a dependent variable. To highlight the changes before and after SOX, we include a firm fixed effect to control for any changes in unobserved firm characteristics. We also include size, book-to-market, liquidity of the stock, past one-year return, and return volatility as control variables. We also control for the number of insider trading of the firm in the past one year to take into account that cluster trading would be naturally increased if there are more insider trading. Table 11 columns 1 and 2 show that cluster purchases and sales are more likely to take place in the post-SOX period, as the coefficients of Post-SOX dummy are significantly positive. We also expect that SOX may particularly affect the probability of shorter-window clusters. As expected, table 11 columns 3–4 show that the cluster ratio within two trading days significantly increased in the post-SOX periods for both purchases and sales. Columns 5–6 show that the cluster ratio longer than two trading days is significantly reduced for sales and is not affected for purchases.[14] The results suggest that the overall increase in cluster trade probability after SOX is mainly due to the increase of short-term cluster transactions.

Next, we investigate possible changes of trading profits in cluster trades after SOX. A majority of insider trading was filed and publicly disclosed on the following business day after SOX, even sooner than the required two business days. As we showed above, the more timely disclosure increased the probability of short-window cluster trades. The changing insider trading pattern and the disclosure practice may speed up information transmission in the market and negatively affect the profitability of late trades in a cluster. Table 12 presents the estimation results for the 21-day BHAR predictability of insider purchases (columns 1–4) and sales (columns 5–8). We include a Post-SOX dummy, along with variables interacting the Post-SOX dummy and variables specifying the positions of trades within a cluster in the regression. Column 1 shows that, SOX did not affect the profitability of first day and two-day clusters. Among the purchase clusters lasting more than two days, the first two day trades yield 2.1% point significantly higher returns after SOX. Columns 2–4 shows that the change in profitability of the early cluster trades occurs in all ranks of insiders after SOX, and the results are stronger for top executives. Columns 5–8 show that SOX leads

[14] We find similar probability patterns using logistic regression analysis.

to higher profitability of early cluster sales in long-window clusters, regardless of insider ranks. Again, SOX did not affect the profitability of first day and two-day trades in sale clusters. In sum, after SOX, the early cluster trades become more profitable than the subsequent trades placed after the early trades are publicly disclosed. This finding is consistent with the prediction that SOX motivates insiders to trade earlier and, thus, increases their cluster trading activities.

# 6 Conclusion

Cluster trading is not only prevalent in the trading activities of corporate insiders but also more informative than their individual trades. This paper provides the first comprehensive empirical analysis on the activities and the informativeness of cluster trades. Because corporate insiders are likely to have shared access to important firm information, studying cluster trading provides important insights on the trading strategies of corporate insiders and the effects of their trades on stock prices.

The findings in the paper reveal that insider trading activities and their informativeness can be driven by both the information asymmetry between insiders and outsiders and the information asymmetry among the different types of insiders, as well as the competition of the insiders who share the information. Future research could employ the group and individual insider trading activities as proxies for the information structure within a firm to study information flow, information sharing among firm management and between firm management and directors.

# Appendix A Sample construction and variable definitions

Below is the details of our sample construction. The parentheses include the variable name in TRIF. We first retrieve the insider purchases (acqdisp=A and trancode=P) and sales (acqdis=D and trancode=S) from 1986 to 2016 using TRIF. We include only the observations of which accuracy is verified by the data provider (cleanse=R, H, C). We also exclude the filings amended later. Using the sample, we classify the insiders into three groups: *top executives* (rolecode=CEO, CO, P, GC, CFO, CI, CT), *other executives* (rolecode=H, OD, AV, EVP, O, OB, OP, OS, OT, OX, S, SVP, TR, VP, C, CP, GM, OE), and *directors* (rolecode=D and no other titles except rolecode=CB, DO, VC, AC, CC, EC, FC, MC, SC, B, BC, BT, SH, T, VT). Both top executives and other executives are also classified as *executives*. We exclude unclassified insiders (e.g., beneficial owners who do not take any executive or director role) from our sample. Finally, we aggregate the purchases and sales into the person-stock-transaction date level. Our final insider trading sample is summarized in Table 1.

We then aggregate the insider purchases and sales into the stock-transaction date level, and merge it with CRSP stock return data. As stock returns, we use raw returns and DGTW-adjusted returns. For DGTW-adjusted return, we construct the benchmark portfolio following Daniel et al. (1997) using COMPUSTAT annual data. The benchmark is assigned to each stock according to size, industry-adjusted book-to-market ratio and momentum quintile. The information of firms until June of the year is used for the benchmark assignments from July of the year until June of the next year. The benchmark return is a value weighted return of the stocks in each DGTW portfolio and is computed at both daily and monthly level. DGTW adjusted return is defined as the excess stock return to the benchmark return. We also classify insider trades as opportunistic and routine trades following Cohen et al. (2012). Their main classification of insider trades is at the insider level. When an insider has a record of insider trading for three consecutive years, an insider can be classified as either routine trader or opportunistic trader. A routine trader is an insider who trades in the same calendar month for at least three consecutive years. An opportunistic trader

is an insider who made transaction for three consecutive years, but is not classified as a routine trader. To obtain forward looking classification, classification applies to transactions after a three-year period of judgment. A routine trade is any transaction that a routine trader does and an opportunistic trade is any trade placed by an opportunistic trader. Unclassified trades include the trades made by the traders who do not have records of insider trades for three continuous years and those during a three-year period of judgment. The holding-period abnormal returns from non-cluster and cluster trading date is summarized in Table 2.

RavenPack computes the ESS by considering emotional factor, analyst rating factor, credit rating factor, and fundamental comparison factor. Emotional factor involves analysis on words and phrases of the news article. Fundamental comparison factor includes information about earnings, revenues, and dividends, but does not includes stock returns. All variables used in this paper is defined in Table A1.

Table A.1: Variable definitions

The table provides the definitions of all variables used in this paper.

| Variable name | Definition |
|---|---|
| **Stock-transaction date-level variables:** | |
| Cluster | 1 for transaction dates of cluster trades, or 0, otherwise |
| Within cluster | 1 for transaction dates of within-group cluster trades, or 0, otherwise |
| Between cluster | 1 for transaction dates of between-group cluster trades, or 0, otherwise |
| One-day cluster | 1 for transaction dates of a cluster that occurs in one day, or 0, otherwise |
| First trade | 1 for the start date of a cluster that occurs in multiple days, or 0, otherwise |
| Last trade | 1 for the end date of a cluster that occurs in multiple days, or 0, otherwise |
| Middle trade | 1 for all the dates between the first date and the end date of a cluster that occurs in multiple days, or 0, otherwise |
| 5-day CAR | 5 trading-day cumulative abnormal return adjusted for DGTW benchmark portfolio returns |
| 21-day (90-day) BHAR | 21 (90) trading-day buy-and-hold abnormal return adjusted for DGTW benchmark portfolio returns |
| **Trade-level variables (see Section 2.2):** | |
| Cluster | 1 if the trade is clustered with other insiders' trades, or 0, otherwise |
| Within cluster | 1 if any of the other trades forming a cluster comes from other insiders within the same rank (executives vs. directors), or 0, otherwise |
| Between cluster | if any of the other trades forming a cluster comes from other insiders of a different rank, or 0, otherwise |
| Routine trades | Trades of routine trading insiders who have placed trades in the same month over the previous three consecutive years (Cohen et al. 2012) |
| Opportunistic trades | Trades of opportunistic trading insiders who have placed trades in the previous three years but in different months (Cohen et al. 2012). Once an insider is identified as either routine trader or opportunistic trader, the classification is going forward until the insider is switched to another group. |
| Unclassified trades | Trades of non-routine and non-opportunistic trading insiders (i.e., insider who have not placed the three consecutive year trades) |
| **Firm (stock)-month-level variables:** | |
| Insider trading | 1 for firm-months in which insider trades occur, or 0, otherwise |
| Cluster | 1 for firm-months in which insider cluster trades occur, or 0, otherwise |
| Within | 1 for firm-months in which only within cluster trades occur, or 0, otherwise |
| Between | 1 for firm-months in which only between cluster trades occur, or 0, otherwise |
| Within&Between | Within $\times$ Between |
| Log size | The natural log of market capitalization |
| Book-to-Market | The natural log of book asset to market capitalization ratio |
| Return (t-1,t) | One month past stock returns |
| Return (t-12,t-1) or Momentum | Stock returns in the previous 11 months |
| Positive news months | 1 for firm-months in which there are more positive news (of which RavenPack Event Sentiment Score (ESS) is above 50) than negative news (of which RavenPack ESS is below 50), or 0, otherwise |
| Negative news months | 1 for firm-months in which there are more negative news than positive news, or 0, otherwise |
| CAR (0,5) of earnings announcements | 5-day cumulative abnormal return adjusted for DGTW benchmark portfolio returns after earnings announcements |
| CAR (0,21) of earnings announcements | 21-day cumulative abnormal return adjusted for DGTW benchmark portfolio returns after earnings announcements |

Table A.1 - *continued*

| Variable name | Definition |
|---|---|
| **Firm (stock)-year-level variables:** | |
| Cluster ratio | The ratio of the number of cluster trades to total number of insider trades during the calendar year |
| Log size | The natural log of market capitalization |
| Book-to-Market | The natural log of book asset to market capitalization ratio |
| Return (t-12,t) or Momentum | Stock returns in the previous 12 months |
| Std. of Returns | Standard deviation of monthly stock returns in the previous 12 months |
| Log (number of insider trade) | The natural log of number of insider trades in the previous 12 months |
| Institutional concentration | The fraction of the shares of the 5 institutional investors that have the largest position, divided by the total shares of all institutional investors |
| Good E-index | 1 if E-index is less than 3, or 0, otherwise |
| Staggered Board | 1 if a board is a staggered board, or 0, otherwise |
| Log (number of financial analysts) | The natural log of average number of financial analysts in the previous year |
| Illiquidity Quintile | Quintile of illiquidity measure, the daily ratio of absolute stock return to its dollar volume, averaged over the previous year |
| Post-SOX | 1 for the period from 8/29/2001, or 0, otherwise |

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## Table 1: Summary statistics of cluster trading of insiders

