Cluster Trading of Corporate Insiders*

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Abstract

Over 40% of insider trades are clustered, i.e., multiple insiders place the same directional trades on the same day or over consecutive days. This paper examines the information content of the cluster trades and the corresponding stock price adjustments. Cluster trades, in particular, purchases are more informative than non-cluster trades. While cluster trades on average accelerate the stock price adjustments, the information contained in long-lasting cluster trades is exceptionally strong and slowly incorporated into the stock price even after the trading disclosures. Finally, we find that cluster trades of informed insiders are more likely to occur in the circumstances where the firm information is more accessible to outside investors and where the insider trades are required to be disclosed sooner, suggesting that cluster trades are facilitated by the trading competition among informed insiders and outside investors.

Keywords: Insider Trading, Cluster Trades, Market Efficiency

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1 Introduction

Corporate insiders have preferential access to information about the company. They may take advantage of the private information in their trading decisions, and thereby the informativeness of their trades has merited particular attention of investors and regulators. Existing studies found empirical evidence of informed insider trades (See, e.g., Jaffe, 1974, Seyhun, 1986, Lakonishok and Lee, 2001, Jeng, Metrick, and Zeckhauser, 2003, and Cohen, Malloy, and Pomorski, 2012, among others). While these studies largely focus on the *individual* trading activities, insiders within a firm tend to share common access to the firm information and thus may not trade shares independently of each other. Yet, we know little about how insiders, as a group, trade stock to exploit the shared information and how the stock market incorporates the information contained in *aggregate* trading pattern of corporate insiders.

In this paper, we study the cluster trading of corporate insiders, namely, the aggregate trading pattern in which multiple insiders within a firm engage in the same directional trades on the same day or over consecutive days.[1] Since the seminal work of Holden and Subrahmanyam (1993), a strand of literature shows that the competition among informed investors induces them to trade aggressively and thus accelerates the price adjustments to their private information. Information sharing among insiders can speed up the price adjustments even further in the current regulatory environment because, after Sarbanes-Oxley Act 2002 (SOX), insider trades must be disclosed publicly within two business days. In this circumstance, insiders may lose the trading opportunities once the trades of other informed insiders are disclosed. Motivated by these theoretical and institutional backgrounds, we explore the information content of cluster trades, vis-à-vis individual insider trades, and the corresponding stock price adjustments.

Understanding the information content of cluster trades is of utmost importance for investors and regulators because insiders often trade together. Figure 1 presents the distribution of the number

[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.

of trading days from an insider purchase to the nearest purchase placed by other insiders within a firm. Before SOX, about 36% of purchases are placed by multiple insiders on the same day (28.8%) or over consecutive days (7.2%).[2] The cluster trades are even more pronounced after SOX: about 41% of purchases occur on the same day (33.3%) or over consecutive days (7.6%). In both periods, the proportion for longer intervals decays exponentially. The prevalence of cluster trades and its time-series and cross-sectional variations motivate a number of important research questions about the informational role of insider trades: Do cluster trades contain stronger signals than individual insider trades? Does the market adjust the price to the information contained in cluster trades properly and promptly? In which informational circumstances, do informed insiders place cluster trades?

We explore these questions using the U.S. corporate insider trading data in 1986–2016. First, we examine the informativeness of cluster trades by testing its future stock return predictability. Cluster trades, in particular, purchases are more informative than non-cluster trades. Over holding horizons of 21 trading days, the abnormal returns earned by cluster purchases are almost twice as high as those of non-cluster purchases (3.8% vs. 2%). The return gap gets even wider over longer horizons, reaching 2.5% in 90 trading days window. Cluster sales, on the other hand, exhibit much weaker return predictability than cluster purchases and they marginally outperforms non-cluster sales. The weak informativeness of cluster sales suggest that liquidity-driven sales may be substantially clustered, for instance, because of the blackout periods for insider trading or the common vesting dates of stock awards.

We further examine the information contents of cluster purchases associated with the informational heterogeneity among the trading insiders. Ravina and Sapienza (2010) find that directors' purchases exhibit weaker return predictability than those of executives, suggesting that the two groups of insiders may have different access to the firm information. Consistent with this prediction, insiders are more likely to purchase shares together with the same group of insiders: among executive cluster purchases, 56% include executives exclusively while only 12% are joined by directors but no other executives; Likewise, among cluster purchases of directors, 50% include directors exclusively while

[2]The sample covers 1986–2016 and sets the post-SOX period as 8/29/2002 and onwards. See section 2 for the details about our sample construction.

14% are joined by executives but no other directors. Regarding informativeness of cluster trades, we find that executives on average access more precise information than directors. Both cluster and non-cluster purchases of executives yield substantially higher returns than the corresponding purchases of directors. Both groups of insiders, however, earn higher returns from cluster purchases. Interestingly, the cluster purchases placed jointly by executives and directors yield higher returns than those placed exclusively by executives, suggesting that stronger signals tend to be shared by both executives and directors who have heterogeneous information accessibility.

Notably, the information contents of cluster trades are orthogonal to those of other insider trading measures widely used in the previous studies. Specifically, we test whether cluster trades contain novel information relative to "routine" and "opportunistic" trading patterns identified by Cohen, Malloy, and Pomorski (2012). Our analysis shows that cluster purchases, but not sales, provide novel information. Specifically, unless the purchase clusters are exclusively formed by routine trades, they exhibit stronger return predictabilities than non-cluster opportunistic purchases, which are still more informative than routine trades. It is noteworthy that a substantial fraction of insider purchases are not identified either routine or opportunistic trades but they can be used for identifying the cluster trades of informed insiders. Moreover, after controlling for the firm-fixed effects, the informational advantage of non-cluster opportunistic trades relative to routine trades disappears while the return predictabilities of cluster trades are enhanced. Clearly, our findings show that cluster trades are not a simple congregation of opportunistic trades. Rather, cluster and routine/opportunistic trading patterns complement each other as identification methodologies for informed insider trades.

Next, we examine how the information contents of the cluster trades, vis-à-vis those of non-cluster trades, are incorporated into the stock prices. Our analysis shows that cluster purchases have larger price impacts and lead to stronger market reaction at their disclosures than non-cluster purchases. Cluster purchases of insiders thus accelerate the stock price adjustments for their private information. Interestingly, despite the larger price impact and stronger market reaction, extremely strong information contained in rarely long-lasting cluster purchases (i.e., those placed over 4–5 trading days) are slowly incorporated into the stock price even after the disclosures of all cluster trades.

Consistent with the weak informativeness of cluster sales, we do not find accelerated price adjustments for cluster sales relative to non-cluster ones.

More specifically, regarding price impacts, we find that cluster purchases yield 0.26% higher abnormal returns on the transaction date than non-cluster ones. Cluster purchases also lead to stronger market reaction to trading disclosures than non-cluster trades and more so and after SOX, the regulatory changes that require earlier disclosure of insider trades. In the post-SOX period, the second disclosures within each trading cluster (i.e., those which allow investors to acknowledge the presence of cluster trades) yield 0.57% higher abnormal returns in two days and 0.52% higher return in the following 20-day period than the non-cluster purchase disclosures. Among cluster purchases, those placed over rarely long horizon exhibit long-run return predictability even after the disclosures. In the post-SOX period, the cluster purchases placed over 4 or 5 consecutive days lead to 5% higher abnormal returns than non-cluster ones even during the 22–90 trading days after the trading disclosures while those placed on the same day yields 0.72% lower return than non-cluster ones. The results suggest that, while the cluster purchases of informed insiders accelerate the price adjustments for their information, the extremely strong signals contained in the long-lasting clusters are slowly incorporated into the price.

Finally, we study how the cluster trades of informed insiders are associated with the corporate information structure and the trading competition among them and informed outside investors. The insider trades are followed by substantial price impact and market reaction to their disclosures, and thus insiders may lose trading opportunities once other insiders or informed outside investors place trades. We therefore predict that the trading competition facilitates the cluster trades of commonly informed insiders by inducing them to trade quicker in the informational circumstances where the investors can obtain their private information sooner or where insider trades are publicly disclosed earlier.

Our empirical tests provide supporting evidence: First, the probability of cluster purchases is positively associated with financial analyst coverage and the institutional ownership concentration, suggesting that the cluster trades are more likely to be place in firms where the information intermedi-

aries such as financial analysts and institutional investors actively collect the firm information; Next, we find that the probability of cluster purchases increases substantially after SOX accelerates insider trading disclosure by mandating insiders to submit their trading filings within two business days.[3] More specifically, in the post-SOX period, more insider purchases are placed within two business days from the first trade in the same cluster and, furthermore, these early trades become more profitable relative to the late cluster trades, i.e., those placed after two business days from the first trade. Our findings suggest that the trading competition among informed insiders and outside investors facilitate the cluster trades of insiders and thus accelerate the price adjustments for the inside information.

This paper provides the first comprehensive empirical analysis on the activities and the informativeness of cluster trades of corporate insiders. A number of previous studies provide evidence of informed insider trading activities by largely focusing on the trading patterns of individual insiders (e.g., Jaffe, 1974, Seyhun, 1986, Lakonishok and Lee, 2001, Jeng, Metrick, and Zeckhauser, 2003, Jagolinzer, 2009, Cohen, Malloy, and Pomorski, 2012, Ali and Hirshleifer 2017, Akbas, Jiang, and Koch 2018). Yet, given that insiders tend to have shared access to important firm information, our analysis on cluster trades provides novel insights on the trading strategies of informed insiders and the corresponding stock price adjustments.

To our best knowledge, only a few studies have considered the aggregate trading pattern of insiders. Seyhun (1988, 1992) have examined the aggregate insider trading activities and the information content at the market level while our paper focuses on the aggregate trading at the firm level. More closely related studies are Seyhun (2000) and the contemporaneous study of Alldredge and Blank (2017). Seyhun (2000) reports that net directional aggregate trades of insiders exhibit strong return predictabilities at the firm-month level. Alldredge and Blank (2017) also examines cluster trades within a framework of insider herding. Relative to these studies, our paper innovates the literature by providing novel evidence that, as predicted by Holden and Subrahmanyam (1992), the cluster trades arise from the trading competition among informed insiders and outside investors and thus accelerate the stock price adjustments for the inside information.

[3]See, e.g., Huddart, Hughes, and Levine (2001) and Brochet (2010) for the effect of insider trading disclosure on the stock price adjustments.

This paper also provides novel insights about the information structure within a firm. Ravina and Sapienza (2010) find that independent directors earn positive abnormal returns from the firm share purchases, and the return difference from the same firm's executives is small. Our findings suggest that this result is largely driven by the cases when information is shared between executives and directors and when directors and executives trade together. Similarly, extant studies show 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 purchases of top executives, not just with other top executives but with other executives and directors, are more informative than their individual trades. Finally, our methodologies of identifying cluster trades within or between insider groups may offer a new empirical proxy for the internal corporate information structure and thus contribute to literature that has employed the trading gains of a specific group of insiders as proxies for their accessibility to the firm information (e.g., Ravina and Sapienza (2010) on directors and Inci, Narayanan, and Seyhun (2017) on female executives).

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 price impact of cluster trades and the market reaction to their disclosures. Section 5 explores the effect of information structure and the trading competition among insiders and outside investors on the cluster trades, 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 (non-employee) 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 observations verified by the data vendor (i.e., the data cleanse

code R, H, or C). Finally, we aggregate the same directional trades (i.e., purchases or sales) at an individual-stock-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, 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

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.[4] 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 123,418 sales clusters in our sample.

We first characterize trading clusters based on the participating insiders' ranks (i.e., executives and directors). Ravina and Sapienza (2010) shows that directors' trading is less informative than executives', suggesting that the two groups of insiders have systematically different information access within a firm. The heterogeneity in the ranks of trading insiders thus can capture how the information sharing is associated with the cluster trades. Specifically, we classify clusters into three mutually exclusive groups, namely, *Exec. Only* clusters joined exclusively by executives, *Dir. Only* clusters placed exclusively by directors, and *Exec. & Dir.* clusters joined by both executives and directors. We also consider the possibility that top executives (CEO, COO, CFO, President, or General Counsel) may have more advantageous information access than other executives or directors, and classify the

[4] In an untabulated analysis, we consider an alternative definition of cluster trades to include the trades placed by multiple insiders over non-consecutive days (with one-day gap) and find qualitatively consistent results.

clusters joined by top executives into three mutually exclusive groups, namely, *Top Exec. Only* clusters joined by top executives only, *With Other Exec.* clusters placed together with other executives but not with directors, and *With Dir.* clusters joined with directors.

Table 1 presents the summary statistics of insider trades and trading clusters. Corporate insiders often trade in clusters. On average, based on the number of insider trades, about 40% of insider trades (37% of purchases and 42% of sales) are cluster trades. The size of cluster trades is also substantial. Cluster trades account for about 34% of total value of insider purchases and 58% of sales, respectively. The relative frequency of cluster trades differs across the ranks of insiders. Executives (40% of purchases and 46% of sales) are more likely to place cluster trades than directors (33% of purchases and 32% of sales). Notably, the relative size of cluster trades exhibits contrasting results: while cluster purchases account for larger fraction of the total value of directors' purchases (35% vs. 32%), cluster sales constitute about 58% of total sales of each groups of insiders. These observations suggest that directors tend to execute relatively larger trades together with other insiders. Among executives, top executives are less likely to place cluster purchases (38%). In all ranks of insiders, sales transactions are more likely than purchases to be placed in clusters.