The table presents the summary statistics of clustered trading of insiders during the 1986–2016 period. Cluster insider purchases (sales) are defined as purchases (sales) placed by multiple insiders on the same day or consecutive trading days. All the same directional cluster trades placed on consecutive trading days form a trading cluster. The length of cluster is defined as difference of trading days between first and last of cluster sequence. Cluster_all is a cluster trading among any insiders, Cluster_within is a cluster trading among any insiders of same groups, where groups are classified as directors and executives, Cluster_between is a cluster trading among any insiders of different groups, and Cluster_between_within is a cluster trading among insiders of different groups and simultaneously a cluster trading among insiders of same groups. The variables are further described in Appendix A. The table reports (i) cluster insider trading ratio among all insider tradings, (ii) percentage of cluster length with the specific length, (iii) the number of insider tradings per each cluster, and (iv) percentage of opposite direction trading within cluster insider trading sequence periods. The summary statistics of insider tradings by different groups of insiders, executives (including top executives), top executives and directors, are reported in separate columns.

| Groups | All | | | | Top Executives | | | | Executives | | | | Director | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Trade Side | Purchases | | Sales | | Purchases | | Sales | | Purchases | | Sales | | Purchases | | Sales | |
| Statistics | Trade % | Value % | Trade % | Value % | Trade % | Value % | Trade % | Value % | Trade % | Value % | Trade % | Value % | Trade % | Value % | Trade % | Value % |
| Cluster trading ratio among insider tradings | | | | | | | | | | | | | | | | |
| All | 37.63 | 36.05 | 46.18 | 62.00 | 38.98 | 33.86 | 51.27 | 62.52 | 41.44 | 34.58 | 50.15 | 62.13 | 33.9 | 37.22 | 35.31 | 61.75 |
| Within | 32.50 | 31.49 | 40.1 | 55.18 | 32.97 | 29.28 | 46.35 | 56.73 | 36.27 | 30.21 | 45.57 | 56.79 | 28.81 | 32.51 | 25.12 | 52.08 |
| Between | 17.52 | 18.44 | 18.55 | 31.17 | 17.67 | 17.54 | 16.42 | 26.39 | 17.95 | 17.76 | 15.67 | 25.66 | 17.1 | 18.98 | 26.44 | 41.78 |
| Within & Between | 12.69 | 14.20 | 13.61 | 25.94 | 12.01 | 13.23 | 12.92 | 22.42 | 13.06 | 13.66 | 12.32 | 21.91 | 12.32 | 14.63 | 17.15 | 33.67 |
| Cluster length ratio among cluster trading | | | | | | | | | | | | | | | | |
| 1 day | 56.67 | 51.29 | 37.93 | 34.47 | 55.01 | 46.32 | 39.31 | 28.64 | 57.52 | 48.34 | 38.79 | 28.37 | 55.65 | 53.47 | 34.74 | 46.25 |
| 2 day | 32.97 | 25.27 | 41.57 | 24.58 | 33.08 | 25.14 | 39.14 | 27.71 | 31.72 | 25.27 | 40.93 | 27.76 | 34.49 | 25.28 | 43.96 | 18.44 |
| 3 day | 6.59 | 8.16 | 12.03 | 13.18 | 7.45 | 11.44 | 12.46 | 14.96 | 6.70 | 10.67 | 11.92 | 15.02 | 6.47 | 6.31 | 12.42 | 9.62 |
| 4 day | 2.17 | 2.61 | 4.53 | 8.05 | 2.56 | 4.03 | 4.88 | 9.10 | 2.33 | 3.46 | 4.52 | 9.00 | 1.99 | 1.99 | 4.54 | 6.21 |
| 5 day | 0.82 | 3.77 | 1.73 | 5.21 | 1.02 | 3.66 | 1.79 | 4.95 | 0.90 | 2.99 | 1.66 | 5.22 | 0.72 | 4.35 | 2.00 | 5.18 |
| > 5 day | 0.77 | 8.89 | 2.21 | 14.52 | 0.88 | 9.41 | 2.41 | 14.63 | 0.84 | 9.27 | 2.17 | 14.62 | 0.67 | 8.60 | 2.34 | 14.32 |
| Statistics | Mean | Std. | Mean | Std. | Mean | Std. | Mean | Std. | Mean | Std. | Mean | Std. | Mean | Std. | Mean | Std. |
| # of insider tradings per each cluster | | | | | | | | | | | | | | | | |
| All | 3.45 | 2.89 | 3.65 | 4.55 | 3.82 | 3.30 | 4.19 | 5.65 | 3.59 | 3.03 | 3.71 | 4.67 | 3.65 | 3.13 | 4.12 | 5.75 |
| # of Director trading | 1.51 | 2.12 | 0.7 | 1.51 | 1.01 | 1.86 | 0.56 | 1.57 | 1.01 | 1.76 | 0.57 | 1.39 | 2.30 | 2.24 | 1.71 | 1.96 |
| # of Top Executive trading | 0.93 | 1.36 | 1.21 | 2.57 | 1.73 | 1.43 | 2.04 | 3.08 | 1.24 | 1.44 | 1.29 | 2.64 | 0.65 | 1.17 | 0.98 | 2.73 |
| Within | 3.01 | 3.17 | 3.25 | 4.73 | 2.09 | 3.72 | 2.73 | 6.04 | 2.99 | 3.39 | 3.29 | 4.86 | 2.96 | 3.53 | 3.13 | 6.12 |
| Between | 1.62 | 2.96 | 1.51 | 4.18 | 3.44 | 3.49 | 3.78 | 5.68 | 2.17 | 3.24 | 1.61 | 4.29 | 2.47 | 3.35 | 3.69 | 5.89 |
| % of opposite direction trading within cluster period | 3.34 | 17.96 | 1.76 | 13.15 | 2.96 | 16.95 | 1.57 | 12.44 | 3.19 | 17.57 | 1.72 | 13.00 | 3.56 | 18.54 | 1.97 | 13.88 |
| Total Obs | 457539 | | 1001188 | | 118594 | | 299433 | | 226430 | | 733312 | | 231109 | | 267876 | |
| Cluster Obs | 49462 | | 123426 | | 26533 | | 73099 | | 37018 | | 115693 | | 32429 | | 50292 | |

Table 2: Profits of cluster and non-cluster insider trades

The table presents the cumulative abnormal returns (CAR) and the buy and hold abnormal return (BHAR) of cluster and non-cluster insider purchases and sales during the 1986-2016 period. Cluster insider purchases (sales) are defined as purchases (sales) placed by multiple insiders on the same day or consecutive trading days. All the same directional cluster trades placed on consecutive trading days form a trading cluster. The length of cluster is defined as difference of trading days between first and last of cluster sequence. The variables are further described in Appendix A. The CAR and BHAR are estimated using Daniel et al. (1997, DGTW) benchmark adjusted returns. The table displays the CARs of two short-term periods, CAR(t, t+5) and BHAR(t, t+21), and BHARs of medium-term period, BHAR(t, t+90). The t-statistics are shown in parentheses. ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively. The CARs and BHARs of insider tradings by different groups of insiders, executives (including top executives), top executives and directors, are reported in separate columns.

| Groups | All | | | Top Executives | | | Executives | | | Director | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Statistics | Mean | Std. (t-stat) | N | Mean | Std. (t-stat) | N | Mean | Std. (t-stat) | N | Mean | Std. (t-stat) | N |
| A. Purchases | | | | | | | | | | | | |
| **DGTW adjusted return** | | | | | | | | | | | | |
| **CAR(t, t+5)** | | | | | | | | | | | | |
| Non-cluster | 1.09 | 8.85 | 200871 | 1.58 | 10.68 | 48934 | 1.33 | 9.81 | 90308 | 0.89 | 7.97 | 110563 |
| Cluster | 2.06 | 10.48 | 53986 | 2.47 | 11.75 | 22420 | 2.31 | 11.22 | 34131 | 1.91 | 9.58 | 30649 |
| Cluster-Noncluster | 0.98 | (19.87) | | 0.89 | (9.68) | | 0.98 | (14.20) | | 1.02 | (17.09) | |
| **BHAR(t, t+21)** | | | | | | | | | | | | |
| Non-cluster | 1.95 | 17.08 | 200682 | 2.58 | 20.31 | 48832 | 2.37 | 18.64 | 90190 | 1.61 | 15.68 | 110492 |
| Cluster | 3.80 | 19.41 | 53971 | 4.42 | 21.25 | 22417 | 4.25 | 20.49 | 34140 | 3.45 | 18.63 | 30627 |
| Cluster-Noncluster | 1.85 | (20.10) | | 1.83 | (10.84) | | 1.88 | (14.81) | | 1.84 | (15.82) | |
| **BHAR(t, t+90)** | | | | | | | | | | | | |
| Non-cluster | 3.95 | 40.93 | 197880 | 4.87 | 47.45 | 47856 | 4.73 | 46.21 | 88722 | 3.31 | 36.07 | 109158 |
| Cluster | 6.41 | 46.95 | 53259 | 7.74 | 55.09 | 22029 | 7.60 | 51.55 | 33635 | 5.04 | 40.28 | 30245 |
| Cluster-Noncluster | 2.46 | (11.02) | | 2.87 | (6.68) | | 2.87 | (8.94) | | 1.73 | (6.75) | |
| B. Sales | | | | | | | | | | | | |
| **DGTW adjusted return** | | | | | | | | | | | | |
| **CAR(t, t+5)** | | | | | | | | | | | | |
| Non-cluster | -0.07 | 6.51 | 446397 | -0.15 | 6.71 | 118505 | -0.10 | 6.40 | 303485 | 0.00 | 6.74 | 142912 |
| Cluster | -0.04 | 6.20 | 208066 | -0.09 | 6.53 | 92489 | -0.05 | 6.14 | 175963 | -0.04 | 6.56 | 62285 |
| Cluster-Noncluster | 0.03 | (1.56) | | 0.06 | (1.92) | | 0.05 | (2.68) | | -0.04 | (-1.36) | |
| **BHAR(t, t+21)** | | | | | | | | | | | | |
| Non-cluster | -0.32 | 12.75 | 445743 | -0.58 | 13.32 | 118353 | -0.41 | 12.50 | 303068 | -0.14 | 13.24 | 142675 |
| Cluster | -0.22 | 12.50 | 207605 | -0.29 | 13.23 | 92282 | -0.24 | 12.45 | 175602 | -0.08 | 12.97 | 62077 |
| Cluster-Noncluster | 0.11 | (3.22) | | 0.29 | (4.91) | | 0.17 | (4.54) | | 0.06 | (0.91) | |
| **BHAR(t, t+90)** | | | | | | | | | | | | |
| Non-cluster | -0.84 | 28.51 | 437710 | -1.40 | 29.65 | 115990 | -1.00 | 27.85 | 297630 | -0.50 | 29.84 | 140080 |
| Cluster | -1.15 | 27.70 | 203509 | -1.29 | 29.48 | 90378 | -1.10 | 27.85 | 172155 | -1.19 | 28.12 | 60724 |
| Cluster-Noncluster | -0.30 | (-4.06) | | 0.11 | (0.85) | | -0.10 | (-1.16) | | -0.69 | (-4.96) | |

## Table 3: Characteristics of insider trading clusters and trading profits

The table presents results for panel regressions with CAR(t, t+5), BHAR(t, t+21), and BHAR(t, t+90) of insider purchases and sales, as the dependent variables. Cluster insider purchases (sales) are defined as purchases (sales) placed by multiple insiders on the same day or consecutive trading days. All the same directional cluster trades placed on consecutive trading days form a trading cluster. The length of cluster is defined as difference of trading days between first and last of cluster sequence. In separate tests, we limit the length of the cluster to 5 trading days. Cluster_all is a cluster trading among any insiders, Cluster_within is a cluster trading among any insiders of same groups, where groups are classified as directors and executives, Cluster_between is a cluster trading among any insiders of different groups, and Cluster_between_within is a cluster trading among insiders of different groups and simultaneously a cluster trading among insiders of same groups. Cluster Dummy is 1 if an insider trading is a cluster trading, otherwise is 0. Within Cluster Dummy is 1 if the corresponding cluster trading is a Cluster_within trading, otherwise is 0. Between Cluster Dummy is 1 if the corresponding cluster trading is a Cluster_between trading, otherwise is 0. Within&Between Cluster Dummy is 1 if the corresponding cluster trading is a Cluster_between_within trading, otherwise is 0. The CAR and BHAR are estimated using Daniel et al. (1997, DGTW) benchmark adjusted returns. Monthly fixed effects are included and standard errors are clustered at the firm level. The t-statistics are shown in parentheses. ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively. The regression results of insider tradings by executives (including top executives), top executives and directors are reported in separate columns.

A. CAR(t, t+5) of Insider Purchases

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) | (16) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Groups | All | | | | Top Executive | | | | Executive | | | | Director | | | |
| Cluster Dummy | 0.847*** | | 1.021*** | | 0.743*** | | 1.129*** | | 0.837*** | | 1.076*** | | 0.903*** | | 1.027*** | |
| | (12.22) | | (14.94) | | (6.35) | | (8.41) | | (9.26) | | (11.41) | | (11.03) | | (12.30) | |
| Within Cluster Dummy | | 0.553*** | | 0.770*** | | 1.224*** | | 1.585*** | | 0.721*** | | 0.944*** | | 0.264*** | | 0.545*** |
| | | (6.54) | | (9.16) | | (3.28) | | (3.95) | | (5.52) | | (6.90) | | (2.63) | | (5.18) |
| Between Cluster Dummy | | 0.878*** | | 0.971*** | | 0.440*** | | 0.917*** | | 0.605*** | | 0.868*** | | 1.197*** | | 1.162*** |
| | | (7.37) | | (8.06) | | (3.35) | | (6.39) | | (4.99) | | (6.98) | | (10.12) | | (9.47) |
| Within&Between Cluster Dummy | | 0.118 | | -0.0323 | | -0.746* | | -1.317*** | | 0.0705 | | -0.0885 | | 0.279 | | 0.134 |
| | | (0.57) | | (-0.15) | | (-1.75) | | (-2.87) | | (0.27) | | (-0.33) | | (1.22) | | (0.57) |
| Constant | 1.106*** | 1.106*** | 2.222*** | 2.202*** | 1.602*** | 1.601*** | -1.792*** | -1.780*** | 1.355*** | 1.355*** | 2.854*** | 2.826*** | 0.908*** | 0.907*** | 0.840 | 0.753 |
| | (40.57) | (40.55) | (2.92) | (2.90) | (24.28) | (24.27) | (-3.32) | (-3.28) | (30.96) | (30.95) | (2.66) | (2.65) | (28.42) | (28.39) | (1.46) | (1.35) |
| Observations | 253129 | 253129 | 253129 | 253129 | 70475 | 70475 | 70475 | 70475 | 123188 | 123188 | 123188 | 123188 | 140338 | 140338 | 140338 | 140338 |
| Adjusted $R^2$ | 0.010 | 0.011 | 0.070 | 0.071 | 0.012 | 0.012 | 0.094 | 0.094 | 0.012 | 0.012 | 0.088 | 0.089 | 0.010 | 0.011 | 0.090 | 0.091 |
| Firm fixed effect | No | No | Yes | Yes | No | No | Yes | Yes | No | No | Yes | Yes | No | No | Yes | Yes |
| Time fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

B. BHAR(t, t+21) of Insider Purchases

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) | (16) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cluster Dummy | 1.669*** | | 1.998*** | | 1.553*** | | 2.101*** | | 1.648*** | | 1.988*** | | 1.761*** | | 2.026*** | |
| | (11.36) | | (14.39) | | (6.29) | | (8.31) | | (8.64) | | (10.51) | | (10.32) | | (12.49) | |
| Within Cluster Dummy | | 0.944*** | | 1.423*** | | 1.386** | | 1.523*** | | 1.107*** | | 1.430*** | | 0.584*** | | 1.197*** |
| | | (5.57) | | (8.54) | | (2.33) | | (2.64) | | (4.33) | | (5.52) | | (2.87) | | (5.90) |
| Between Cluster Dummy | | 1.783*** | | 1.880*** | | 1.021*** | | 1.946*** | | 1.279*** | | 1.722*** | | 2.168*** | | 2.213*** |
| | | (6.61) | | (7.23) | | (3.89) | | (6.96) | | (4.95) | | (6.77) | | (8.28) | | (8.85) |
| Within&Between Cluster Dummy | | 0.635 | | 0.277 | | -0.0639 | | -0.836 | | 0.959* | | 0.635 | | 0.729 | | 0.0785 |
| | | (1.44) | | (0.66) | | (-0.09) | | (-1.17) | | (1.84) | | (1.23) | | (1.54) | | (0.17) |
| Constant | 1.960*** | 1.959*** | 7.922* | 7.875* | 2.599*** | 2.598*** | -5.171*** | -5.174*** | 2.378*** | 2.377*** | 3.329 | 3.285 | 1.619*** | 1.617*** | 11.20* | 11.05 |
| | (29.03) | (29.01) | (1.95) | (1.94) | (16.63) | (16.63) | (-4.61) | (-4.61) | (22.47) | (22.46) | (1.32) | (1.29) | (20.36) | (20.35) | (1.67) | (1.64) |
| Observations | 252924 | 252924 | 252924 | 252924 | 70368 | 70368 | 70368 | 70368 | 123079 | 123079 | 123079 | 123079 | 140244 | 140244 | 140244 | 140244 |
| Adjusted $R^2$ | 0.020 | 0.020 | 0.128 | 0.128 | 0.025 | 0.025 | 0.192 | 0.192 | 0.022 | 0.022 | 0.159 | 0.159 | 0.021 | 0.022 | 0.174 | 0.175 |
| Firm fixed effect | No | No | Yes | Yes | No | No | Yes | Yes | No | No | Yes | Yes | No | No | Yes | Yes |
| Time fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

Table 3 - *continued*

| C. BHAR(t, t+90) of Insider Purchases | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) | (16) |
| Groups | All | | | | Top Executive | | | | Executive | | | | Director | | | |
| Cluster Dummy | 2.219*** | | 2.922*** | | 2.408*** | | 3.022*** | | 2.449*** | | 2.902*** | | 1.734*** | | 2.714*** | |
| | (6.01) | | (9.10) | | (3.40) | | (5.01) | | (4.69) | | (6.73) | | (4.53) | | (8.15) | |
| Within Cluster Dummy | | 1.333*** | | 2.209*** | | 0.439 | | 0.347 | | 2.480*** | | 2.783*** | | -0.359 | | 1.038** |
| | | (2.85) | | (5.25) | | (0.34) | | (0.26) | | (3.27) | | (4.46) | | (-0.77) | | (2.27) |
| Between Cluster Dummy | | 2.403*** | | 2.939*** | | 2.132** | | 3.012*** | | 0.934 | | 1.669*** | | 3.183*** | | 4.069*** |
| | | (4.07) | | (5.41) | | (2.24) | | (4.18) | | (1.59) | | (2.96) | | (5.29) | | (7.71) |
| Within&Between Cluster Dummy | | 0.512 | | -0.426 | | 1.149 | | 1.113 | | 0.923 | | 0.616 | | 0.985 | | -0.930 |
| | | (0.51) | | (-0.44) | | (0.65) | | (0.65) | | (0.70) | | (0.51) | | (0.98) | | (-0.91) |
| Constant | 3.951*** | 3.950*** | -0.617 | -0.673 | 4.843*** | 4.842*** | 9.014** | 8.975** | 4.736*** | 4.734*** | 1.326 | 1.176 | 3.307*** | 3.305*** | -4.609 | -4.951 |
| | (18.99) | (18.99) | (-0.05) | (-0.06) | (10.19) | (10.19) | (2.42) | (2.41) | (14.35) | (14.35) | (0.40) | (0.35) | (14.24) | (14.23) | (-0.24) | (-0.26) |
| Observations | 249446 | 249446 | 249446 | 249446 | 69023 | 69023 | 69023 | 69023 | 121125 | 121125 | 121125 | 121125 | 138548 | 138548 | 138548 | 138548 |
| Adjusted $R^2$ | 0.012 | 0.012 | 0.183 | 0.183 | 0.015 | 0.015 | 0.270 | 0.270 | 0.013 | 0.013 | 0.213 | 0.213 | 0.016 | 0.016 | 0.238 | 0.238 |
| Firm fixed effect | No | No | Yes | Yes | No | No | Yes | Yes | No | No | Yes | Yes | No | No | Yes | Yes |
| Time fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