The table also shows that insiders are more likely to trade with the same rank of insiders: the trading clusters exclusively joined by executives (i.e., *Exec. only*) account for 57% of purchases and 71% of sales of executives while those exclusively placed by directors (i.e., *Dir. only*) constitute 50% of purchases and 25% of sales of directors. The proportion of *Dir. only* is relatively small partly because executives receive equity grants more than directors and thus sell shares about 2.7 times more frequently. In the sample of top executives' trades, 22% (resp. 55%) of purchases form clusters without those of other ranks (resp. directors) while 21% (resp. 70%) of sales do so.

Finally, the table presents summary statistics of other cluster characteristics including the length (i.e., number of trading days) of clusters, the number of trades placed by each rank of insiders in clusters, and the number of opposite directional trades placed during the cluster trading. Regarding the length of clusters, we find that purchases are placed in a shorter window than sales. While about 57% of purchases clusters do not last over multiple days, more than 62% of sales clusters do so. In

both directional trades, most clusters (99% of purchases and 98% of sales) end in five trading days. We find these patterns of cluster trades across all three ranks of insiders. Regarding the number of trades, both purchases and sales clusters on average include more than 3 trades. Sales clusters include fewer directors' trades than purchases clusters mainly because directors sell shares much less frequently than executives. Notably, the identified trading clusters are rarely accompanied with the opposite directional trades. Only 3% of purchases and 2% of sales clusters overlap with the opposite directional insider trades within a firm.

3 Informativeness of Cluster Trades

In this section, we study the informativeness of the cluster trades. We first examine the return predictability of cluster trades relative to that of unclustered trades, and then investigate how the return predictability of cluster trades is associated with the ranks of trading insiders. Finally, we compare the information contents of cluster trades with those of other informed insider trading measures proposed by previous studies.

3.1 Return predictability of cluster trades

We first examine whether cluster and non-cluster trades differ in their profitabilities. 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. As presented in Table 1, however, a substantial portion of trades in each cluster are placed on the same date and thus yield the same abnormal holding period returns. To address the concern of overweighing on the returns of cluster trades placed by a large number of insiders on the same date, we compare the abnormal returns of cluster and non-cluster trades after aggregating the same directional trades at a stock-transaction date level.[5]

[5]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.

Table 2 presents summary statistics of the average abnormal returns of insider purchases (Panel A) and sales (Panel B) over different holding periods. In each panel, we report three holding period returns adjusted for the Daniel, Grinblatt, Titman, and Wermers (1997) characteristics benchmark returns (DGTW-adjusted returns), namely, 5 trading-day cumulative abnormal returns, 21 trading-day buy-and-hold abnormal returns (BHAR), and 90 trading-day BHAR.

Panel A shows that cluster purchases earn higher returns than non-cluster purchases, notwithstanding that 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 2.06% and 1.09% 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 3.80% and 6.41% abnormal returns over 21-day and 90-day horizons, respectively, while non-cluster purchases earn 1.95% and 3.95% during the corresponding holding periods. The return gaps between cluster and non-cluster purchases are also statistically significant.

Panel A also presents the abnormal returns of cluster and non-cluster purchases of different ranks of insiders. On average, executives earn higher returns than directors from both types of purchases. Regarding the return difference between cluster and non-cluster purchases, all three ranks of insiders gain higher returns from cluster purchases. Notably, 90-day return difference is more pronounced in the executives' purchases (2.87% vs. 1.73%) while the shorter period return differences do not differ significantly across the three ranks of insiders. Among executives, top executives earn higher returns from purchases though the two executives groups exhibit identical return differences between cluster and non-cluster purchases.[6]

Panel B presents the return predictability of insider sales. Consistent with the well-documented evidence in previous studies (See, e.g., Lakonishok and Lee, 2001), insider sales exhibit much weaker return predictability than purchases. 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

[6]In Table 2, the executives subsample nests the top-executives subsample and, thus, the difference between trading profits of top executives and other executives can be obtained by comparing the two samples.

holding horizons, and the pattern reverses for the 90-day holding horizon. Note however that the informativeness of cluster trades may be associated with firm characteristics and, thus, the univariate comparison in this table should be interpreted with caution.

Next, we formally test the return predictability of cluster and non-cluster trades after controlling for time (calendar year-month) and/or firm fixed effects. Table 3 presents the regression results for purchases (panel A) and sales (panel B). To facilitate the presentation, we report the estimation results for 21-day BHAR in this table.[7] The two panels are parallel: In column 1, we regress 21-day BHAR on the cluster trades indicator and calendar year-month fixed effects; In column 2, we examine how the return predictability of cluster trades are associated with the ranks of trading insiders. With controlling for year-month fixed effects, we regress 21-day BHAR on the indicators of *Exec. Only*, *Dir. Only*, and *Exec. & Dir.* cluster trades as well as the indicator of non-cluster trades of directors. Notice that the coefficient estimates of these indicators correspond to the mean abnormal return differences between the trades designated by each indicator and the non-cluster trades of executives. In columns 3 and 4, we additionally control for the firm fixed effects to test whether the return predictability of cluster and non-cluster trades significantly differs within a firm.

Panel A shows that the main observations in Table 2 are robust to controlling for year-month and firm fixed effects. First, cluster purchases predict 1.67% higher return than non-cluster ones, confirming that cluster purchases contain stronger signals. Next, for both executives and directors, cluster purchases are more profitable than non-cluster ones though executives' trades are more informative. Specifically, while cluster purchases exclusively placed by executives predict 1.11% higher return than non-cluster purchases of executives, cluster purchases exclusively joined by directors (resp. non-cluster purchases of directors) predict 0.1% (resp. 0.7%) lower returns than non-cluster purchases of executives. Third, cluster purchases placed by both executives and directors exhibit stronger return predictability than other types of purchases and specifically predict 2.25% higher returns than non-cluster trades of executives. Finally, after controlling for the firm fixed effects, the return difference between cluster and non-cluster purchases becomes economically and statistically more significant.

[7]The estimation results for 5-day CAR and 90-day BHAR are reported in Appendix.

Our findings suggest that, while executives and directors have heterogeneous information access channels, stronger signals tend to be shared by both ranks of insiders.

Panel B presents that the return predictability of both cluster and non-cluster sales and their difference are much weaker than those of purchases. After controlling for the year-month fixed effects, we do not find evidence of the significant return difference between cluster and non-cluster sales though the return predictability of cluster sales differs across the ranks of trading insiders. Specifically, those exclusively placed by directors predict 0.41% lower returns than their non-cluster sales while those placed by both executives and directors predict highest returns among all types of insider sales. After controlling for the firm fixed effects, however, the negative return predictability of cluster sales becomes stronger than that of non-cluster sales. In particular, those exclusively placed by executives (resp. directors) predict 0.29% (reps. 0.62%) lower returns than their non-cluster sales. In contrast to the case of purchases, cluster sales placed by both executives and directors still exhibit weaker return predictabilities than the other two cluster sales. The firm-fixed effect regression result suggests that insider sales, on average, are less informative in firms in which insiders are more likely to sell together.

We also run a subsample analysis using the trades of top executives who may have superior access to the firm information. The estimation results are reported in columns 5–8 of each panel. Panel A, column 5, shows that, after controlling for the year-month fixed effects, cluster purchases of top executives predict 1.55% higher returns than their non-cluster purchases. In column 6, we regress 21-day BHAR on the indicators of *Top Exec. Only*, *With Other Exec.*, and *With Dir.* cluster trades. The cluster purchases exclusively placed by top executives and those placed along with directors, respectively, predict 1.38% and 2.31% higher returns than non-cluster ones. Finally, columns 7 and 8 show that the return difference between cluster and non-cluster purchases of top executives becomes economically and statistically more significant after controlling for the firm fixed effects.

Panel B, columns 5–8, shows that, as in the full sample analysis, cluster sales of top executives exhibit weaker return predictability than their cluster purchases. In particular, column 6 shows that cluster sales placed along with directors predict 0.35% higher returns than non-cluster sales. After controlling for the firm fixed effects, however, the negative return predictability of cluster sales becomes

stronger than non-cluster sales. Specifically, cluster sales predict 0.23% lower returns than non-cluster sales while the information gains of cluster sales arise only if top executives sell shares together with executives but not with directors.

3.2 Stock-month level analysis

Next, we test the informativeness of cluster trades using the stock-month level data. The stock-transaction date level analysis in section 3.1 may overestimate the informativeness of cluster trades because, by construction, cluster trades are concentrated in certain time periods. To address this concern, we test whether the presence of cluster purchases (resp. sales) in month t predicts higher (resp. lower) stock returns in the subsequent month $t+1$.[8] Specifically, for purchases and sales, respectively, we create two dummy variables—*Insider trade dummy* that indicate firm-months having insider trades and *Cluster trade dummy* that indicates firm-months having cluster trades—and estimate panel estimations as follows: for stock i and 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).[9] Notice that the coefficient estimate β_2 measures the average return differences between the calendar-months next to cluster trading dates and those after non-cluster trading dates. Out of 2,494,847 sample firm-months (which reduce to 1,692,518 firm-months after merging controls), 127,547 (5.1%) and 27,232 (1.1%) firm-months have insider purchases and cluster purchases, respectively, while 198,663 (8.0%) and 56,255 (2.3%) firm-months have insider sales and cluster sales, respectively.[10]

Table 4 presents the estimation results for insider purchases (columns 1–6) and sales (columns 7–12).[11] Column 1 shows that, after controlling for firm characteristics and year-month fixed effects,

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

[9] The variable definitions are provided in Appendix A.

[10] To be consistent with the stock-transaction date level analysis, we only consider the clusters ending in five trading days.

[11] Standard errors of pooled panel and within-firm panel estimations are clustered by time. Petersen (2009) shows that

the presence of insider purchases predicts 0.96% higher returns in the following calendar month than other months subsequent to no insider purchases. Cluster purchases are more informative. The monthly returns following cluster purchases are on average 0.65% higher than those after non-cluster purchases. We find qualitatively consistent results in within-firm panel estimations and Fama-Macbeth regressions. Column 2 shows that, after controlling for firm-fixed effects, the months after cluster purchases yield 0.77% higher returns than those after non-cluster purchases while the monthly returns after non-cluster purchases are 0.98% higher than other months. Likewise, column 3 reports that, in a Fama-Macbeth estimations, the months after cluster purchases yield 0.57% higher returns than those after non-cluster purchases while the monthly returns after non-cluster purchases are, on average, 0.83% higher.

We also examine how the return predictability of cluster trades is associated with the ranks of trading insiders. Specifically, we estimate (1) by replacing cluster trade dummy with the following four indicators: *Exec. Only Cluster* and *Dir. Only Cluster* months in which cluster trades are placed exclusively by executives and directors, respectively, *Exec. & Dir. Cluster* months in which cluster trades are placed by both executives and directors, and *Non-Cluster Dir.* months in which only non-cluster trades of directors are placed. Note that, within insider trading firm-months, the firm-months indicated by these four dummy variables and the rest, referred to as *Non-cluster Executives* months (i.e., the firm-months which contain non-cluster trades of executives but not any cluster trades), are mutually exclusive. The coefficient estimate of each dummy variable, therefore, captures the mean return difference between the month following the insider trades designated by the dummy and the one after*Non-cluster Executives* months.

The estimation results for insider purchases are reported in columns 4–6. Overall, the results are qualitatively consistent across all specifications. In what follows, unless otherwise stated, we focus on the pooled panel estimation results in column 4. Insider purchases, in particular, those of executives predict higher monthly returns. The months following non-cluster purchases of executives yield 1.21% higher returns than the months without insider purchases and 0.45% higher returns than the months

the Fama-MacBeth standard errors are close to the standard errors cluster by time in the stock return regression where a significant time effect is present.

after non-cluster purchases of directors. Next, cluster purchases predict higher future returns than non-cluster purchases in both executives and directors trading months. Specifically, the months following cluster purchases exclusively placed by executives and by directors, respectively, yield about 0.6% and 0.2% higher returns than the months after non-cluster purchases of the corresponding groups of insiders. Finally, the cluster trades placed by both executives and directors exhibit strongest return predictability, in particular, in Fama-Macbeth regressions. Column 6 shows that the months after cluster trades placed by both executives and directors yield nearly 2% higher returns than the months following no insider purchase.[12]

Lastly, cluster sales on average do not exhibit stronger return predictability than non-cluster sales in the stock-month level analysis. Among the cluster sales, however, those exclusively placed by directors predict about 0.2% lower returns of the following month than non-cluster sales of directors. The weaker return predictability of cluster trades in stock-month level analysis is not surprising given that, as shown in Table 3, cluster trades predict returns from the day after the transaction date. The stock-month level analysis does not consider the return predictability during the period between the transaction date and the insider trading month end.