| D. CAR(t, t+5) of Insider Sales | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) | (16) |
| Groups | All | | | | Top Executive | | | | Executive | | | | Director | | | |
| Cluster Dummy | -0.0280 | | -0.0883*** | | -0.0198 | | -0.0851** | | -0.0111 | | -0.0620** | | -0.0959** | | -0.171*** | |
| | (-1.25) | | (-3.88) | | (-0.54) | | (-2.20) | | (-0.46) | | (-2.53) | | (-2.37) | | (-3.94) | |
| Within Cluster Dummy | | -0.0516** | | -0.106*** | | -0.0480 | | -0.119 | | -0.0271 | | -0.0694** | | -0.106 | | -0.200** |
| | | (-1.98) | | (-4.02) | | (-0.62) | | (-1.51) | | (-0.97) | | (-2.46) | | (-1.24) | | (-2.31) |
| Between Cluster Dummy | | -0.0510 | | -0.0846* | | -0.0944** | | -0.164*** | | -0.0995** | | -0.132*** | | -0.118** | | -0.164*** |
| | | (-1.04) | | (-1.74) | | (-2.31) | | (-3.87) | | (-2.05) | | (-2.69) | | (-2.54) | | (-3.36) |
| Within&Between Cluster Dummy | | 0.159** | | 0.152** | | 0.194** | | 0.281*** | | 0.241*** | | 0.227*** | | 0.178 | | 0.203* |
| | | (2.22) | | (2.13) | | (2.06) | | (2.94) | | (3.19) | | (3.05) | | (1.51) | | (1.70) |
| Constant | -0.0695*** | -0.0695*** | 0.196 | 0.199 | -0.148*** | -0.148*** | -1.235*** | -1.234*** | -0.0987*** | -0.0989*** | 0.430 | 0.433 | -0.00718 | -0.00723 | -0.432 | -0.431 |
| | (-5.57) | (-5.57) | (0.28) | (0.29) | (-5.80) | (-5.80) | (-16.93) | (-16.93) | (-6.54) | (-6.55) | (0.55) | (0.55) | (-0.31) | (-0.32) | (-0.32) | (-0.32) |
| Observations | 635316 | 635316 | 635316 | 635316 | 200094 | 200094 | 200094 | 200094 | 462814 | 462814 | 462814 | 462814 | 198941 | 198941 | 198941 | 198941 |
| Adjusted $R^2$ | 0.002 | 0.002 | 0.056 | 0.056 | 0.003 | 0.003 | 0.065 | 0.065 | 0.002 | 0.002 | 0.069 | 0.069 | 0.002 | 0.002 | 0.078 | 0.078 |
| Firm fixed effect | No | No | Yes | Yes | No | No | Yes | Yes | No | No | Yes | Yes | No | No | Yes | Yes |
| Time fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

Table 3 - *continued*

| E. BHAR(t, t+21) of Insider Sales | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) | (16) |
| Groups | All | | | | Top Executive | | | | Executive | | | | Director | | | |
| Cluster Dummy | 0.0104 | | -0.281*** | | 0.156 | | -0.232*** | | 0.0756 | | -0.223*** | | -0.0688 | | -0.413*** | |
| | (0.18) | | (-5.28) | | (1.61) | | (-2.64) | | (1.22) | | (-3.98) | | (-0.70) | | (-4.20) | |
| Within Cluster Dummy | | -0.138** | | -0.367*** | | -0.0319 | | -0.357** | | -0.0369 | | -0.279*** | | -0.409** | | -0.635*** |
| | | (-2.10) | | (-6.08) | | (-0.16) | | (-2.05) | | (-0.53) | | (-4.38) | | (-2.25) | | (-3.57) |
| Between Cluster Dummy | | 0.171 | | -0.0641 | | 0.153 | | -0.215** | | 0.136 | | -0.0959 | | -0.0770 | | -0.338*** |
| | | (1.47) | | (-0.57) | | (1.50) | | (-2.19) | | (1.16) | | (-0.83) | | (-0.72) | | (-3.08) |
| Within&Between Cluster Dummy | | 0.285* | | 0.230 | | 0.107 | | 0.377* | | 0.335** | | 0.261* | | 0.672** | | 0.577** |
| | | (1.79) | | (1.49) | | (0.47) | | (1.76) | | (2.06) | | (1.67) | | (2.54) | | (2.26) |
| Constant | -0.317*** | -0.317*** | 3.222 | 3.234 | -0.572*** | -0.572*** | -1.802*** | -1.796*** | -0.403*** | -0.404*** | 2.287 | 2.300 | -0.132** | -0.133** | 7.397*** | 7.401*** |
| | (-8.50) | (-8.51) | (1.37) | (1.38) | (-7.36) | (-7.37) | (-8.67) | (-8.65) | (-9.34) | (-9.34) | (0.73) | (0.74) | (-2.12) | (-2.13) | (3.72) | (3.72) |
| Observations | 634290 | 634290 | 634290 | 634290 | 199787 | 199787 | 199787 | 199787 | 462106 | 462106 | 462106 | 462106 | 198551 | 198551 | 198551 | 198551 |
| Adjusted $R^2$ | 0.005 | 0.005 | 0.081 | 0.082 | 0.011 | 0.011 | 0.135 | 0.135 | 0.006 | 0.007 | 0.092 | 0.092 | 0.006 | 0.006 | 0.131 | 0.131 |
| Firm fixed effect | No | No | Yes | Yes | No | No | Yes | Yes | No | No | Yes | Yes | No | No | Yes | Yes |
| Time fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

| F. BHAR(t, t+90) of Insider Sales | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cluster Dummy | -0.222 | | -1.497*** | | 0.232 | | -1.391*** | | -0.0240 | | -1.314*** | | -0.628** | | -1.981*** | |
| | (-1.39) | | (-11.61) | | (0.86) | | (-6.64) | | (-0.14) | | (-9.43) | | (-2.43) | | (-8.95) | |
| Within Cluster Dummy | | -0.305 | | -1.377*** | | 0.0669 | | -1.261*** | | -0.0694 | | -1.224*** | | -1.219*** | | -1.716*** |
| | | (-1.64) | | (-9.19) | | (0.13) | | (-3.04) | | (-0.35) | | (-7.76) | | (-2.71) | | (-4.31) |
| Between Cluster Dummy | | 0.196 | | -0.873*** | | 0.247 | | -1.098*** | | 0.261 | | -0.734*** | | -0.358 | | -1.711*** |
| | | (0.68) | | (-3.40) | | (0.90) | | (-4.76) | | (0.87) | | (-2.65) | | (-1.31) | | (-6.98) |
| Within&Between Cluster Dummy | | -0.189 | | -0.127 | | -0.0335 | | 0.659 | | -0.273 | | -0.202 | | 0.844 | | 0.654 |
| | | (-0.48) | | (-0.34) | | (-0.06) | | (1.32) | | (-0.67) | | (-0.53) | | (1.39) | | (1.20) |
| Constant | -0.847*** | -0.847*** | 14.23 | 14.21 | -1.429*** | -1.429*** | 9.880*** | 9.878*** | -1.014*** | -1.013*** | 20.38 | 20.36 | -0.505*** | -0.505*** | -2.380 | -2.380 |
| | (-7.25) | (-7.25) | (1.13) | (1.13) | (-6.16) | (-6.16) | (22.81) | (22.80) | (-7.61) | (-7.61) | (1.29) | (1.29) | (-2.61) | (-2.61) | (-0.92) | (-0.92) |
| Observations | 622611 | 622611 | 622611 | 622611 | 195797 | 195797 | 195797 | 195797 | 453623 | 453623 | 453623 | 453623 | 194787 | 194787 | 194787 | 194787 |
| Adjusted $R^2$ | 0.008 | 0.008 | 0.135 | 0.135 | 0.015 | 0.015 | 0.201 | 0.201 | 0.010 | 0.010 | 0.150 | 0.150 | 0.010 | 0.010 | 0.187 | 0.187 |
| Firm fixed effect | No | No | Yes | Yes | No | No | Yes | Yes | No | No | Yes | Yes | No | No | Yes | Yes |
| Time fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

Table 4: Robustness check: Extended cluster trades

The table presents results for panel regressions using BHAR(t, t+21) of insider purchases (sales) as the dependent variable. We use an alternative measure of trading clusters that extend the interval between cluster trades. In this table, cluster trades are defined as the same directions insider placed by multiple insiders on the same day, consecutive trading days, or in two trading days. All the same directional cluster trades placed in two trading days constitute an extended trading cluster. The length of cluster is defined as difference of trading days between first and last of cluster sequence. We limit the length of the cluster to 5 trading days as default. Cluster_all is a cluster trading among any insiders, Cluster_within is a cluster trading among any insiders of same groups, where groups are classified as directors and executives, Cluster_between is a cluster trading among any insiders of different groups, and Cluster_between_within is a cluster trading among insiders of different groups and simultaneously a cluster trading among insiders of same groups. Cluster Dummy is 1 if an insider trading is a cluster trading, otherwise is 0. Within Cluster Dummy is 1 if the corresponding cluster trading is a Cluster_within trading, otherwise is 0. Between Cluster Dummy is 1 if the corresponding cluster trading is a Cluster_between trading, otherwise is 0. Within&Between Cluster Dummy is 1 if the corresponding cluster trading is a Cluster_between_within trading, otherwise is 0. The CAR is estimated using Daniel et al. (1997, DGTW) benchmark adjusted returns. Firm- and month-fixed effects are included and standard errors are clustered at the firm level. The t-statistics are shown in parentheses. ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively. The regression results of insider tradings by executives (including top executives), top executives and directors are reported in separate columns.

| A. BHAR(t, t+21) of Insider Purchases | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Groups | All | | Top Executive | | Executive | | Director | |
| Cluster Dummy | 1.965*** | | 2.058*** | | 1.915*** | | 1.973*** | |
| | (15.26) | | (8.45) | | (11.01) | | (12.52) | |
| Within Cluster Dummy | | 1.440*** | | 1.054* | | 1.363*** | | 1.288*** |
| | | (9.04) | | (1.85) | | (5.67) | | (6.28) |
| Between Cluster Dummy | | 1.736*** | | 1.951*** | | 1.690*** | | 2.076*** |
| | | (7.19) | | (7.29) | | (6.96) | | (8.62) |
| Within&Between Cluster Dummy | | 0.187 | | -0.327 | | 0.423 | | -0.124 |
| | | (0.50) | | (-0.47) | | (0.91) | | (-0.30) |
| Constant | 7.952* | 7.873* | -5.331*** | -5.343*** | 3.219 | 3.181 | 11.26* | 11.08* |
| | (1.96) | (1.94) | (-4.76) | (-4.77) | (1.26) | (1.24) | (1.68) | (1.65) |
| Observations | 249188 | 249188 | 68691 | 68691 | 120600 | 120600 | 138364 | 138364 |
| Adjusted $R^2$ | 0.126 | 0.126 | 0.189 | 0.189 | 0.156 | 0.157 | 0.172 | 0.173 |
| Firm fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Time fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| B. BHAR(t, t+21) of Insider Sales | | | | | | | | |
| Cluster Dummy | -0.328*** | | -0.308*** | | -0.286*** | | -0.397*** | |
| | (-6.13) | | (-3.36) | | (-4.98) | | (-4.11) | |
| Within Cluster Dummy | | -0.394*** | | -0.432** | | -0.323*** | | -0.404** |
| | | (-6.47) | | (-2.50) | | (-5.00) | | (-2.19) |
| Between Cluster Dummy | | -0.168 | | -0.241** | | -0.221** | | -0.322*** |
| | | (-1.59) | | (-2.38) | | (-1.99) | | (-2.99) |
| Within&Between Cluster Dummy | | 0.291** | | 0.362* | | 0.340** | | 0.198 |
| | | (2.00) | | (1.72) | | (2.23) | | (0.81) |
| Constant | 2.756 | 2.762 | -2.008*** | -2.002*** | 1.686 | 1.691 | 7.416*** | 7.423*** |
| | (1.20) | (1.20) | (-9.56) | (-9.50) | (0.55) | (0.55) | (3.72) | (3.72) |
| Observations | 600888 | 600888 | 184819 | 184819 | 434682 | 434682 | 188545 | 188545 |
| Adjusted $R^2$ | 0.081 | 0.081 | 0.138 | 0.138 | 0.091 | 0.091 | 0.135 | 0.135 |
| Firm fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Time fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

Table 5: Monthly trading activities and return predictability of cluster trades

The table reports the regression results of monthly return predictability. The dependent variable is a one-month-ahead stock return. All firm-months are included in the estimation regardless of existence of insider trading in the months. Cluster insider purchases (sales) are defined as purchases (sales) placed by multiple insiders on the same day or consecutive trading days. All the same directional cluster trades placed on consecutive trading days form a trading cluster. The length of cluster is defined as difference of trading days between first and last of cluster sequence. Cluster_within is a cluster trading among any insiders of same groups, where groups are classified as directors and executives, Cluster_between is a cluster trading among any insiders of different groups, and Cluster_between_within is a cluster trading among insiders of different groups and simultaneously a cluster trading among insiders of same groups. "Insider trading" is 1 if any insider trading occurs in the months, otherwise is 0. "Cluster" is 1 if cluster insider trading occurs in the months, otherwise is 0. "Between & Within" is 1 if Cluster_between_within trading occurs in the months, otherwise is 0. "Within" is 1 if Cluster_within trading only occurs in the months, otherwise is 0. "Between" is 1 if Cluster_between trading only occurs in the months, otherwise is 0. The control variables include log firm size, log book-to-market ratio, one month past return (Return (t-1, t)), and momentum (Return (t-12, t-1)). Multiple insider dummy is 1 if multiple insiders buy (sell) stocks in the months, otherwise is 0. The standard errors are clustered by time (months) and the t-statistics are shown in parentheses. ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively.

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| Trading Side | Purchases | | | | Sales | | | |
| Dependent Variable | Monthly raw stock return | | | | | | | |
| Insider trading | 0.9566*** | 0.9825*** | 0.9567*** | 0.9831*** | -0.0987 | -0.0456 | -0.0985 | -0.0450 |
| | (10.821) | (11.275) | (10.820) | (11.273) | (-1.535) | (-0.771) | (-1.531) | (-0.759) |
| Cluster | 0.6538*** | 0.7773*** | | | -0.0326 | -0.0425 | | |
| | (4.566) | (5.350) | | | (-0.363) | (-0.557) | | |
| Within | | | 0.4536*** | 0.5467*** | | | -0.0549 | -0.1245 |
| | | | (3.420) | (3.935) | | | (-0.626) | (-1.535) |
| Between | | | 0.5665*** | 0.6490*** | | | -0.0854 | 0.0112 |
| | | | (2.802) | (3.226) | | | (-0.750) | (0.099) |
| Within&Between | | | 0.2052 | 0.2772 | | | 0.2020 | 0.2591 |
| | | | (0.641) | (0.844) | | | (1.218) | (1.611) |
| Log Size | -0.1898*** | -2.3827*** | -0.1897*** | -2.3825*** | -0.1829*** | -2.3874*** | -0.1830*** | -2.3881*** |
| | (-3.509) | (-16.782) | (-3.507) | (-16.784) | (-3.305) | (-16.642) | (-3.304) | (-16.642) |
| Book-to-Market | 0.0033* | -0.0057*** | 0.0033* | -0.0056*** | 0.0031 | -0.0056*** | 0.0031 | -0.0056*** |
| | (1.671) | (-2.628) | (1.672) | (-2.627) | (1.621) | (-2.622) | (1.622) | (-2.623) |
| Return (t-1, t) | -3.7743*** | -3.9381*** | -3.7741*** | -3.9379*** | -3.7928*** | -3.9556*** | -3.7938*** | -3.9573*** |
| | (-3.957) | (-4.176) | (-3.957) | (-4.176) | (-3.971) | (-4.191) | (-3.972) | (-4.192) |
| Return (t-12, t-1) | 0.2198 | 0.2876 | 0.2200 | 0.2878 | 0.2107 | 0.2788 | 0.2103 | 0.2782 |
| | (1.133) | (1.494) | (1.134) | (1.495) | (1.091) | (1.457) | (1.090) | (1.454) |
| Constant | 4.2326*** | 13.7506*** | 4.2317*** | 13.7492*** | 4.2048*** | 13.7837*** | 4.2052*** | 13.7867*** |
| | (16.675) | (20.958) | (16.677) | (20.963) | (16.241) | (20.783) | (16.235) | (20.781) |
| Observations | 1,692,525 | 1,692,525 | 1,692,525 | 1,692,525 | 1,692,525 | 1,692,525 | 1,692,525 | 1,692,525 |
| Adjusted $R^2$ | 0.098 | 0.118 | 0.098 | 0.118 | 0.098 | 0.118 | 0.098 | 0.118 |
| Firm fixed effect | No | Yes | No | Yes | No | Yes | No | Yes |
| Time fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Cluster | Months | Months | Months | Months | Months | Months | Months | Months |

## Table 6: Opportunistic trades and cluster trades

The table presents results for panel regressions using BHAR(t, t+21) of insider purchases (sales) as the dependent variable. We identify routine traders following Cohen et al. (2012). A routine trader is defined as an insider who purchase (sales) in the same calendar month for at least consecutive three years. Insider trades placed by these routine traders are also considered as routine trades. Unclassified trades are the insider trades wich do not meet the requirements to classify trades as routine or opportunistic trades. Cluster insider purchases (sales) are defined as purchases (sales) placed by multiple insiders on the same day or consecutive trading days. All the same directional cluster trades placed on consecutive trading days form a trading cluster. We limit the length of the cluster to 5 trading days as default. Cluster_all is a cluster trading among any insiders, Cluster_within is a cluster trading among any insiders of same groups, where groups are classified as directors and executives, Cluster_between is a cluster trading among any insiders of different groups, and Cluster_between_within is a cluster trading among insiders of different groups and simultaneously a cluster trading among insiders of same groups. Cluster Dummy is 1 if an insider trading is a cluster trading, otherwise is 0. Opportunistic Trading Dummy is 1 if an insider trading is identified as opportunistic insider trade, otherwise is 0. Unclassified Trading Dummy is 1 if an insider trading is unclassified, otherwise is 0. The CAR is estimated using Daniel et al. (1997, DGTW) benchmark adjusted returns. Time-fixed effect is included and standard errors are cluster at the firm level. The t-statistics are shown in parentheses. ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively. The regression results of insider tradings by executives (including top executives), top executives and directors are reported in separate columns.

| A. BHAR(t, t+21) of Insider Purchases | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Groups | All | | Top Executive | | Executive | | Director | |
| Opportunistic Trading Dummy | 1.509*** | 0.181 | 0.527 | -0.935* | 1.341*** | 0.033 | 1.592*** | 0.108 |
| | (6.344) | (0.936) | (1.164) | (-1.853) | (3.700) | (0.091) | (5.786) | (0.462) |
| Unclassified Trading Dummy | 1.785*** | -0.022 | 1.437*** | -0.760* | 1.637*** | -0.045 | 1.908*** | -0.065 |
| | (8.986) | (-0.141) | (3.790) | (-1.783) | (5.560) | (-0.153) | (8.771) | (-0.332) |
| Cluster Dummy | 1.167*** | 1.890*** | 1.318*** | 1.866*** | 1.061*** | 1.699*** | 1.192*** | 1.982*** |
| | (7.214) | (12.435) | (4.810) | (6.723) | (5.077) | (7.910) | (6.409) | (11.451) |
| Constant | 0.081 | 1.805*** | 7.733** | 9.216** | 1.674* | 2.179** | -0.787 | 1.373** |
| | (0.158) | (3.521) | (2.210) | (2.017) | (1.745) | (2.277) | (-1.497) | (2.476) |
| Observations | 314,034 | 314,034 | 77,935 | 77,935 | 149,272 | 149,272 | 164,762 | 164,762 |
| Adjusted $R^2$ | 0.005 | 0.165 | 0.007 | 0.278 | 0.005 | 0.221 | 0.004 | 0.217 |
| Firm fixed effect | No | Yes | No | Yes | No | Yes | No | Yes |
| Time fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| B. BHAR(t, t+21) of Insider Sales | | | | | | | | |
| Opportunistic Trading Dummy | 0.020 | 0.349*** | 0.020 | 0.600*** | 0.001 | 0.385*** | 0.091 | 0.312* |
| | (0.205) | (3.874) | (0.127) | (3.255) | (0.010) | (3.630) | (0.552) | (1.703) |
| Unclassified Trading Dummy | -0.045 | 0.459*** | -0.105 | 0.672*** | -0.058 | 0.469*** | 0.019 | 0.562*** |
| | (-0.497) | (5.091) | (-0.731) | (3.854) | (-0.552) | (4.434) | (0.131) | (3.099) |
| Cluster Dummy | -0.081 | -0.385*** | 0.007 | -0.419*** | -0.043 | -0.343*** | -0.125 | -0.465*** |
| | (-1.162) | (-5.645) | (0.064) | (-3.986) | (-0.562) | (-4.640) | (-1.127) | (-4.243) |
| Constant | 0.340 | 0.509* | 2.436 | 4.125** | 0.471 | 0.596* | 0.040 | 0.384 |
| | (1.255) | (1.740) | (1.629) | (2.416) | (1.464) | (1.717) | (0.101) | (0.775) |
| Observations | 811,136 | 811,136 | 237,392 | 237,392 | 593,792 | 593,792 | 217,344 | 217,344 |
| Adjusted $R^2$ | 0.002 | 0.098 | 0.003 | 0.159 | 0.002 | 0.110 | 0.001 | 0.169 |
| Firm fixed effect | No | Yes | No | Yes | No | Yes | No | Yes |
| Time fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