3.3 Cluster trades and opportunistic trades

Finally, we test whether cluster trades contain novel information relative to "opportunistic trades," a proxy for informed insider trades identified by Cohen, Malloy, and Pomorski (2012) and widely used in the literature. Following their methodology, we first identify routine traders and opportunistic traders among the 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

[12]We also run the analysis after excluding the *Exec. & Dir. Cluster* months in which *Exec. Only* or *Dir. Only* cluster trades are placed, and find qualitatively consistent results. This result suggests that the return predictability of *Exec. & Dir. Cluster* months is significantly associated with the presence of *Exec. & Dir.* cluster trades.

without such discernible pattern.[13] The trades of non-routine and non-opportunistic insiders remain unclassified. The details of routine and opportunistic trades 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. Using the individual insider trade level data, we run the following panel estimation: for insider i and trading date d,

$$\begin{aligned} r_{i,d+21} = \alpha &+ \beta_1 \left(\text{Non-cluster unclassified}\right)_{i,d} + \beta_2 \left(\text{Non-cluster opportunisitc}\right)_{i,d} \\ &+ \beta_3 \left(\text{Routine only cluster}\right)_{i,d} + \beta_4 \left(\text{With unclassified cluster}\right)_{i,d} \\ &+ \beta_5 \left(\text{With opportunistic cluster}\right)_{i,d} + \varepsilon_{i,d+21}, \end{aligned} \tag{2}$$

where $r_{i,d+21}$ is 21-day BHAR and the first five explanatory variables are indicators of the corresponding insider trade group. Notice that the β coefficients measure the difference in average return predictability between the corresponding inside trade group and non-cluster routine trades. We control for time (calendar year-month) and/or firm fixed effects.

Table 5 presents the panel estimation results for insider purchases (panel A) and sales (panel B). Regarding the informativeness of insider purchases, the key findings in panel A are summarized as follows: First, after controlling for time fixed-effects, non-cluster routine trades are less informative than other non-cluster trades or cluster trades that include opportunistic or unclassified trades. Interestingly, clus-

[13] In an untabulated analysis, we alternately identify routine trades using trade-level classification as suggested by Cohen, Malloy, and Pomorski (2012), and find that the results are largely similar to those reported in this section.

ter trades formed exclusively by routine trades exhibits weaker return predictability than non-cluster routine trades, suggesting that routine trading pattern successfully identify non-information-driven trades. Second, cluster trades provide novel information relative to the opportunistic trading pattern. The clusters that include opportunistic trades exhibit stronger return predictability than non-cluster opportunistic trades (by 1.11%) , and moreover, those which contain unclassified trades are also more informative than non-cluster opportunistic trades (about 0.77%) . Third, controlling for the firm-fixed effects wash out the informational advantage of non-cluster opportunistic trades relative to routine trades while enhancing the return predictabilities of cluster trades that include unclassified or opportunistic trades. This result also suggest that investors can extract information content of insider trades better by considering both cluster and opportunistic trading patterns. Finally, all these findings are robust in the subsamples of all insider ranks.

Panel B shows that both opportunistic and cluster sales have much weaker return predictability than the corresponding purchases. Without controlling for the firm fixed effects, we do not find significant difference in return predictability between these trades and non-cluster routine sales. After controlling for the firm fixed effects, however, all types of cluster sales including those formed exclusively by routine trades predict lower future returns than non-cluster ones. These results hold for all groups of insiders. The results suggest that cluster sales and routine sales are more likely to be placed in firms where insider sales are less informative.

Overall, our findings suggest that cluster trades and opportunistic trades, in particular purchases, represent heterogeneous trading patterns of informed insiders. Clearly, cluster trades are not a simple congregation of opportunistic trades. While opportunistic trades are more informative than routine trades, their cluster with routine and other opportunistic trades contains exhibits even stronger future return predictability. Furthermore, the cluster trades can be used for extracting information from the trades unclassified as routine or opportunistic trades. Cluster trading and opportunistic trading patterns complement each other as identification methodologies for informed insider trades.

4 Cluster Trades And Price Adjustments

In this section, we examine how the stock prices adjust for the information contents of cluster trades relative to those of non-cluster trades. Cluster trades of insiders who share information can accelerate the price adjustment for the inside information. First, Holden and Subrahmanyam (1993, 1995) model a non-coordinated trading of multiple informed investors and show that the trading competition makes them trade more aggressively and thus accelerates the price adjustments for their private information. Furthermore, under Sarbanes-Oxley Act 2002, insiders must disclose their trades within two business days from the transaction date, suggesting that the insiders who share information may trade more aggressively to take advantage of the information before the trading disclosure of other insiders. Motivated by these theoretical and institutional backgrounds, we test whether price impacts and disclosure of cluster trades expedite the stock price adjustments for the inside information.

4.1 Price impact of cluster trades

We first investigate the price impact of cluster trades vis-à-vis unclustered trades. Table 6 presents the DGTW-adjusted returns of cluster and non-cluster insider purchases and sales on the transaction dates. To control for the market reaction to the trading disclosures, we measure the price impact of cluster trades only at the first transaction date of each trading cluster while dropping the clusters that include a single trade on the first transaction date. Regarding purchases, the average abnormal return on the transaction dates of non-cluster trades is 0.25% while the average return on the transaction dates of the first-day cluster purchases is 0.51%. The return difference between cluster and non-cluster purchases is statistically significant. The stronger price impact of cluster purchases are consistent with the prediction of Holden and Subrahmanyam (1993, 1995). As a robustness check, we also consider the price impact of one-day clusters and find that the average return is 0.45%, which is still significantly higher than the return of non-cluster purchases.

Regarding sales, we find contrasting results. The price impacts of both non-cluster and cluster sales are significantly positive and, furthermore, the impact of cluster sales is even stronger. Specifically, the

average abnormal return of non-cluster sales is 0.22% while that of the first-day multiple cluster sales is 0.59%. The return difference between non-cluster and cluster sales is statistically significant. The price impact of one-day cluster sales is also positive and substantially higher than that of non-cluster sales. These results suggest that insiders tend to sell shares for non-informative reasons and provide liquidity for increased buying demands.

4.2 Disclosure of cluster trades and price adjustments

Next, we examine the market reaction to the disclosure of cluster and non-cluster trades and their post-disclosure returns. For cluster trades, we set the disclosure date as the first date when outside investors can recognize each trading cluster (i.e., the second disclosure among all trade disclosures in each cluster). By focusing on the earliest disclosure date of clusters, our tests minimize biases arising from the possibility that the post-disclosure returns of cluster trades turn out to be weaker than those of non-cluster trades mechanically because of the longer disclosure window. Before presenting our analysis results, it is noteworthy that Sarbanes-Oxley Act 2002 (SOX) shortened the insider trading disclosure period substantially: Before SOX, insiders must disclose their trades before the 10th business days of the calendar month following the transaction date while SOX mandates disclosure within two business days from the transaction date. To control for the effect of the regulatory change on the market reaction, we run the estimation using two subsamples, namely, the pre-SOX period and the post-SOX period.

Table 7 presents three abnormal returns—*CAR(0,1)*, *BHAR(2,21)*, *BHAR(22,90)*—which correspond to 2-day CAR from the filing date, the following 20-day BHAR, and the next 69-day BHAR, respectively. Panel A shows that, in both pre- and post-SOX periods, the disclosure of cluster purchases accelerates the price adjustments though the effect is more pronounced after SOX. Specifically, relative to the disclosures of non-cluster purchases, those of cluster purchases on average lead to 0.10% higher CAR(0,1) and 0.72% higher BHAR(2,21) before SOX and 0.57% higher CAR(0,1) and 0.52% higher BHAR(2,21) after SOX. In a longer horizon, on the other hand, cluster purchases disclosures is still followed by significantly positive BHAR (22,90) which is, however, not much different from

the return of non-cluster purchases disclosures. Regarding sales, we do not find significant difference returns between cluster and non-cluster sales in the market reaction to their disclosure nor the post-disclosure returns. Overall, our findings suggest that cluster purchase disclosures allow the stock market to incorporate inside information into the price more saliently.

Panel B displays how the market reaction to disclosures and the post-disclosure returns are associated with the length of clusters. As SOX mandates prompt disclosure of insider trades, we focus on the estimation results of post-SOX subsample. First, relative to the disclosures of non-cluster purchases, those of one-day cluster purchases lead to stronger market reaction by 0.24% but weaker post-disclosure returns by 0.18% of BHAR(2,21) and 0.72% of BHAR(22,90). Notably, the post-disclosure returns of cluster purchases do not exhibit reversal, implying that the disclosure leads to stronger market reaction and thus accelerates the price adjustments for the inside information. Next, the disclosure of multi-day cluster purchases, in particular, those placed over the longest window in our sample (i.e., 4–5 days) leads to significantly higher post-disclosure returns than the disclosure of non-cluster purchases. Specifically, 4–5 days cluster purchases are on average followed by over 5% higher BHAR (22,90) than non-cluster trades. The results show that extremely strong inside information, though it rarely occurs, is slowly incorporated into the stock price even after the disclosures of cluster trades.

5 Information Structure, Trading Competition, And Cluster Trades

Finally, we study how the cluster trades are associated with the corporate information environment and the trading competition among insiders and informed outside investors. As shown in Section 4, insider trades lead to significant stock price adjustments, implying that informed insiders lose trading profits or even trading opportunities if they fail to trade earlier than other insiders or informed outside investors. We predict that the trading competition facilitates the cluster trades of (commonly) informed insiders by inducing them to trade quicker. In what follows, we test this prediction by considering two economic channels in which outside investors can get access to the inside information and thus accelerate informed trading of insiders. First, we test whether insiders are more likely to place cluster trades in firms where information intermediaries such as financial analysts and institutional

investors collect their information more actively. Next, we examine how the insider trading disclosure requirement influences cluster trades. Using the regulatory change under SOX, we test whether the mandated early disclosure of insider trades speeds up the price adjustments for inside information and whether it facilitates the cluster trades of insiders.

5.1 Information intermediaries and cluster trades

We first examine whether insiders are more likely to place cluster trades in firms where financial analysts and institutional investors actively collect information and thus reduce the duration of revealing inside information to outside investors. As proxies for the information collection activities of analysts and institutional investors in each firm-year, we consider *analyst coverage* measured by "Log(1+number of financial analysts)" and *institutional ownership concentration* defined as "Top five institutional ownership," respectively. Using these measures, we run a panel estimation as follows: for each stock i and year t,

$$\text{Cluster ratio}_{i,t+1} = \alpha + \beta \left(\text{Information collection of intermediaries}\right)_{i,t} + \left(\text{Controls}\right)_{i,t} \cdot \Gamma + \varepsilon_{i,t+1}, \quad (3)$$

where Cluster ratio$_{i,t+1}$ is the fraction of cluster purchases (resp. sales) out of total insider purchases (resp. sales).[14] Control variables include firm size, book-to-market ratio, return volatility, R&D and liquidity, 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 control for industry fixed effects and year fixed effects and adjust the standard errors for firm-level clusters. Notably, the dependent variable *cluster ratio* allows us to isolate the effect of information intermediaries on cluster insider trading from their effect on overall insider trading activities.[15]

Table 8 presents the estimation results for purchases (column 1–3) and sales (columns 4–6). After controlling for other firm characteristics, the propensity of cluster purchases increases with the analyst coverage (column 1) and the concentration of institutional ownership (column 2) of the firm. Column 3 presents including both measures in the panel regression do not change the estimates significantly.

[14] We find qualitatively consistent results in the firm-month level analysis.

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

Likewise, insiders are more likely to sell shares together as the firm is covered by analysts more heavily (columns 4) or as the institutional investors' ownership is more concentrated (column 5) though the estimates of analyst coverage becomes statistically insignificant after including both measure in the regression (column 6). Overall, the results support the prediction that financial analysts and institutional investors can acquire the firm information better than other outside investors and thus induce the informed insiders to trade quicker, in particular, if the insiders share common information with each other. Our findings suggest that the presence of information intermediaries can enhance the market efficiency by accelerating the trading of commonly informed insiders.

5.2 Cluster trades in Pre- and Post-SOX periods

Next, we examine whether the disclosure of insider trades facilitates the cluster trades of commonly informed insiders. If the disclosure leads to the stock price adjustment to the information contained in insider trades and thus reduces the subsequent insider trading returns, commonly informed insiders are more likely to place cluster trades because they are willing to trade shares before the transaction disclosure of other informed insiders. To test these predictions, we employ the regulatory change imposed by SOX. Specifically, SOX shortens the insider trading disclosure period substantially: Before SOX, insiders must disclose their trades before the 10th business days of the calendar month following the transaction date while SOX mandates disclosure within two business days from the transaction date. We predict that this regulatory change allows outside investors to acquire information about insider trades quicker and thus accelerates the trading of informed insiders, in particular, those who share information with other insiders.