Table 7: Cluster trades and corporate news

The table reports the regression results of monthly news predictability. The dependent variable is a month-ahead positive (negative) news dummy. If the number of positive (negative) sentiment news about the company is more than the number of negative (positive) sentiment news in months, the positive (negative) news Month is 1, otherwise is 0. If there exist equal number of positive and negative news or zero news, news dummy is coded as 0. We employ Event Sentiment Score (ESS) of RavenPack News Analytics as our news sentiment score. We only include the relevant news about the firm if (1) the source of the news is Dow Jones Newswire, (2) the relevance of news about the firm is above 80%, and (3) ESS are provided by RavenPack. The positive (negative) news is defined if ESS of the news is greater (less) than 50. If the ESS of the news is 50, we consider the news as neutral. All firm-months are included in the estimation regardless of existence of insider trading in the months. Cluster insider purchases (sales) are defined as purchases (sales) placed by multiple insiders on the same day or consecutive trading days. All the same directional cluster trades placed on consecutive trading days form a trading cluster. The length of cluster is defined as difference of trading days between first and last of cluster sequence. "Insider trading" is 1 if any insider trading occurs in the months, otherwise is 0. "Cluster" is 1 if cluster insider trading occurs in the months, otherwise is 0. The control variables include log firm size, log book-to-market ratio, one month past return (Return (t-1, t)), and momentum (Return (t-12, t-1)). Multiple insider dummy is 1 if multiple insiders buy (sell) stocks in the months, otherwise is 0. Time fixed effect is included and standard errors are clustered by time (months) and the t-statistics are shown in parentheses. ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively.

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| Trading Side | Purchases | | | | Sales | | | |
| Dependent Variable | Positive News Month | | Negative News Month | | Positive News Month | | Negative News Month | |
| Insider trading | 0.0218*** | 0.0133*** | -0.0225*** | -0.0144*** | -0.0253*** | -0.0325*** | 0.0514*** | 0.0340*** |
| | (8.342) | (6.768) | (-13.790) | (-11.109) | (-10.411) | (-15.656) | (14.065) | (13.158) |
| Cluster | 0.0305*** | 0.0226*** | -0.0197*** | -0.0126*** | -0.0442*** | -0.0380*** | 0.0746*** | 0.0512*** |
| | (7.791) | (7.232) | (-9.230) | (-6.756) | (-10.875) | (-12.583) | (17.396) | (14.437) |
| Log Size | 0.0258*** | 0.0277*** | 0.0111*** | 0.0133*** | 0.0278*** | 0.0309*** | 0.0073*** | 0.0095*** |
| | (16.436) | (20.586) | (16.939) | (15.120) | (17.466) | (23.090) | (14.666) | (12.898) |
| Book-to-Market | -0.0004*** | 0.0000** | -0.0002*** | 0.0001*** | -0.0004*** | 0.0000*** | -0.0002*** | 0.0001*** |
| | (-9.586) | (1.981) | (-11.714) | (3.938) | (-9.494) | (2.649) | (-11.741) | (3.387) |
| Return (t-1, t) | -0.0310*** | -0.0352*** | 0.0182*** | 0.0159*** | -0.0280*** | -0.0324*** | 0.0120*** | 0.0125*** |
| | (-6.789) | (-8.344) | (4.934) | (4.594) | (-6.303) | (-7.850) | (3.538) | (3.816) |
| Return (t-12, t-1) | 0.0005 | -0.0014** | -0.0015** | -0.0032*** | 0.0017 | -0.0003 | -0.0039*** | -0.0045*** |
| | (0.597) | (-2.039) | (-2.058) | (-3.469) | (1.629) | (-0.430) | (-3.647) | (-3.837) |
| Constant | -0.1141*** | -0.1319*** | -0.0499*** | -0.0545*** | -0.1236*** | -0.1457*** | -0.0320*** | -0.0385*** |
| | (-16.177) | (-23.081) | (-16.651) | (-13.915) | (-17.305) | (-25.487) | (-14.446) | (-11.811) |
| Observations | 1,692,525 | 1,692,525 | 1,692,525 | 1,692,525 | 1,692,525 | 1,692,525 | 1,692,525 | 1,692,525 |
| Adjusted $R^2$ | 0.276 | 0.343 | 0.146 | 0.204 | 0.277 | 0.344 | 0.155 | 0.208 |
| Firm fixed effect | No | Yes | No | Yes | No | Yes | No | Yes |
| Time fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Cluster | Months | Months | Months | Months | Months | Months | Months | Months |

Table 8: Cluster trades and earnings surprises

This table provides regression results of earnings surprise on insider trading dummy and cluster dummy. Cluster insider purchases (sales) are defined as purchases (sales) placed by multiple insiders on the same day or consecutive trading days. All the same directional cluster trades placed on consecutive trading days form a trading cluster. Insider Trading Dummy is 1 if any insider trading occurs during trading windows, otherwise is 0. Cluster Dummy is 1 if cluster insider trading occurs during trading windows, otherwise is 0. The trading windows is 4 weeks before the announcement date until the date. The dependent variables are CAR(0,5) and CAR(0,21) around earnings announcement date. CAR(0,5) is the cumulative benchmark-adjusted return in the trading day window $(t, t+5)$ starting from the earnings announcement date $t$. CAR(0,21) is the cumulative benchmark-adjusted return in the trading day window $(t, t+21)$ starting from the earnings announcement date $t$. Each regression includes the log size, book-to-market ratio, and last quarter 21 day CAR of the corresponding firm as control variables. Time fixed effect is included. $t$-statistics are shown in parentheses and standard errors clustered at the firm level. ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively.

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| Trading Side | Purchases | | | | Sales | | | |
| Variables | CAR (0, 5) | | CAR (0, 21) | | CAR (0, 5) | | CAR (0, 21) | |
| Insider Trading Dummy | 0.0040*** | 0.0029*** | 0.0081*** | 0.0075*** | -0.0011** | -0.0008 | -0.0016* | -0.0007 |
| | (6.281) | (4.405) | (7.522) | (6.570) | (-2.415) | (-1.546) | (-1.734) | (-0.702) |
| Cluster Dummy | 0.0049*** | 0.0045*** | 0.0057** | 0.0076*** | 0.0003 | 0.0004 | 0.0002 | -0.0008 |
| | (3.244) | (2.608) | (2.309) | (2.815) | (0.327) | (0.386) | (0.117) | (-0.439) |
| Log Size | -0.0001 | -0.0081*** | -0.0027*** | -0.0236*** | -0.0001 | -0.0081*** | -0.0027*** | -0.0236*** |
| | (-1.191) | (-23.753) | (-16.140) | (-36.212) | (-0.962) | (-23.698) | (-15.665) | (-35.983) |
| Book-to-Market | 0.0006** | 0.0001 | 0.0014*** | 0.0010* | 0.0006** | 0.0001 | 0.0014*** | 0.0010* |
| | (2.263) | (0.534) | (3.020) | (1.792) | (2.257) | (0.518) | (3.018) | (1.787) |
| Last Quarter CAR(0,21) | 0.0057*** | -0.0054*** | 0.0098*** | -0.0229*** | 0.0057*** | -0.0054*** | 0.0097*** | -0.0229*** |
| | (3.417) | (-3.238) | (2.651) | (-7.140) | (3.396) | (-3.253) | (2.635) | (-7.175) |
| Constant | 0.0037* | 0.0397*** | 0.0161*** | 0.1113*** | 0.0036* | 0.0397*** | 0.0160*** | 0.1116*** |
| | (1.941) | (15.751) | (5.130) | (25.476) | (1.910) | (15.770) | (5.100) | (25.473) |
| Observations | 424,985 | 424,985 | 424,577 | 424,577 | 424,985 | 424,985 | 424,577 | 424,577 |
| Adjusted $R^2$ | 0.001 | 0.055 | 0.004 | 0.064 | 0.001 | 0.055 | 0.004 | 0.063 |
| Firm fixed effect | No | Yes | No | Yes | No | Yes | No | Yes |
| Time fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

Table 9: Firm characteristics and insider cluster trades

The table examines determinants of cluster insider trading. Panel A shows the regression results of cluster ratio on the proxies of information asymmetry between insiders and outsiders. The depedend variable is Cluster ratio, a percentage of cluster purchases (sales) out of total insider purchases (sales) at firm-year level. We include firm characterstics related to information structure as independent variable, Log size, Book-to-Market, Std. of Return, R&D dummy, and Illiquidity Quintile. R&D dummy is 1 if a firm has a positive R&D expenditure, and 0 otherwise. Illiquidity Qunitile is the quintile rank of Amihud (2002). We also control Return (t-12, t) and Log (1+number of insider trades). In addition to these independent variables, we consider the following information production measures: (1) Log(1+ number of financial analysts) and (2) institutional ownership. The number of financial analysts is the number of financial analysts who reports forecast of annual earnings in IBES. Institutional ownership is defined as a ratio of shares held by institutional investors over shares outstanding. We also consider two governance measures: (1) the E-index and (2) a staggered board. E-index is the management entrenchment index from Bebchuk et al. (2009). . The governance is classified as "Good" if E-index is less than 3, a board is a staggered board, and institutional concentration is top tercile. The governance is classified as "Bad" if E-index is greater than or equal to 3, a board is a declassified board, and institutional concentration is bottom tercile. Panel B shows the regression results of Between-Cluster ratio on the proxies of information asymmetry among insiders. Between-Cluster ratio is the cluster ratio between executives and directors. We consider two CEO power measures as the proxies of information asymmetry among insiders: (1) CEO centrality and (2) fraction of non-co-opted independent directors. CEO centrality is defined as the ratio of CEO's compensation to the sum of compensation of top five executives following Bebchuck et al. (2011). The fraction of non-co-opted independent directors is the number of independent directors to the number who are not co-opted of all directors. Industry (Fama-French 48) fixed effect and year fixed effect are included and the standard errors are clustered at the firm level. The t-statistics are shown in parentheses. ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively.

| A. Information Asymmetry between Insiders and Outsiders | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Trading Side | Purchases | | | | Sales | | | |
| Dependent Variable | Cluster ratio | | | | | | | |
| Log Size | -0.0146*** | -0.0166*** | -0.0196*** | -0.0235*** | 0.0231*** | 0.0225*** | 0.0152*** | 0.0158*** |
| | (-11.308) | (-11.542) | (-7.578) | (-7.569) | (16.446) | (14.958) | (5.580) | (5.032) |
| Book-to-Market | 0.0018 | 0.0012 | 0.0119*** | 0.0110*** | -0.0007 | -0.0012* | -0.0323*** | -0.0314*** |
| | (0.861) | (0.547) | (4.515) | (4.185) | (-1.073) | (-1.805) | (-6.132) | (-5.898) |
| Std. of Return | 0.0693*** | 0.0688*** | 0.0440 | 0.0233 | 0.0541*** | 0.0671*** | 0.2112*** | 0.2202*** |
| | (4.057) | (4.036) | (0.857) | (0.461) | (3.327) | (4.068) | (4.578) | (4.708) |
| R&D dummy | -0.0035 | -0.0034 | -0.0012 | -0.0014 | 0.0075* | 0.0085** | 0.0228*** | 0.0232*** |
| | (-0.901) | (-0.860) | (-0.137) | (-0.165) | (1.810) | (2.082) | (2.845) | (2.923) |
| Illiquidity Quintile | -0.0149*** | -0.0117*** | -0.0167*** | -0.0146** | 0.0011 | 0.0072*** | -0.0070 | -0.0001 |
| | (-8.583) | (-6.125) | (-3.171) | (-2.423) | (0.609) | (3.993) | (-1.410) | (-0.012) |
| Return (t-12, t) | 0.0035* | 0.0038** | 0.0041 | 0.0070 | 0.0198*** | 0.0187*** | 0.0377*** | 0.0360*** |
| | (1.948) | (2.040) | (0.789) | (1.299) | (10.465) | (9.932) | (7.396) | (7.272) |
| Log (1+number of insider trades) | 0.0537*** | 0.0539*** | 0.0628*** | 0.0624*** | 0.0476*** | 0.0467*** | 0.0537*** | 0.0530*** |
| | (25.320) | (25.422) | (12.050) | (12.018) | (43.410) | (42.826) | (23.701) | (23.211) |
| Log(1+number of financial analysts) | | 0.0067*** | | 0.0123** | | 0.0013 | | 0.0019 |
| | | (2.659) | | (2.080) | | (0.598) | | (0.382) |
| Institutional ownership | | 0.0156** | | -0.0227 | | 0.0537*** | | 0.0629*** |
| | | (2.259) | | (-1.335) | | (8.637) | | (4.292) |
| Good E-Index dummy | | | 0.0020 | 0.0017 | | | -0.0031 | -0.0015 |
| | | | (0.293) | (0.241) | | | (-0.511) | (-0.242) |
| Staggered Board dummy | | | 0.0093 | 0.0084 | | | -0.0046 | -0.0033 |
| | | | (1.288) | (1.170) | | | (-0.741) | (-0.540) |
| Constant | 0.2181*** | 0.2060*** | 0.0936** | 0.1084*** | -0.1901*** | -0.2200*** | -0.0520 | -0.0996** |
| | (7.305) | (7.050) | (2.489) | (2.756) | (-9.570) | (-11.090) | (-1.092) | (-2.139) |
| Observations | 62,776 | 62,776 | 11,979 | 11,979 | 76,056 | 76,056 | 16,747 | 16,747 |
| Adjusted $R^2$ | 0.066 | 0.066 | 0.087 | 0.088 | 0.150 | 0.152 | 0.159 | 0.161 |
| Industry fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Time fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

Table 9 - *continued*

| B. Information Asymmetry among Insiders | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Trading Side | Purchases | | | | Sales | | | |
| Sample | Insider Trading of Directors | | | | | | | |
| Dependent Variable | Between-Cluster ratio | | | | | | | |
| CEO Centrality | -0.1358*** | | -0.1147** | -0.1130** | -0.1387* | | -0.1495 | -0.1663* |
| | (-3.343) | | (-2.085) | (-2.047) | (-1.832) | | (-1.572) | (-1.747) |
| Fraction of Non-co-opted | | 0.0468* | 0.0514* | 0.0527* | | -0.1953*** | -0.1942*** | -0.1910*** |
| Independent Directors | | (1.660) | (1.809) | (1.851) | | (-4.152) | (-4.142) | (-4.090) |
| Log Size | -0.0440*** | -0.0377*** | -0.0385*** | -0.0446*** | 0.0633*** | 0.0680*** | 0.0662*** | 0.0666*** |
| | (-10.163) | (-6.957) | (-7.008) | (-6.063) | (5.195) | (4.739) | (4.584) | (4.012) |
| Book-to-Market | 0.0269** | 0.0279* | 0.0319* | 0.0301* | -0.0802*** | -0.0796*** | -0.0770*** | -0.0687*** |
| | (2.412) | (1.761) | (1.943) | (1.804) | (-4.635) | (-2.876) | (-2.826) | (-2.603) |
| Std. of Return | 0.4647*** | 0.5644*** | 0.5403*** | 0.5083*** | 1.3698*** | 1.1451*** | 1.1001*** | 0.9976*** |
| | (4.221) | (3.661) | (3.460) | (3.248) | (6.962) | (4.494) | (4.296) | (3.868) |
| R&D dummy | 0.0014 | -0.0069 | -0.0036 | -0.0013 | 0.1348*** | 0.1204*** | 0.1215*** | 0.1226*** |
| | (0.123) | (-0.505) | (-0.261) | (-0.095) | (5.640) | (4.253) | (4.300) | (4.351) |
| Illiquidity Quintile | -0.0305*** | -0.0161 | -0.0197 | -0.0137 | 0.0210 | 0.0142 | 0.0080 | 0.0365 |
| | (-3.044) | (-1.032) | (-1.233) | (-0.806) | (1.154) | (0.578) | (0.325) | (1.348) |
| Return (t-12, t) | -0.0193** | -0.0232* | -0.0200 | -0.0171 | 0.1139*** | 0.1513*** | 0.1551*** | 0.1544*** |
| | (-2.172) | (-1.665) | (-1.420) | (-1.225) | (5.709) | (5.381) | (5.470) | (5.445) |
| Log (1+number of insider trades) | 0.0553*** | 0.0560*** | 0.0553*** | 0.0555*** | 0.2093*** | 0.1737*** | 0.1723*** | 0.1677*** |
| | (6.816) | (5.402) | (5.290) | (5.403) | (20.027) | (13.576) | (13.312) | (12.889) |
| Log(1+number of financial analysts) | | | | 0.0235 | | | | 0.0345 |
| | | | | (1.504) | | | | (1.180) |
| Institutional ownership | | | | -0.0069 | | | | 0.2088*** |
| | | | | (-0.164) | | | | (2.793) |
| Constant | 0.4462*** | 0.3284*** | 0.3827*** | 0.3726*** | -0.2514* | -0.4755*** | -0.4025** | -0.6241*** |
| | (5.709) | (4.477) | (4.556) | (3.767) | (-1.676) | (-3.148) | (-2.523) | (-3.621) |
| Observations | 14,538 | 7,669 | 7,561 | 7,561 | 20,039 | 11,721 | 11,608 | 11,608 |
| Adjusted $R^2$ | 0.044 | 0.047 | 0.048 | 0.048 | 0.070 | 0.069 | 0.070 | 0.071 |
| Industry fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Time fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

## Table 10: Insider trades within a cluster

The table presents return predictability results of different sequential positions of cluster insider trades. Panel A displays the probability of becoming the first trader of the cluster for different groups of insiders. Panel B presents the return of cluster trading based on the sequential positions of the cluster. For Panel A, the dependent variables are One Day/First Trade Dummy and First Trade Dummy in the cluster. For Panel B, the dependent variable is BHAR(t, t+21) of cluster insider purchases (sales). Cluster insider purchases (sales) are defined as purchases (sales) placed by multiple insiders on the same day or consecutive trading days. All the same directional cluster trades placed on consecutive trading days form a trading cluster. The length of cluster is defined as difference of trading days between first and last of cluster sequence. We limit the length of the cluster to 5 trading days as default. One day cluster dummy is 1 if all trades of cluster trading occur in one day, otherwise is 0. First day in a cluster dummy is 1 if the corresponding insider trading is the trade of the start date of cluster insider trading sequence, otherwise is 0. Last day in a cluster dummy is 1 if the corresponding insider trading is the trade of the end date of cluster insider trading sequence, otherwise is 0. Middle days in a cluster dummy is 1 if the corresponding insider trading occur in between the start date and the end date of cluster insider trading sequence, otherwise is 0. Firm- and month-fixed effects are included and standard errors are clustered at the firm level. The t-statistics are shown in parentheses. ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively. The regression results of insider tradings by executives (including top executives), top executives and directors are reported in separate columns.

| A. Probability of First Trade | | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Trading Side | Purchases | | | Sales | | |
| Sample | Between Cluster | Between Cluster | Between and Multi-Date Cluster | Between Cluster | Between Cluster | Between and Multi-Date Cluster |
| Dependent Variable | One Day/First Trade Dummy | First Trade Dummy | First Trade Dummy | One Day/First Trade Dummy | First Trade Dummy | First Trade Dummy |
| Top Executives | 0.00375 | 0.0155*** | 0.0201*** | -0.0211*** | -0.000224 | -0.0113*** |
| | (0.94) | (3.76) | (2.80) | (-5.89) | (-0.07) | (-2.64) |
| Other Executives | -0.000679 | -0.00873** | -0.0134 | -0.0149*** | 0.00106 | -0.00692* |
| | (-0.16) | (-2.00) | (-1.60) | (-4.54) | (0.36) | (-1.79) |
| Constant | 0.881*** | 0.134*** | 0.466*** | 0.597*** | 0.289*** | 0.419*** |
| | (28.41) | (5.97) | (3.71) | (15.42) | (8.72) | (11.56) |
| Observations | 76707 | 76707 | 38628 | 154179 | 154179 | 117187 |
| Adjusted $R^2$ | 0.183 | 0.106 | -0.035 | 0.075 | 0.017 | -0.006 |
| Firm fixed effect | Yes | Yes | Yes | Yes | Yes | Yes |
| Time fixed effect | Yes | Yes | Yes | Yes | Yes | Yes |