We first test whether SOX, which requires the filing of trades within two business days, weakens the return predictability of insider trades placed after the first two days in each cluster. Specifically,

we estimate a panel regression as follows: for stock i and insider transaction date d,

$$\begin{aligned} \mathrm{r}_{i,d+21} &= \alpha + \beta_1 \left(\text{Short cluster}\right)_{i,d} + \beta_2 \left(\text{Long cluster}\right)_{i,d} + \beta_3 \left(\text{Long cluster early trade}\right)_{i,d} \\ &+ \mathrm{SOX}_d \times \Big[\gamma_0 + \gamma_1 \left(\text{Short cluster}\right)_{i,d} + \gamma_2 \left(\text{Long cluster}\right)_{i,d} + \gamma_3 \left(\text{Long cluster early trade}\right)_{i,d}\Big] \\ &+ \lambda_i + \varepsilon_{i,d+21}, \end{aligned} \tag{4}$$

where $\mathrm{r}_{i,d+21}$ is the 21-day BHAR, SOX_d is an indicator of post-SOX period (Aug/29/2002 and afterwards), $\left(\text{Short cluster}\right)_{i,d}$ and $\left(\text{Long cluster}\right)_{i,d}$ are indicators of trading clusters that last 2 trading days or less and an indicator of those which last 3 days or longer, respectively, and $\left(\text{Long cluster early trade}\right)_{i,d}$ is an indicator of long cluster trades placed within the first two days. Notice that the coefficients β_1 and β_2 estimate the difference in average return predictability between the corresponding cluster trades and the non-cluster trades in the pre-SOX period, respectively, while β_3 measures the difference between the early trades and the late ones within long clusters. Likewise, γ coefficients correspond to the post-SOX period increment in the differences measured by the corresponding β coefficients.

Table 10 presents the estimation results for insider purchases (columns 1–4) and sales (columns 5–8). The full sample analysis in column 1 shows that, relative to non-cluster purchases, short and long cluster purchases earn 1.50% and 2.93% higher abnormal returns before SOX but do not find evidence of the significant change in these return differences after the enactment of SOX. The disclosure of insider trades, however, reduces the returns of subsequent trades in the same cluster substantially. While the return advantage of the early trades (i.e., trades in the first two days) relative to the late ones in long clusters is not significant before SOX, it increases more than 2.12% after SOX. Columns 2–4 show that these results are robust in the subsample analysis of top executives, all executives, and directors, respectively. Likewise, columns 5–8 present that SOX enhances the return predictability of early sales relative to the late ones regardless of the insider ranks. Our findings support the prediction that the disclosure of insider trades conveys information to the market and thus reduces the return of subsequent insider trades.

Next, we test whether the earlier disclosure requirement imposed by SOX facilitates the cluster trades of insiders. Specifically, we estimate a panel regression (3) by adding SOX_t, an indicator of post-

SOX period, as an explanatory variable. Table 9 presents the estimation results. Columns 1 and 2, respectively, show that cluster purchases and sales are more likely to take place in the post-SOX period. The fraction of cluster trades out of the total insider purchases increases about 1.8% while the fraction of cluster sales increases nearly 1%. To test the effect of early disclosure requirements on cluster trades, we also estimate the changes in *Short Cluster Ratio* and *Long Cluster Ratio*, i.e., the fractions of short and long cluster trades out of total insider trades, respectively. Columns 3 and 4, respectively, show that SOX facilitates the short cluster purchases and sales substantially. Specifically, after SOX, the fractions of short cluster purchases and sales increase nearly 1.8% and 2.2%, respectively. Columns 5 and 6, on the other hand, show that the fraction of long cluster purchases does not change while that of sales declines significantly.[16] Overall, our results suggest that the disclosure of insider trades leads to the stock price to inside information and thus induces commonly informed insiders to place cluster trades.

6 Conclusion

Cluster trades of corporate insiders is prevalent and, in particular, their cluster purchases are more informative than non-cluster 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 are associated with the informational environment of firms. In the circumstances in which the firm information is more accessible to outside information intermediaries or the insider trades must be disclosed more promptly, informed insiders are more likely to trade together and thus accelerate the stock price adjustments for their 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.

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

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Figure 1: Minimum intervals between insider trades

This figure plots the distribution of minimum intervals between insider trades during the 1986–2016 period. For each insider trade, we choose the closest insider trade by other insiders in a firm and measure the interval between insider trade and closest insider trade. The x-axis lists the minimum interval days and y-axis lists the percentage (frequency) of the corresponding intervals. The first distributions (blue) is the distribution of minimum intervals during Pre-SOX periods and the second distributions (orange) is the distribution of minimum intervals during Post-SOX periods. The pre-SOX period ranges from 1/1/1986 to 8/28/2002. The post-SOX period ranges from 8/29/2002 to 12/31/2016.

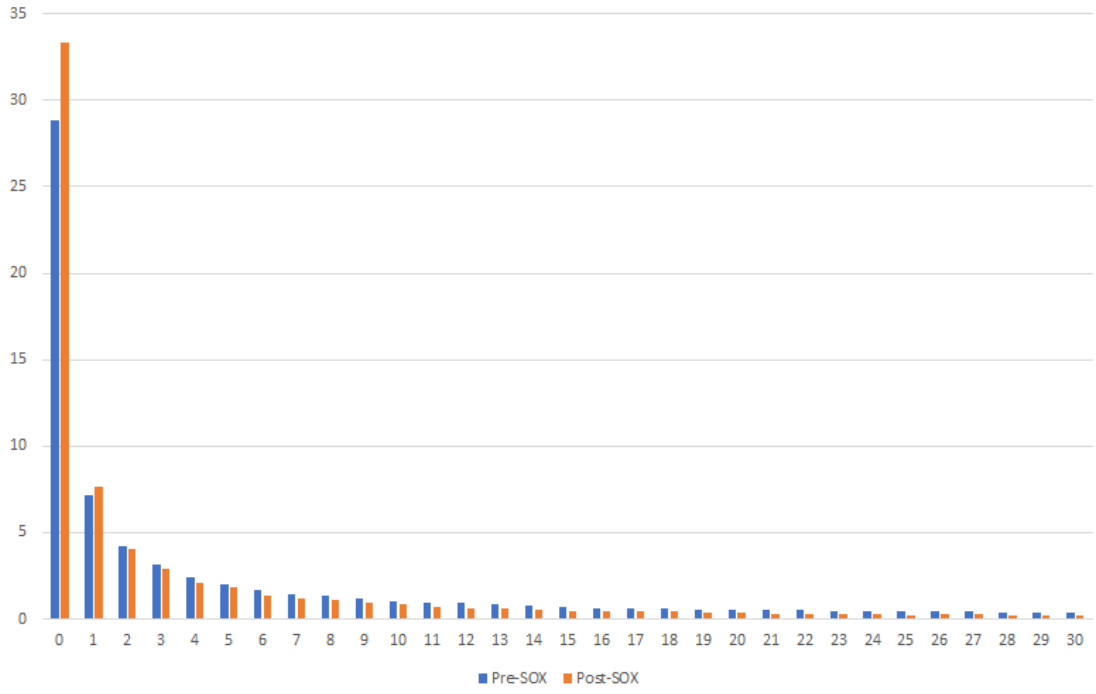

Table 1: Summary statistics of cluster trading of insiders

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. All Cluster is a cluster trading among any insiders, Within Cluster is a cluster trading by only the same rank of insiders, where ranks are classified as executives (top) and directors, and Between Cluster is a cluster trading by both executives and directors. For top executives sample, With Other Exec. Cluster is a cluster trading with other executives but without directors by top executives, and With Directors Cluster is a cluster trading with directors by top executives. The variables are further described in Appendix A. The table reports (i) percentage of cluster 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, top executives, executives (including 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 %
% of Cluster Trading Among Insider Tradings	All Clusters	36.54	33.92	42.44	57.72	37.62	31.64	46.8	58.1	40.22	32.41	46.31	57.76	32.97	35.12	32.05	57.63
	Within Exec. Only	11.22	7.03	23.98	23.61					22.76	15.92	32.92	35.92				
	Within Diir. Only	8.3	9.1	2.16	6.74									16.38	16.3	7.94	19.65
	Between Exec. & Dir.	17.02	17.79	16.31	27.37					17.46	16.49	13.4	21.84	16.6	18.82	24.11	37.98
	Within Top Exec. Only					8.26	6.02	9.94	9.36								
	With Other Exec.					12.31	9.25	22.97	26.07								
	With Directors					17.04	16.37	13.9	22.68								
% of Cluster Length Among Cluster Tradings	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	All Clusters	3.35	2.37	3.32	2.12	3.68	2.69	3.71	2.43	3.47	2.51	3.37	2.15	3.55	2.58	3.6	2.37
# of Top Exec. Trading	All Clusters	0.89	1.18	1.08	1.31	1.66	1.14	1.83	1.24	1.19	1.22	1.15	1.32	0.62	0.98	0.79	1.19
# of Director Trading	All Clusters	1.53	1.88	0.68	1.11	1.02	1.66	0.5	0.97	1.03	1.6	0.55	0.95	2.34	1.87	1.7	1.15
# of Insider Tradings	Within Exec. Only	2.99	1.84	3.14	1.91					2.99	1.84	3.14	1.91				
	Within Diir. Only	3.02	1.84	2.66	1.32									3.02	1.84	2.66	1.32
	Between Exec. & Dir.	3.88	2.9	3.77	2.48					3.88	2.9	3.77	2.48	3.88	2.9	3.77	2.48
	Within Top Exec. Only					2.56	1.31	2.69	1.22								
	With Other Exec.					3.3	2.1	3.58	2.26								
	With Directors					4.27	3.16	4.39	2.87								
% of Opposite Direction Trading Within Cluster Period	All Clusters	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		123418		26533		73098		37018		115693		32429		50293	

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+1, t+5) and BHAR(t+1, t+21), and BHARs of medium-term period, BHAR(t+1, 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+1, t+5)												
Noncluster	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+1, t+21)												
Noncluster	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+1, t+90)												
Noncluster	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+1, t+5)												
Noncluster	-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+1, t+21)												
Noncluster	-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+1, t+90)												
Noncluster	-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 BHAR(t+1, t+21) 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. We limit the length of the cluster to 5 trading days. Cluster Dummy is 1 if an insider trading is a cluster trading among any insiders, otherwise is 0. Within Cluster Dummy is 1 if an insider trading is a cluster trading by only the same rank of insiders, where ranks are classified as executives (top) and directors, otherwise is 0. Between Cluster Dummy is 1 if an insider trading is a cluster trading by both executives and directors, otherwise is 0. Within and Between Cluster Dummy are mutually exclusive. For top executives sample, With Other Exec. Cluster Dummy is 1 if an insider trading is a cluster trading with other executives but without directors by top executives, otherwise is 0. With Directors Cluster Dummy is 1 if an insider trading is a cluster trading with directors by top executives, otherwise is 0. Noncluster Director Dummy is 1 if an insider trading is placed by a director and is not a cluster trading, otherwise is 0. The 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 top executives are reported in separate columns.

A. BHAR(t+1, t+21) of Insider Purchases								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Groups	All				Top Executive			
Cluster Dummy	1.670***		1.998***		1.553***		2.101***	
	(11.37)		(14.41)		(6.29)		(8.31)	
Within Exec. Only Cluster Dummy		1.112***		1.470***				
		(4.34)		(5.91)				
Within Dir. Only Cluster Dummy		-0.104		0.767***				
		(-0.46)		(3.30)				
Between Exec. & Dir. Cluster Dummy		2.252***		2.507***				
		(9.62)		(11.38)				
Noncluster Director Dummy		-0.693***		-0.464***				
		(-5.54)		(-3.77)				
Within Top Exec. Only Cluster Dummy						1.378**		1.478**
						(2.32)		(2.57)
With Other Exec. Cluster Dummy						0.543		1.283***
						(1.57)		(3.33)
With Directors Cluster Dummy						2.321***		2.882***
						(7.05)		(8.50)
Constant	1.959***	2.338***	1.891***	2.147***	2.599***	2.599***	2.432***	2.432***
	(29.05)	(23.02)	(66.02)	(28.27)	(16.63)	(16.63)	(31.44)	(31.53)
Observations	252930	252930	252930	252930	70368	70368	70368	70368
Adjusted R^2	0.020	0.020	0.128	0.128	0.025	0.025	0.192	0.192
Firm fixed effect	No	No	Yes	Yes	No	No	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 3 - *continued*

B. BHAR(t+1, t+21) of Insider Sales								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Groups	All				Top Executive			
Cluster Dummy	0.0109		-0.281***		0.156		-0.231***	
	(0.19)		(-5.28)		(1.61)		(-2.64)	
Within Exec. Only Cluster Dummy		-0.0442		-0.288***				
		(-0.64)		(-4.50)				
Within Dir. Only Cluster Dummy		-0.132		-0.341*				
		(-0.72)		(-1.85)				
Between Exec. & Dir. Cluster Dummy		0.347***		-0.0474				
		(3.73)		(-0.54)				
Noncluster Director Dummy		0.276***		0.282***				
		(3.86)		(4.10)				
Within Top Exec. Only Cluster Dummy						-0.0323		-0.357**
						(-0.17)		(-2.06)
With Other Exec. Cluster Dummy						0.102		-0.193*
						(0.89)		(-1.81)
With Directors Cluster Dummy						0.346**		-0.222
						(2.47)		(-1.62)
Constant	-0.317***	-0.405***	-0.230***	-0.318***	-0.572***	-0.572***	-0.414***	-0.415***
	(-8.49)	(-9.38)	(-14.54)	(-12.38)	(-7.37)	(-7.37)	(-11.59)	(-11.61)
Observations	634286	634286	634286	634286	199792	199792	199792	199792
Adjusted R^2	0.005	0.005	0.081	0.082	0.011	0.011	0.135	0.135
Firm fixed effect	No	No	Yes	Yes	No	No	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 4: 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. Insider Trading Dummy is 1 if any insider trading occurs in the months, otherwise is 0. Cluster Dummy is 1 if cluster insider trading occurs in the months, otherwise is 0. Within Cluster Dummy is 1 if within cluster trading occurs in the months, otherwise is 0. Between Cluster Dummy is 1 if between cluster trading occurs in the months, otherwise is 0. Cluster Dummy captures an additional effect from the effect of insider trading. If a cluster insider trading occurs in a month, both Insider Trading Dummy and Cluster Dummy are 1. 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)). 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)	(9)	(10)	(11)	(12)
Trading Side	Purchases						Sales					
Dependent Variable	Monthly raw stock return											
Insider Trading Dummy	0.958***	0.983***	0.826***	1.205***	1.241***	1.024***	-0.0983	-0.0454	-0.127**	-0.120*	-0.108*	-0.136*
	(10.83)	(11.28)	(9.85)	(10.80)	(10.91)	(10.45)	(-1.53)	(-0.77)	(-2.01)	(-1.72)	(-1.75)	(-1.94)
Cluster Dummy	0.646***	0.770***	0.569***				-0.0345	-0.0443	0.127			
	(4.46)	(5.24)	(4.00)				(-0.38)	(-0.58)	(0.75)			
Within Exec. Only Cluster Dummy				0.564***	0.644***	0.375*				-0.0305	-0.0919	0.0589
				(2.86)	(3.19)	(1.83)				(-0.34)	(-1.11)	(0.44)
Within Dir. Only Cluster Dummy				-0.264	-0.198	-0.125				-0.0826	0.136	-0.138
				(-1.16)	(-0.94)	(-0.58)				(-0.45)	(0.74)	(-0.72)
Between Exec. & Dir. Cluster Dummy				0.680***	0.838***	0.835***				0.0211	0.149	0.134
				(3.09)	(3.84)	(3.37)				(0.17)	(1.38)	(0.96)
Noncluster Director Only Dummy				-0.454***	-0.475***	-0.346***				0.0736	0.213***	0.0264
				(-4.29)	(-4.59)	(-3.99)				(1.08)	(3.17)	(0.34)
Log Size	-0.190***	-2.383***	-0.157***	-0.188***	-2.381***	-0.155***	-0.183***	-2.387***	-0.145***	-0.183***	-2.388***	-0.145***
	(-3.51)	(-16.78)	(-3.58)	(-3.48)	(-16.77)	(-3.55)	(-3.30)	(-16.64)	(-3.27)	(-3.30)	(-16.64)	(-3.26)
Book-to-Market	0.00326*	-0.00565***	0.0293***	0.00327*	-0.00564***	0.0293***	0.00314	-0.00564***	0.0277**	0.00314	-0.00565***	0.0277**
	(1.67)	(-2.63)	(2.60)	(1.68)	(-2.62)	(2.60)	(1.62)	(-2.62)	(2.50)	(1.62)	(-2.62)	(2.50)
Return (t-1, t)	-3.774***	-3.938***	-3.613***	-3.773***	-3.937***	-3.613***	-3.793***	-3.956***	-3.637***	-3.793***	-3.957***	-3.638***
	(-3.96)	(-4.18)	(-8.25)	(-3.96)	(-4.18)	(-8.24)	(-3.97)	(-4.19)	(-8.30)	(-3.97)	(-4.19)	(-8.30)
Return (t-12, t-1)	0.220	0.288	0.249	0.220	0.288	0.250	0.211	0.279	0.237	0.211	0.278	0.236
	(1.13)	(1.49)	(1.10)	(1.13)	(1.50)	(1.10)	(1.09)	(1.46)	(1.04)	(1.09)	(1.45)	(1.04)
Constant	2.155***	13.89***	1.710***	2.146***	13.88***	1.705***	2.246***	14.03***	1.770***	2.244***	14.04***	1.769***
	(7.45)	(18.14)	(3.60)	(7.43)	(18.13)	(3.60)	(7.67)	(18.09)	(3.73)	(7.66)	(18.09)	(3.72)
Observations	1692518	1692518	1692518	1692518	1692518	1692518	1692518	1692518	1692518	1692518	1692518	1692518
Adjusted R^2	0.002	0.012	0.025	0.002	0.012	0.026	0.002	0.012	0.025	0.002	0.012	0.025
Fama-MacBeth	No	No	Yes	No	No	Yes	No	No	Yes	No	No	Yes
Firm fixed effect	No	Yes	No	No	Yes	No	No	Yes	No	No	Yes	No
Time fixed effect	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No
Cluster	Months	Months	No	Months	Months	No	Months	Months	No	Months	Months	No

Table 5: Opportunistic trades and cluster trades

The table presents results for panel regressions using BHAR(t+1, 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 which 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. Opportunistic Trading Noncluster Dummy is 1 if an insider trading is identified as opportunistic insider trade and not clustered, otherwise is 0. Unclassified Trading Noncluster Dummy is 1 if an insider trading is unclassified and not clustered, otherwise is 0. Routine Only Cluster Dummy is 1 if an insider trading is a cluster trading among any insiders and all trading in the cluster are routine insider trades, otherwise is 0. With Unclassified Cluster Dummy is 1 if an insider trading is a cluster trading among any insiders and the cluster contains unclassified insider trades, but does not have opportunistic insider trades, otherwise is 0. With Opport Cluster Dummy is 1 if an insider trading is a cluster trading among any insiders and the cluster contains opportunistic insider trades, 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+1, t+21) of Insider Purchases								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Groups	All		Top Executive		Executive		Director	
Unclassified Trading Noncluster Dummy	0.617***	-0.548**	0.725*	-1.124**	-0.527	-0.527	0.649**	-0.526*
	(2.81)	(-2.29)	(1.65)	(-1.99)	(-1.36)	(-1.36)	(2.56)	(-1.77)
Opportunistic Trading Noncluster Dummy	0.452*	-0.219	-0.364	-1.412**	-0.412	-0.412	0.476	-0.188
	(1.68)	(-0.76)	(-0.69)	(-2.19)	(-0.85)	(-0.85)	(1.56)	(-0.58)
Routine Only Cluster Dummy	-1.340***	0.304	-1.289*	0.179	0.486	0.486	-1.079**	0.483
	(-3.02)	(0.59)	(-1.77)	(0.16)	(0.64)	(0.64)	(-2.07)	(0.87)
With Unclassified Cluster Dummy	2.312***	1.447***	2.208***	0.933*	1.449***	1.449***	2.505***	1.517***
	(8.90)	(5.46)	(4.64)	(1.66)	(3.54)	(3.54)	(8.44)	(4.79)
With Opportunistic Cluster Dummy	2.532***	2.034***	2.081***	1.458**	1.910***	1.910***	2.526***	2.060***
	(7.77)	(6.16)	(3.80)	(2.19)	(3.90)	(3.90)	(6.95)	(5.52)
Constant	1.409***	2.750***	8.431**	9.726**	3.120***	3.120***	0.701	2.204***
	(2.86)	(5.22)	(2.41)	(2.10)	(3.10)	(3.10)	(1.40)	(3.77)
Observations	252930	252930	70368	70368	123071	123071	140269	140269
Adjusted R^2	0.004	0.114	0.006	0.176	0.144	0.144	0.004	0.161
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+1, t+21) of Insider Sales								
Unclassified Trading Noncluster Dummy	-0.0699	0.376***	-0.0871	0.506***	0.362***	0.362***	-0.100	0.527**
	(-0.71)	(3.87)	(-0.50)	(2.88)	(3.23)	(3.23)	(-0.58)	(2.56)
Opportunistic Trading Noncluster Dummy	0.0186	0.274**	0.0658	0.464**	0.254**	0.254**	0.106	0.344
	(0.16)	(2.54)	(0.35)	(2.46)	(2.06)	(2.06)	(0.51)	(1.58)
Routine Only Cluster Dummy	-0.0562	-0.328	0.378	-0.0339	-0.223	-0.223	-0.486	-0.696
	(-0.26)	(-1.55)	(1.48)	(-0.13)	(-1.05)	(-1.05)	(-1.03)	(-1.53)
With Unclassified Cluster Dummy	-0.0411	0.0692	0.0907	0.222	0.110	0.110	-0.0469	0.116
	(-0.36)	(0.64)	(0.50)	(1.25)	(0.92)	(0.92)	(-0.24)	(0.53)
With Opportunistic Cluster Dummy	0.0206	0.0177	0.182	0.176	0.0675	0.0675	-0.164	-0.0814
	(0.18)	(0.16)	(1.08)	(1.06)	(0.57)	(0.57)	(-0.87)	(-0.39)
Constant	0.361	0.445	2.378	4.160**	0.554	0.554	0.168	0.452
	(1.37)	(1.54)	(1.59)	(2.42)	(1.61)	(1.61)	(0.41)	(0.90)
Observations	634286	634286	199792	199792	462098	462098	198544	198544
Adjusted R^2	0.001	0.078	0.002	0.128	0.087	0.087	0.001	0.128
Firm fixed effect	No	Yes	No	Yes	No	Yes	No	Yes
Time fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 6: Price impact of insider cluster trades

The table presents trading date abnormal return of cluster and non-cluster insider purchases and sales during the 1986-2016 period. We only include one observation per cluster and the trading date of cluster is defined as the first trading date. 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 abnormal return is estimated using Daniel et al. (1997, DGTW) benchmark adjusted returns. The table shows trading date returns of noncluster trades, 1-day clusters, and clusters with multiple trades in the first day of the sequence in separate rows and compare those of cluster trades and noncluster trades in separate columns. The t-statistics are shown in parentheses. ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively.

		Abnormal return at trade day t			
		Purchases		Sales	
Trade type	Stat.	Cl. (Noncl.)	Cl.-Noncl.	Cl. (Noncl.)	Cl.-Noncl.
Noncluster	Mean	0.25		0.22	
	t-stat	5.45		3.81	
	N	202515		465688	
Cluster with	Mean	0.51	0.26	0.59	0.37
Multiple trades	t-stat	(11.45)	(5.59)	(22.65)	(13.78)
in the first day	N	22820		58723	
1-day Cluster	Mean	0.45	0.19	0.52	0.30
	t-stat	(9.72)	(4.10)	(23.19)	(12.94)
	N	18393		37708	

Table 7: Market reaction to trade disclosure and post disclosure returns

The table presents cumulative abnormal returns (CAR) and buy and hold abnormal return (BHAR) of cluster and non-cluster insider purchases and sales from filing dates of the trades during the 1986-2016 period. We only include one observation per cluster and the filing date of cluster is defined as the second filing of cluster 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. The length of cluster is defined as difference of trading days between first and last of cluster sequence. The CAR and BHAR are estimated using Daniel et al. (1997, DGTW) benchmark adjusted returns. The table displays the insider trading returns of three periods, CAR(0,1), BHAR(2,21), and BHAR(22,90) of filing date. The pre-SOX period ranges from 1/1/1986 to 8/28/2002. The post-SOX period ranges from 8/29/2002 to 12/31/2016. Panel A compares all cluster trades and noncluster trades. Panel B compares cluster trades with different cluster lengths. The t-statistics are shown in parentheses. ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively.

Panel A. All cluster trades

Side		Purchases						Sales					
		Pre-SOX			Post-SOX			Pre-SOX			Post-SOX		
Return Variables	Stat.	CAR(0,1)	BHAR(2,21)	BHAR(22,90)	CAR(0,1)	BHAR(2,21)	BHAR(22,90)	CAR(0,1)	BHAR(2,21)	BHAR(22,90)	CAR(0,1)	BHAR(2,21)	BHAR(22,90)
Noncluster	Mean	0.21	1.57	1.44	0.99	1.01	1.50	-0.01	-0.49	-0.88	-0.06	-0.11	-0.07
	t-stat	(12.77)	(32.47)	(14.68)	(47.22)	(18.28)	(11.37)	(-0.94)	(-15.11)	(-13.82)	(-8.57)	(-5.44)	(-1.61)
	N	129925	129561	127961	72254	71864	70195	208461	207711	204742	241441	240208	234632
Cluster	Mean	0.31	2.29	1.41	1.56	1.53	1.62	0.03	-0.78	-0.94	-0.07	-0.19	-0.28
	t-stat	6.20	17.43	36.63	6.63	15.95	34.06	4.86	14.86	28.00	3.07	9.43	19.37
	N	19097	19049	18827	14120	14068	13800	39383	39193	38609	14120	14068	13800
Cluster-Noncluster	Mean	0.10	0.72	-0.03	0.57	0.52	0.13	0.04	-0.29	-0.06	-0.01	-0.07	-0.21
	t-stat	(2.02)	(5.34)	(-0.12)	(9.58)	(3.59)	(0.40)	(1.49)	(-3.56)	(-0.41)	(-0.26)	(-0.86)	(-1.26)
	N	10584	10552	10430	7916	7888	7739	13441	13371	13146	24241	24124	23568

Panel B. cluster length

Side			Purchases						Sales					
			Pre-SOX			Post-SOX			Pre-SOX			Post-SOX		
Length	Return Variables	Stat.	CAR(0,1)	BHAR(2,21)	BHAR(22,90)	CAR(0,1)	BHAR(2,21)	BHAR(22,90)	CAR(0,1)	BHAR(2,21)	BHAR(22,90)	CAR(0,1)	BHAR(2,21)	BHAR(22,90)
1 day	Cluster	Mean	0.20	1.55	1.38	1.23	0.83	0.78	0.05	-0.65	-0.74	-0.09	-0.08	-0.34
		t-stat	(3.64)	(9.74)	(4.04)	(18.22)	(5.27)	(2.42)	(1.27)	(-5.07)	(-3.11)	(-4.48)	(-1.29)	(-2.67)
	Cluster-Noncluster	Mean	-0.02	-0.03	-0.06	0.24	-0.18	-0.72	0.06	-0.16	0.13	-0.03	0.03	-0.27
		t-stat	(-0.28)	(-0.16)	(-0.16)	(3.38)	(-1.09)	(-2.05)	(1.48)	(-1.21)	(0.54)	(-1.48)	(0.53)	(-2.02)
		N	10584	10552	10430	7916	7888	7739	13441	13371	13146	24241	24124	23568
2 days	Cluster	Mean	0.35	2.88	1.66	1.89	1.98	2.27	0.01	-0.79	-0.96	-0.12	-0.28	-0.25
		t-stat	(4.52)	(13.02)	(3.63)	(18.57)	(7.88)	(3.80)	(0.32)	(-7.25)	(-4.66)	(-6.74)	(-4.93)	(-2.06)
	Cluster-Noncluster	Mean	0.14	1.31	0.22	0.90	0.97	0.77	0.02	-0.30	-0.08	-0.07	-0.17	-0.19
		t-stat	(1.75)	(5.78)	(0.47)	(8.66)	(3.77)	(1.26)	(0.59)	(-2.62)	(-0.38)	(-3.33)	(-2.75)	(-1.42)
		N	6699	6689	6606	4717	4695	4611	17807	17726	17495	25548	25423	24871
3 days	Cluster	Mean	0.60	4.61	0.69	2.40	3.94	3.06	0.02	-0.98	-0.74	0.04	-0.22	0.14
		t-stat	(2.49)	(8.05)	(0.56)	(9.78)	(6.19)	(2.85)	(0.25)	(-4.53)	(-1.75)	(0.94)	(-1.98)	(0.63)
	Cluster-Noncluster	Mean	0.38	3.04	-0.76	1.41	2.93	1.56	0.03	-0.49	0.14	0.09	-0.11	0.21
		t-stat	(1.59)	(5.29)	(-0.61)	(5.73)	(4.59)	(1.45)	(0.40)	(-2.23)	(0.33)	(2.46)	(-0.95)	(0.92)
		N	1255	1252	1240	1058	1057	1033	5130	5113	5042	7279	7239	7088
4-5 days	Cluster	Mean	1.28	4.23	0.42	2.04	3.65	6.58	0.05	-0.99	-2.07	0.32	-0.11	-1.01
		t-stat	(3.81)	(4.49)	(0.23)	(4.47)	(3.65)	(2.87)	(0.55)	(-3.39)	(-3.67)	(5.61)	(-0.71)	(-3.02)
	Cluster-Noncluster	Mean	1.07	2.66	-1.02	1.05	2.64	5.08	0.06	-0.50	-1.19	0.38	0.00	-0.94
		t-stat	(3.17)	(2.82)	(-0.56)	(2.30)	(2.64)	(2.21)	(0.65)	(-1.71)	(-2.09)	(6.58)	(0.01)	(-2.79)
		N	559	556	551	429	428	417	3005	2983	2926	3446	3429	3350

Table 8: Cluster trades and firm characteristics

The table examines determinants of cluster insider trading. It shows the regression results of cluster ratio on the proxies of information asymmetry between insiders and outsiders. The dependent variable is Cluster ratio, a percentage of cluster purchases (sales) out of total insider purchases (sales) at firm-year level. We include firm characteristics related to information structure as independent variable, Log size, Book-to-Market, Std. of Return, R&D dummy, Illiquidity Quintile, and Log(number of business segments). R&D dummy is 1 if a firm has a positive R&D expenditure, and 0 otherwise. Illiquidity Quintile 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) Top 5 institutional ownership. The number of financial analysts is the number of financial analysts who reports forecast of annual earnings in IBES. Top 5 institutional ownership is defined as a ratio of shares of the five institutional investors that have the largest position over shares outstanding. 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.

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable	Cluster ratio					
Trading Side	Purchases			Sales		
Log(1+number of financial analysts)	0.00947***		0.00847***	0.00413*		0.00114
	(3.59)		(3.19)	(1.69)		(0.45)
Top 5 Institutional ownership		0.0361***	0.0330***		0.0646***	0.0643***
		(2.86)	(2.62)		(5.34)	(5.29)
Log (1+number of insider trades)	0.0583***	0.0579***	0.0579***	0.0577***	0.0568***	0.0568***
	(27.40)	(27.13)	(27.12)	(47.45)	(45.71)	(45.67)
Log Size	-0.0194***	-0.0164***	-0.0187***	0.0278***	0.0301***	0.0298***
	(-12.61)	(-11.87)	(-12.08)	(15.92)	(18.99)	(16.97)
Book-to-Market	0.00172	0.00232	0.00178	-0.000842	-0.00129*	-0.00129*
	(0.82)	(1.16)	(0.88)	(-1.04)	(-1.67)	(-1.66)
Std. of Return	0.0721***	0.0806***	0.0760***	0.0626***	0.0724***	0.0719***
	(3.98)	(4.35)	(4.12)	(3.40)	(3.78)	(3.75)
R&D dummy	-0.00356	-0.00406	-0.00429	0.00967**	0.0108**	0.0107**
	(-0.82)	(-0.93)	(-0.98)	(2.13)	(2.35)	(2.35)
Illiquidity Quintile	-0.0165***	-0.0179***	-0.0159***	0.00267	0.00398**	0.00426**
	(-8.36)	(-9.43)	(-7.88)	(1.33)	(2.01)	(2.09)
Return (t-12, t)	0.00488**	0.00387**	0.00461**	0.0237***	0.0232***	0.0232***
	(2.53)	(2.02)	(2.37)	(10.60)	(10.38)	(10.30)
Log(number of business segments)	-0.0134***	-0.0159***	-0.0151***	0.000631	0.00277	0.00285
	(-3.51)	(-4.01)	(-3.80)	(0.20)	(0.84)	(0.87)
Constant	0.196***	0.188***	0.186***	-0.194***	-0.210***	-0.210***
	(7.00)	(6.65)	(6.78)	(-8.31)	(-8.64)	(-8.67)
Observations	62766	59319	59319	76038	71203	71203
Adjusted R^2	0.066	0.067	0.067	0.167	0.169	0.169
Industry fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes	Yes	Yes

Table 9: 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 8/28/2002. The post-SOX period ranges from 8/29/2002 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) occurred 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

Table 10: 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+1, t+21) of insider purchases (sales) as the dependent variable. The pre-SOX period ranges from 1/1/1986 to 8/28/2002. The post-SOX period ranges from 8/29/2002 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≤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+1, t+21)							
Cluster Length≤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≤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

Table B1: Number of insider trading and firm characterstics

The table examines determinants of insider trading. It shows the regression results of number of insider trading on the proxies of information asymmetry between insiders and outsiders. The dependent variable is log (1+the number of insider traindg) at firm-year level. We include firm characteristics related to information structure as independent variable, Log size, Book-to-Market, Std. of Return, R&D dummy, Illiquidity Quintile, and Log(number of business segments). R&D dummy is 1 if a firm has a positive R&D expenditure, and 0 otherwise. Illiquidity Quintile is the quintile rank of Amihud (2002). We also control Return (t-12, t). In addition to these independent variables, we consider the following information production measures: (1) Log(1+ number of financial analysts) and (2) Top 5 institutional ownership. The number of financial analysts is the number of financial analysts who reports forecast of annual earnings in IBES. Top 5 institutional ownership is defined as a ratio of shares of the five institutional investors that have the largest position over shares outstanding. We also include Log(number of business segments) as proxy for decentralized information structure. 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.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent Variable	Log(1+Number of insider trades)							
Trading Side	Purchases				Sales			
Log(1+number of financial analysts)		0.00371		0.00928		0.119***		0.117***
		(0.35)		(0.86)		(10.87)		(10.54)
Top 5 Institutional ownership			-0.343***	-0.346***			0.180***	0.143***
			(-7.25)	(-7.29)			(3.39)	(2.74)
Log Size	0.00497	0.00397	0.00323	0.000678	0.128***	0.0977***	0.129***	0.0981***
	(0.87)	(0.62)	(0.56)	(0.11)	(18.93)	(13.09)	(18.94)	(13.05)
Book-to-Market	0.0164**	0.0162**	0.0196***	0.0190***	-0.00707	-0.00742	-0.00813*	-0.00819
	(2.37)	(2.33)	(2.80)	(2.71)	(-1.42)	(-1.38)	(-1.74)	(-1.61)
Std. of Return	0.298***	0.296***	0.296***	0.291***	0.120*	0.0703	0.174**	0.121*
	(4.87)	(4.85)	(4.73)	(4.66)	(1.67)	(0.97)	(2.39)	(1.66)
R&D dummy	-0.0392**	-0.0393**	-0.0510***	-0.0512***	0.122***	0.119***	0.119***	0.115***
	(-2.43)	(-2.44)	(-3.08)	(-3.09)	(5.75)	(5.62)	(5.52)	(5.37)
Illiquidity Quintile	0.0542***	0.0552***	0.0382***	0.0403***	-0.182***	-0.150***	-0.178***	-0.149***
	(7.59)	(7.26)	(5.28)	(5.27)	(-21.89)	(-17.44)	(-21.16)	(-17.08)
Return (t-12, t)	-0.0656***	-0.0653***	-0.0615***	-0.0607***	0.113***	0.122***	0.108***	0.117***
	(-6.73)	(-6.65)	(-6.39)	(-6.28)	(10.89)	(11.21)	(10.50)	(10.84)
Log(number of business segments)	-0.0531***	-0.0527***	-0.0522***	-0.0513***	-0.00361	0.00542	-0.00248	0.00632
	(-3.93)	(-3.91)	(-3.70)	(-3.64)	(-0.27)	(0.41)	(-0.18)	(0.46)
Constant	0.428***	0.426***	0.550***	0.548***	0.599***	0.539***	0.603***	0.561***
	(3.62)	(3.62)	(4.76)	(4.75)	(4.26)	(3.80)	(4.24)	(3.90)
Observations	62766	62766	59319	59319	76038	76038	71203	71203
Adjusted R^2	0.107	0.106	0.109	0.109	0.232	0.235	0.229	0.232
Industry fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table C1: Cluster trades and market reaction to earnings news

This table provides regression results of cumulative abnormal return of earnings announcement 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. Cluster Dummy captures an additional effect from the effect of insider trading. If a cluster insider trading occurs in trading windows, both Insider Trading Dummy and Cluster Dummy are 1. The trading windows is 75 calendar days before the announcement date until 15 calendar days before the date. The dependent variables are CAR(-1,1) and CAR(-1,5) around earnings announcement date. CAR(-1,1) is the cumulative benchmark-adjusted return in the trading day window $(t-1, t+1)$ around the earnings announcement date t. CAR(-1,5) is the cumulative benchmark-adjusted return in the trading day window $(t-1, t+5)$ around the earnings announcement date t. Regression without firm fixed effect includes the log size, book-to-market ratio, lagged 1 year return, and past quarter CAR(-1,5) of the corresponding firm as control variables. Quarter 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.

Panel A. Purchases								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Variables	CAR (-1, 1)				CAR (-1, 5)			
Cluster Dummy	0.00309***	0.0000749	0.00479***	0.00130	0.00675***	0.00198*	0.00888***	0.00377***
	(3.59)	(0.08)	(5.23)	(1.34)	(6.21)	(1.69)	(7.58)	(3.05)
Insider Trading Dummy		0.00362***		0.00466***		0.00572***		0.00683***
		(8.47)		(10.41)		(10.76)		(12.15)
Log Size	-0.000668***	-0.000664***			-0.000639***	-0.000632***		
	(-7.27)	(-7.23)			(-5.60)	(-5.55)		
Book-to-Market	0.00189***	0.00186***			0.00259***	0.00255***		
	(4.27)	(4.24)			(4.30)	(4.26)		
Return (t-12, t)	0.000610**	0.000676**			-0.00113***	-0.00103***		
	(2.06)	(2.28)			(-2.95)	(-2.68)		
Lag CAR (0, 5)	0.0175***	0.0177***			0.0114***	0.0117***		
	(7.61)	(7.69)			(3.98)	(4.09)		
Constant	0.00529***	0.00474***	0.00192	0.00193	0.00488***	0.00401***	0.00496**	0.00498**
	(6.90)	(6.18)	(1.18)	(1.19)	(4.92)	(4.05)	(2.32)	(2.33)
Observations	325694	325694	344477	344477	325733	325733	344530	344530
Adjusted R^2	0.002	0.003	0.017	0.017	0.002	0.002	0.016	0.017
Firm fixed effect	No	No	Yes	Yes	No	No	Yes	Yes
Quarter fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table B2 - *continued*

Panel B. Sales								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Variables	CAR (-1, 1)				CAR (-1, 5)			
Cluster Dummy	-0.000842	-0.000258	-0.00539***	-0.00326***	-0.00285***	-0.00166**	-0.00875***	-0.00530***
	(-1.63)	(-0.47)	(-10.00)	(-5.68)	(-4.66)	(-2.51)	(-13.67)	(-7.74)
Insider Trading Dummy		-0.000894**		-0.00344***		-0.00183***		-0.00557***
		(-2.53)		(-9.34)		(-4.22)		(-12.46)
Log Size	-0.000652***	-0.000614***			-0.000574***	-0.000495***		
	(-7.09)	(-6.66)			(-5.03)	(-4.35)		
Book-to-Market	0.00188***	0.00185***			0.00256***	0.00250***		
	(4.28)	(4.21)			(4.28)	(4.19)		
Return (t-12, t)	0.000627**	0.000657**			-0.00105***	-0.000986**		
	(2.10)	(2.20)			(-2.71)	(-2.56)		
Lag CAR (0, 5)	0.0175***	0.0176***			0.0115***	0.0117***		
	(7.60)	(7.65)			(4.02)	(4.09)		
Constant	0.00538***	0.00540***	0.00194	0.00185	0.00502***	0.00507***	0.00499**	0.00484**
	(7.07)	(7.10)	(1.19)	(1.14)	(5.12)	(5.17)	(2.34)	(2.27)
Observations	325694	325694	344477	344477	325733	325733	344530	344530
Adjusted R^2	0.002	0.002	0.017	0.017	0.002	0.002	0.017	0.017
Firm fixed effect	No	No	Yes	Yes	No	No	Yes	Yes
Quarter fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table C2: Probability of first trade within a cluster

The table presents the probability of becoming the first trader of the cluster for different groups of insiders. The dependent variables are One Day/First Trade Dummy and First Trade Dummy in the cluster. 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. 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.

	(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 C3: Director cluster trades and information structure in corporation

The table examines determinants of directors' cluster trading. Panel A examines whether the directors who sit in the same committee tend to trade together. It shows the regression results of cluster dummy between pair of directors on Same Committee Dummy. The director pair-year level data has observations for all pairs of directors in the firm for each year. Cluster dummy between pair of directors is 1 if this pair of directors have ever traded together, in the same cluster trades, in the year, and 0 otherwise. Same committee dummy is 1 if the pair of directors sit in the same committee in the year, and 0 otherwise. Frim fixed effect and year fixed effect are included and the standard errors are clustered at the firm level. Panel B shows the regression results of directors' Between-Cluster ratio on the proxies of information asymmetry among insiders. Directors' Between-Cluster ratio is the ratio of cluster trades between directors and executives among directors' trades. 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. We also include firm characteristics related to information structure as independent variables, 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 Quintile is the quintile rank of Amihud (2002). We also control Return (t-12, t) and Log (1+number of insider trades). 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. Directors' cluster trades and committee		
	(1)	(2)
Dependent Variable	Cluster Dummy between pair of directors	
Trading Side	Purchases	Sales
Same Committee Dummy	0.00144***	0.000601*
	(5.29)	(1.83)
Constant	0.00282	-0.000140
	(1.46)	(-0.08)
Observations	243122	243122
Adjusted R^2	0.062	0.037
Firm fixed effect	Yes	Yes
Time fixed effect	Yes	Yes

B. Information Asymmetry among Insiders						
	(1)	(2)	(3)	(4)	(5)	(6)
Sample	Insider Trading of Directors					
Dependent Variable	Directors' Between-Cluster ratio					
Trading Side	Purchases			Sales		
CEO Centrality	-0.147***		-0.133**	-0.173**		-0.183*
	(-3.16)		(-2.12)	(-1.99)		(-1.72)
Fraction of Non-co-opted Independent Directors		0.0513	0.0554*		-0.236***	-0.234***
		(1.64)	(1.76)		(-4.53)	(-4.51)
Log Size	-0.0515***	-0.0455***	-0.0461***	0.0842***	0.0884***	0.0855***
	(-10.12)	(-7.01)	(-7.04)	(6.13)	(5.59)	(5.40)
Book-to-Market	0.0385***	0.0379**	0.0423**	-0.0940***	-0.107***	-0.107***
	(2.81)	(2.14)	(2.31)	(-4.65)	(-3.30)	(-3.30)
Std. of Return	0.488***	0.656***	0.638***	1.187***	1.052***	0.986***
	(3.81)	(3.76)	(3.62)	(5.23)	(3.63)	(3.39)
R&D dummy	0.0485**	0.0759***	0.0800***	0.0824**	0.0603	0.0532
	(2.36)	(3.09)	(3.22)	(2.34)	(1.38)	(1.22)
Illiquidity Quintile	-0.0335***	-0.0163	-0.0200	0.0363*	0.0389	0.0303
	(-2.92)	(-0.91)	(-1.09)	(1.77)	(1.42)	(1.10)
Return (t-12, t)	-0.0225**	-0.0310**	-0.0272*	0.123***	0.161***	0.167***
	(-2.27)	(-2.10)	(-1.83)	(5.76)	(5.21)	(5.34)
Log (1+number of insider trades)	0.0631***	0.0644***	0.0603***	0.244***	0.204***	0.202***
	(6.80)	(5.28)	(5.16)	(19.58)	(13.90)	(13.59)
Constant	0.320***	0.106	0.157*	-0.671**	-0.825***	-0.695***
	(2.93)	(1.41)	(1.87)	(-2.50)	(-4.30)	(-3.39)
Observations	14424	7633	7525	19796	11611	11498
Adjusted R^2	0.046	0.050	0.050	0.086	0.083	0.083
Industry fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes	Yes	Yes

Table C4: Return of cluster trades and firm characterstics

The table examines determinants of cluster trading returns. It shows the regression results of number of insider trading on the proxies of information asymmetry between insiders and outsiders. The dependent variable is cluster trading return relative to noncluster trading, mean BHAR(0,21) of cluster trading minus mean BHAR(0,21) of noncluster trading at firm-year level. We include firm characteristics 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 Quintile is the quintile rank of Amihud (2002). We also control Return (t-12, t). In addition to these independent variables, we consider the following information production measures: (1) Log(1+ number of financial analysts) and (2) Top 5 institutional ownership. The number of financial analysts is the number of financial analysts who reports forecast of annual earnings in IBES. Top 5 institutional ownership is defined as a ratio of shares of the five institutional investors that have the largest position over shares outstanding. We also include Log(number of business segments) as proxy for decentralized information structure. 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.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent Variable	Mean Cluster BHAR(0,21) - Mean Noncluster BHAR(0,21)							
Trading Side	Purchases				Sales			
Log(1+number of financial analysts)		0.00234		-0.0154*		0.00169		0.00598**
		(0.68)		(-1.66)		(1.04)		(2.17)
Top 5 Institutional ownership			0.0177	0.0142			-0.00300	0.00157
			(1.05)	(0.30)			(-0.38)	(0.12)
Log(number of business segments)				-0.000737				0.00255**
				(-0.12)				(2.39)
Log Size	-0.00189	-0.00245	-0.00189	-0.00702	0.000336	-0.0000899	0.000453	-0.00216*
	(-0.91)	(-1.07)	(-0.90)	(-1.13)	(0.51)	(-0.12)	(0.64)	(-1.79)
Book-to-Market	-0.000405	-0.000510	-0.000176	0.00218	0.000459	0.000453	0.000727	-0.00113
	(-0.14)	(-0.18)	(-0.06)	(0.36)	(0.48)	(0.47)	(0.64)	(-0.60)
Std. of Return	0.120***	0.119***	0.122***	0.119*	-0.0390**	-0.0393**	-0.0326**	-0.0275
	(2.82)	(2.80)	(2.75)	(1.67)	(-2.53)	(-2.54)	(-2.06)	(-1.21)
R&D dummy	-0.00804	-0.00797	-0.00867	0.00224	0.00182	0.00183	0.00144	0.00464
	(-1.18)	(-1.17)	(-1.23)	(0.16)	(0.87)	(0.88)	(0.68)	(1.55)
Illiquidity Quintile	-0.00280	-0.00215	-0.00258	-0.0215**	-0.00263**	-0.00219*	-0.00273**	-0.00138
	(-1.05)	(-0.76)	(-0.92)	(-2.47)	(-2.46)	(-1.85)	(-2.44)	(-0.72)
Return (t-12, t)	-0.00789	-0.00794	-0.00716	-0.0225*	-0.00160	-0.00163	-0.00244	-0.00563
	(-0.64)	(-0.64)	(-0.57)	(-1.78)	(-0.56)	(-0.58)	(-0.85)	(-1.22)
Constant	0.0188	0.0182	0.0152	0.170**	0.0131	0.0127	0.0117	-0.0342
	(0.79)	(0.77)	(0.62)	(2.45)	(1.07)	(1.04)	(0.84)	(-1.54)
Observations	11066	11066	10691	1640	24796	24796	23776	6786
Adjusted R^2	0.004	0.004	0.005	0.009	0.006	0.006	0.006	0.000
Industry fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table C5: Return predictability of sequential positions within cluster trades

The table presents the return predictability of cluster trading based on the sequential positions of the cluster. The dependent variable is BHAR(t+1, 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 restrict the length of the cluster from 2 trading days to 5 trading days. 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. 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. Cluster insider trade-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.

	(1)	(2)	(3)	(4)
Groups	Pre-SOX		Post-SOX	
Trading Side	Purchases	Sales	Purchases	Sales
First Day in a Cluster	0.710***	0.672***	1.152***	0.240***
	(4.66)	(12.12)	(7.23)	(8.49)
Middle Days in a Cluster	0.672**	0.0471	0.898***	0.00533
	(2.36)	(0.67)	(3.81)	(0.15)
Constant	3.619***	-0.444***	4.335***	-0.449***
	(41.42)	(-15.27)	(54.66)	(-30.42)
Observations	17827	56810	16014	94214
Adjusted R^2	0.872	0.913	0.886	0.913
Cluster fixed effect	Yes	Yes	Yes	Yes

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.

Appendix B Additional Tests

In this section, we present additional empirical test results.7

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

Appendix B Additional Tests

In this section, we present additional empirical test results.

Table B1: Number of insider trading and firm characterstics

The table examines determinants of insider trading. It shows the regression results of number of insider trading on the proxies of information asymmetry between insiders and outsiders. The dependent variable is log (1+the number of insider traindg) at firm-year level. We include firm characteristics related to information structure as independent variable, Log size, Book-to-Market, Std. of Return, R&D dummy, Illiquidity Quintile, and Log(number of business segments). R&D dummy is 1 if a firm has a positive R&D expenditure, and 0 otherwise. Illiquidity Quintile is the quintile rank of Amihud (2002). We also control Return (t-12, t). In addition to these independent variables, we consider the following information production measures: (1) Log(1+ number of financial analysts) and (2) Top 5 institutional ownership. The number of financial analysts is the number of financial analysts who reports forecast of annual earnings in IBES. Top 5 institutional ownership is defined as a ratio of shares of the five institutional investors that have the largest position over shares outstanding. We also include Log(number of business segments) as proxy for decentralized information structure. 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.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent Variable	Log(1+Number of insider trades)							
Trading Side	Purchases				Sales			
Log(1+number of financial analysts)		0.00371		0.00928		0.119***		0.117***
		(0.35)		(0.86)		(10.87)		(10.54)
Top 5 Institutional ownership			-0.343***	-0.346***			0.180***	0.143***
			(-7.25)	(-7.29)			(3.39)	(2.74)
Log Size	0.00497	0.00397	0.00323	0.000678	0.128***	0.0977***	0.129***	0.0981***
	(0.87)	(0.62)	(0.56)	(0.11)	(18.93)	(13.09)	(18.94)	(13.05)
Book-to-Market	0.0164**	0.0162**	0.0196***	0.0190***	-0.00707	-0.00742	-0.00813*	-0.00819
	(2.37)	(2.33)	(2.80)	(2.71)	(-1.42)	(-1.38)	(-1.74)	(-1.61)
Std. of Return	0.298***	0.296***	0.296***	0.291***	0.120*	0.0703	0.174**	0.121*
	(4.87)	(4.85)	(4.73)	(4.66)	(1.67)	(0.97)	(2.39)	(1.66)
R&D dummy	-0.0392**	-0.0393**	-0.0510***	-0.0512***	0.122***	0.119***	0.119***	0.115***
	(-2.43)	(-2.44)	(-3.08)	(-3.09)	(5.75)	(5.62)	(5.52)	(5.37)
Illiquidity Quintile	0.0542***	0.0552***	0.0382***	0.0403***	-0.182***	-0.150***	-0.178***	-0.149***
	(7.59)	(7.26)	(5.28)	(5.27)	(-21.89)	(-17.44)	(-21.16)	(-17.08)
Return (t-12, t)	-0.0656***	-0.0653***	-0.0615***	-0.0607***	0.113***	0.122***	0.108***	0.117***
	(-6.73)	(-6.65)	(-6.39)	(-6.28)	(10.89)	(11.21)	(10.50)	(10.84)
Log(number of business segments)	-0.0531***	-0.0527***	-0.0522***	-0.0513***	-0.00361	0.00542	-0.00248	0.00632
	(-3.93)	(-3.91)	(-3.70)	(-3.64)	(-0.27)	(0.41)	(-0.18)	(0.46)
Constant	0.428***	0.426***	0.550***	0.548***	0.599***	0.539***	0.603***	0.561***
	(3.62)	(3.62)	(4.76)	(4.75)	(4.26)	(3.80)	(4.24)	(3.90)
Observations	62766	62766	59319	59319	76038	76038	71203	71203
Adjusted R^2	0.107	0.106	0.109	0.109	0.232	0.235	0.229	0.232
Industry fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table B2: Cluster trades and market reaction to earnings news

This table provides regression results of cumulative abnormal return of earnings announcement 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. Cluster Dummy captures an additional effect from the effect of insider trading. If a cluster insider trading occurs in trading windows, both Insider Trading Dummy and Cluster Dummy are 1. The trading windows is 75 calendar days before the announcement date until 15 calendar days before the date. The dependent variables are CAR(-1,1) and CAR(-1,5) around earnings announcement date. CAR(-1,1) is the cumulative benchmark-adjusted return in the trading day window $(t-1, t+1)$ around the earnings announcement date t. CAR(-1,5) is the cumulative benchmark-adjusted return in the trading day window $(t-1, t+5)$ around the earnings announcement date t. Regression without firm fixed effect includes the log size, book-to-market ratio, lagged 1 year return, and past quarter CAR(-1,5) of the corresponding firm as control variables. Quarter 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.

Panel A. Purchases

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Variables	CAR (-1, 1)				CAR (-1, 5)			
Cluster Dummy	0.00309***	0.0000749	0.00479***	0.00130	0.00675***	0.00198*	0.00888***	0.00377***
	(3.59)	(0.08)	(5.23)	(1.34)	(6.21)	(1.69)	(7.58)	(3.05)
Insider Trading Dummy		0.00362***		0.00466***		0.00572***		0.00683***
		(8.47)		(10.41)		(10.76)		(12.15)
Log Size	-0.000668***	-0.000664***			-0.000639***	-0.000632***		
	(-7.27)	(-7.23)			(-5.60)	(-5.55)		
Book-to-Market	0.00189***	0.00186***			0.00259***	0.00255***		
	(4.27)	(4.24)			(4.30)	(4.26)		
Return (t-12, t)	0.000610**	0.000676**			-0.00113***	-0.00103***		
	(2.06)	(2.28)			(-2.95)	(-2.68)		
Lag CAR (0, 5)	0.0175***	0.0177***			0.0114***	0.0117***		
	(7.61)	(7.69)			(3.98)	(4.09)		
Constant	0.00529***	0.00474***	0.00192	0.00193	0.00488***	0.00401***	0.00496**	0.00498**
	(6.90)	(6.18)	(1.18)	(1.19)	(4.92)	(4.05)	(2.32)	(2.33)
Observations	325694	325694	344477	344477	325733	325733	344530	344530
Adjusted R^2	0.002	0.003	0.017	0.017	0.002	0.002	0.016	0.017
Firm fixed effect	No	No	Yes	Yes	No	No	Yes	Yes
Quarter fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Panel B. Sales

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Variables	CAR (-1, 1)				CAR (-1, 5)			
Cluster Dummy	-0.000842	-0.000258	-0.00539***	-0.00326***	-0.00285***	-0.00166**	-0.00875***	-0.00530***
	(-1.63)	(-0.47)	(-10.00)	(-5.68)	(-4.66)	(-2.51)	(-13.67)	(-7.74)
Insider Trading Dummy		-0.000894**		-0.00344***		-0.00183***		-0.00557***
		(-2.53)		(-9.34)		(-4.22)		(-12.46)
Log Size	-0.000652***	-0.000614***			-0.000574***	-0.000495***		
	(-7.09)	(-6.66)			(-5.03)	(-4.35)		
Book-to-Market	0.00188***	0.00185***			0.00256***	0.00250***		
	(4.28)	(4.21)			(4.28)	(4.19)		
Return (t-12, t)	0.000627**	0.000657**			-0.00105***	-0.000986**		
	(2.10)	(2.20)			(-2.71)	(-2.56)		
Lag CAR (0, 5)	0.0175***	0.0176***			0.0115***	0.0117***		
	(7.60)	(7.65)			(4.02)	(4.09)		
Constant	0.00538***	0.00540***	0.00194	0.00185	0.00502***	0.00507***	0.00499**	0.00484**
	(7.07)	(7.10)	(1.19)	(1.14)	(5.12)	(5.17)	(2.34)	(2.27)
Observations	325694	325694	344477	344477	325733	325733	344530	344530
Adjusted R^2	0.002	0.002	0.017	0.017	0.002	0.002	0.017	0.017
Firm fixed effect	No	No	Yes	Yes	No	No	Yes	Yes
Quarter fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table B3: Probability of first trade within a cluster

The table presents the probability of becoming the first trader of the cluster for different groups of insiders. The dependent variables are One Day/First Trade Dummy and First Trade Dummy in the cluster. 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. 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.

	(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 B4: Director cluster trades and information structure in corporation

The table examines determinants of directors' cluster trading. Panel A examines whether the directors who sit in the same committee tend to trade together. It shows the regression results of cluster dummy between pair of directors on Same Committee Dummy. The director pair-year level data has observations for all pairs of directors in the firm for each year. Cluster dummy between pair of directors is 1 if this pair of directors have ever traded together, in the same cluster trades, in the year, and 0 otherwise. Same committee dummy is 1 if the pair of directors sit in the same committee in the year, and 0 otherwise. Frim fixed effect and year fixed effect are included and the standard errors are clustered at the firm level. Panel B shows the regression results of directors' Between-Cluster ratio on the proxies of information asymmetry among insiders. Directors' Between-Cluster ratio is the ratio of cluster trades between directors and executives among directors' trades. 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. We also include firm characteristics related to information structure as independent variables, 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 Quintile is the quintile rank of Amihud (2002). We also control Return (t-12, t) and Log (1+number of insider trades). 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. Directors' cluster trades and committee

	(1)	(2)
Dependent Variable	Cluster Dummy between pair of directors	
Trading Side	Purchases	Sales
Same Committee Dummy	0.00144***	0.000601*
	(5.29)	(1.83)
Constant	0.00282	-0.000140
	(1.46)	(-0.08)
Observations	243122	243122
Adjusted R^2	0.062	0.037
Firm fixed effect	Yes	Yes
Time fixed effect	Yes	Yes

B. Information Asymmetry among Insiders

	(1)	(2)	(3)	(4)	(5)	(6)
Sample	Insider Trading of Directors					
Dependent Variable	Directors' Between-Cluster ratio					
Trading Side	Purchases			Sales		
CEO Centrality	-0.147***		-0.133**	-0.173**		-0.183*
	(-3.16)		(-2.12)	(-1.99)		(-1.72)
Fraction of Non-co-opted		0.0513	0.0554*		-0.236***	-0.234***
Independent Directors		(1.64)	(1.76)		(-4.53)	(-4.51)
Log Size	-0.0515***	-0.0455***	-0.0461***	0.0842***	0.0884***	0.0855***
	(-10.12)	(-7.01)	(-7.04)	(6.13)	(5.59)	(5.40)
Book-to-Market	0.0385***	0.0379**	0.0423**	-0.0940***	-0.107***	-0.107***
	(2.81)	(2.14)	(2.31)	(-4.65)	(-3.30)	(-3.30)
Std. of Return	0.488***	0.656***	0.638***	1.187***	1.052***	0.986***
	(3.81)	(3.76)	(3.62)	(5.23)	(3.63)	(3.39)
R&D dummy	0.0485**	0.0759***	0.0800***	0.0824**	0.0603	0.0532
	(2.36)	(3.09)	(3.22)	(2.34)	(1.38)	(1.22)
Illiquidity Quintile	-0.0335***	-0.0163	-0.0200	0.0363*	0.0389	0.0303
	(-2.92)	(-0.91)	(-1.09)	(1.77)	(1.42)	(1.10)
Return (t-12, t)	-0.0225**	-0.0310**	-0.0272*	0.123***	0.161***	0.167***
	(-2.27)	(-2.10)	(-1.83)	(5.76)	(5.21)	(5.34)
Log (1+number of insider trades)	0.0631***	0.0614***	0.0603***	0.244***	0.204***	0.202***
	(6.80)	(5.28)	(5.16)	(19.58)	(13.90)	(13.59)
Constant	0.320***	0.106	0.157*	-0.671**	-0.825***	-0.695***
	(2.93)	(1.41)	(1.87)	(-2.50)	(-4.30)	(-3.39)
Observations	14424	7633	7525	19796	11611	11498
Adjusted R^2	0.046	0.050	0.050	0.086	0.083	0.083
Industry fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes	Yes	Yes

Table B5: Return of cluster trades and firm characterstics

The table examines determinants of cluster trading returns. It shows the regression results of number of insider trading on the proxies of information asymmetry between insiders and outsiders. The dependent variable is cluster trading return relative to noncluster trading, mean BHAR(0,21) of cluster trading minus mean BHAR(0,21) of noncluster trading at firm-year level. We include firm characteristics 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 Quintile is the quintile rank of Amihud (2002). We also control Return (t-12, t). In addition to these independent variables, we consider the following information production measures: (1) Log(1+ number of financial analysts) and (2) Top 5 institutional ownership. The number of financial analysts is the number of financial analysts who reports forecast of annual earnings in IBES. Top 5 institutional ownership is defined as a ratio of shares of the five institutional investors that have the largest position over shares outstanding. We also include Log(number of business segments) as proxy for decentralized information structure. 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.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent Variable	Mean Cluster BHAR(0,21) - Mean Noncluster BHAR(0,21)							
Trading Side	Purchases				Sales			
Log(1+number of financial analysts)		0.00234		-0.0154*		0.00169		0.00598**
		(0.68)		(-1.66)		(1.04)		(2.17)
Top 5 Institutional ownership			0.0177	0.0142			-0.00300	0.00157
			(1.05)	(0.30)			(-0.38)	(0.12)
Log(number of business segments)				-0.000737				0.00255**
				(-0.12)				(2.39)
Log Size	-0.00189	-0.00245	-0.00189	-0.00702	0.000336	-0.0000899	0.000453	-0.00216*
	(-0.91)	(-1.07)	(-0.90)	(-1.13)	(0.51)	(-0.12)	(0.64)	(-1.79)
Book-to-Market	-0.000405	-0.000510	-0.000176	0.00218	0.000459	0.000453	0.000727	-0.00113
	(-0.14)	(-0.18)	(-0.06)	(0.36)	(0.48)	(0.47)	(0.64)	(-0.60)
Std. of Return	0.120***	0.119***	0.122***	0.119*	-0.0390**	-0.0393**	-0.0326**	-0.0275
	(2.82)	(2.80)	(2.75)	(1.67)	(-2.53)	(-2.54)	(-2.06)	(-1.21)
R&D dummy	-0.00804	-0.00797	-0.00867	0.00224	0.00182	0.00183	0.00144	0.00464
	(-1.18)	(-1.17)	(-1.23)	(0.16)	(0.87)	(0.88)	(0.68)	(1.55)
Illiquidity Quintile	-0.00280	-0.00215	-0.00258	-0.0215**	-0.00263**	-0.00219*	-0.00273**	-0.00138
	(-1.05)	(-0.76)	(-0.92)	(-2.47)	(-2.46)	(-1.85)	(-2.44)	(-0.72)
Return (t-12, t)	-0.00789	-0.00794	-0.00716	-0.0225*	-0.00160	-0.00163	-0.00244	-0.00563
	(-0.64)	(-0.64)	(-0.57)	(-1.78)	(-0.56)	(-0.58)	(-0.85)	(-1.22)
Constant	0.0188	0.0182	0.0152	0.170**	0.0131	0.0127	0.0117	-0.0342
	(0.79)	(0.77)	(0.62)	(2.45)	(1.07)	(1.04)	(0.84)	(-1.54)
Observations	11066	11066	10691	1640	24796	24796	23776	6786
Adjusted R^2	0.004	0.004	0.005	0.009	0.006	0.006	0.006	0.000