Table 10 - *continued*

| B. Return of Cluster Sequence - BHAR(t, t+21) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Groups | All | Top Executive | Executive | Director | All | Top Executive | Executive | Director |
| Trading Side | Purchases | | | | Sales | | | |
| One Day Cluster | 0.992*** | 1.048*** | 0.933*** | 1.393*** | -0.291*** | -0.150 | -0.236*** | -0.619*** |
| | (6.34) | (3.49) | (4.42) | (7.18) | (-4.05) | (-1.35) | (-3.09) | (-4.91) |
| First Day in a Cluster | 2.769*** | 3.062*** | 2.741*** | 2.691*** | -0.105* | -0.143 | -0.0491 | -0.114 |
| | (15.78) | (9.16) | (10.66) | (11.98) | (-1.83) | (-1.42) | (-0.78) | (-0.95) |
| Last Day in a Cluster | 1.257*** | 0.839** | 1.048*** | 1.022*** | -0.458*** | -0.346*** | -0.369*** | -0.735*** |
| | (8.51) | (2.53) | (4.79) | (5.06) | (-9.40) | (-3.81) | (-6.81) | (-7.35) |
| Middle Days in a Cluster | 2.321*** | 2.645*** | 2.593*** | 2.306*** | -0.179** | -0.208* | -0.199** | -0.0791 |
| | (7.87) | (5.21) | (6.63) | (6.59) | (-2.24) | (-1.71) | (-2.38) | (-0.56) |
| Constant | 7.922* | -5.091*** | 3.366 | 11.16* | 3.229 | -1.780*** | 2.294 | 7.392*** |
| | (1.94) | (-4.54) | (1.31) | (1.66) | (1.38) | (-8.53) | (0.73) | (3.72) |
| Observations | 252924 | 70353 | 123079 | 140244 | 634290 | 199809 | 462106 | 198551 |
| Adjusted $R^2$ | 0.128 | 0.193 | 0.159 | 0.174 | 0.082 | 0.135 | 0.092 | 0.131 |
| Firm fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Time fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

Table 11: Cluster trades in Pre- and Post-SOX periods

The table presents panel regression results of sub-periods, pre- and post-SOX, using cluster ratio as the dependent variables. Firm- and time fixed effects are included in the panel regression. The pre-SOX period ranges from 1/1/1986 to 8/28/2001. The post-SOX period ranges from 8/29/2001 to 12/31/2016. Cluster insider purchases (sales) are defined as purchases (sales) placed by multiple insiders on the same day or consecutive trading days. All the same directional cluster trades placed on consecutive trading days form a trading cluster. The length of cluster is defined as difference of trading days between first and last of cluster sequence. We limit the length of the cluster to 5 trading days as default. Cluster ratio is percentage of cluster purchases (sales) out of total insider purchases (sales) at firm-year level. Cluster within (longer than) 2 trading days ratio is percentage of cluster purchases (sales) occured within (longer than) 2 trading days out of total insider purchases (sales) at firm-year level. We control for Log(1+number of insider tradings of the firm in previous one year), log size, book-to-market, Illiquidity Quintile, Std. of Return, and Return (t-12, t), where Illiquidity Quintile is quintile rank of Amihud illiquidity in the past year, Std. of Return is standard deviation of stock return over the past one year, and Return (t-12, t) is the past 12 month (one year) return. $t$-statistics are shown in parentheses and standard errors clustered at the firm level. ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively.

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Dependent Variable | Cluster ratio | | Cluster within two trading days ratio | | Cluster longer than two trading days ratio | |
| Trading side | Purchases | Sales | Purchases | Sales | Purchases | Sales |
| Post-Sox | 0.0181*** | 0.0097** | 0.0176*** | 0.0218*** | 0.0005 | -0.0121*** |
| | (4.121) | (2.490) | (4.288) | (6.877) | (0.323) | (-5.228) |
| Log Size | -0.0018 | 0.0458*** | -0.0017 | 0.0286*** | -0.0001 | 0.0172*** |
| | (-0.842) | (22.641) | (-0.862) | (16.945) | (-0.126) | (14.727) |
| Book-to-Market | 0.0054** | -0.0132*** | 0.0033 | -0.0067*** | 0.0021** | -0.0065*** |
| | (2.305) | (-4.346) | (1.618) | (-2.739) | (2.259) | (-5.414) |
| Return (t-12, t) | -0.0015 | 0.0194*** | 0.0013 | 0.0096*** | -0.0028*** | 0.0098*** |
| | (-0.841) | (10.040) | (0.790) | (6.883) | (-3.750) | (8.726) |
| Std. of Return | 0.0248 | 0.0322 | 0.0016 | -0.0098 | 0.0232** | 0.0420*** |
| | (1.204) | (1.435) | (0.089) | (-0.586) | (2.414) | (3.645) |
| Log(1+number of insider trades) | 0.0240*** | 0.0258*** | 0.0229*** | 0.0137*** | 0.0011 | 0.0122*** |
| | (11.914) | (20.212) | (11.825) | (12.785) | (1.623) | (16.145) |
| Constant | 0.1202*** | -0.1260*** | 0.1062*** | -0.0556*** | 0.0140*** | -0.0704*** |
| | (9.299) | (-9.859) | (8.889) | (-5.224) | (3.120) | (-9.983) |
| Observations | 64,502 | 78,578 | 64,502 | 78,578 | 64,502 | 78,578 |
| Adjusted $R^2$ | 0.311 | 0.363 | 0.304 | 0.304 | 0.226 | 0.259 |
| Firm fixed effect | Yes | Yes | Yes | Yes | Yes | Yes |
| Time fixed effect | No | No | No | No | No | No |

Table 12: Trading profits in Pre- and Post-SOX periods

The table displays panel regression results of two sub-periods, pre- and post-SOX, using BHAR(t, t+21) of insider purchases (sales) as the dependent variable. The pre-SOX period ranges from 1/1/1986 to 8/28/2001. The post-SOX period ranges from 8/29/2001 to 12/31/2016. Cluster insider purchases (sales) are defined as purchases (sales) placed by multiple insiders on the same day or consecutive trading days. All the same directional cluster trades placed on consecutive trading days form a trading cluster. The length of cluster is defined as difference of trading days between first and last of cluster sequence. We limit the length of the cluster to 5 trading days as default. Cluster Length$\leq$2 Days Dummy is 1 if an insider trading is a clustered trading and length of the cluster is less than equal to 2 days, otherwise is 0. Cluster Length>2 Days Dummy is 1 if an insider trading is a clustered trading and length of the cluster is longer than 2 days, otherwise is 0. First Two-day of Cluster Length>2 Days Dummy is 1 if an insider trading is a clustered trading within two-days from the first trade of the clusters and cluster length is longer than 2 days, otherwise is 0. The CAR is estimated using Daniel et al. (1997, DGTW) benchmark adjusted returns. Firm fixed effect is included and standard errors are clustered at the firm level. The t-statistics are shown in parentheses. ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively. The regression results of insider tradings by executives (including top executives), top executives and directors are reported in separate columns.

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| Trading side | Purchases | | | | Sales | | | |
| Groups | All | Top Executive | Executive | Director | All | Top Executive | Executive | Director |
| Dependent Variable | BHAR(t, t+21) | | | | | | | |
| Cluster Length$\leq$2 Days | 1.503*** | 1.338*** | 1.206*** | 1.689*** | -0.378*** | -0.503** | -0.305*** | -0.709*** |
| | (8.66) | (3.68) | (5.02) | (7.87) | (-3.49) | (-2.14) | (-2.64) | (-3.66) |
| Cluster Length>2 Days | 2.936*** | 2.849** | 2.924*** | 2.477*** | -0.425** | -0.558 | -0.385* | -0.218 |
| | (4.72) | (2.31) | (3.46) | (3.25) | (-2.01) | (-1.49) | (-1.79) | (-0.56) |
| First Two-day of Cluster Length>2 Days | 0.177 | -0.766 | -0.0677 | 0.344 | 0.869*** | 0.828*** | 0.794*** | 1.109*** |
| | (0.44) | (-0.77) | (-0.11) | (0.56) | (7.65) | (3.24) | (6.11) | (3.95) |
| Post-SOX | 2.102 | 2.843 | 3.000 | -1.220 | -1.336 | 4.081 | 0.271 | -3.628** |
| | (0.66) | (0.52) | (0.64) | (-0.40) | (-1.23) | (1.61) | (0.20) | (-2.05) |
| Post-SOX× Cluster Length$\leq$2 Days | 0.211 | 0.596 | 0.620* | 0.200 | 0.0143 | 0.258 | 0.0260 | 0.128 |
| | (0.84) | (1.20) | (1.76) | (0.66) | (0.12) | (1.01) | (0.19) | (0.60) |
| Post-SOX× Cluster Length>2 Days | -0.244 | 0.646 | 0.789 | -0.411 | 0.0933 | 0.403 | 0.0755 | -0.300 |
| | (-0.29) | (0.42) | (0.70) | (-0.40) | (0.39) | (0.99) | (0.30) | (-0.68) |
| Post-SOX× First Two-day of Cluster Length>2 Days | 2.124*** | 3.277*** | 2.396*** | 1.779** | -0.660*** | -0.708** | -0.572*** | -0.661** |
| | (3.95) | (2.62) | (2.80) | (2.23) | (-5.23) | (-2.57) | (-3.88) | (-2.10) |
| Constant | 7.987** | -5.020*** | 3.418 | 11.25* | 3.244 | -1.792*** | 2.314 | 7.349*** |
| | (1.97) | (-4.45) | (1.33) | (1.68) | (1.38) | (-8.63) | (0.74) | (3.71) |
| Observations | 252930 | 70368 | 123071 | 140268 | 634286 | 199787 | 462098 | 198539 |
| Adjusted $R^2$ | 0.128 | 0.193 | 0.159 | 0.175 | 0.082 | 0.135 | 0.092 | 0.131 |
| Firm fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Time fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |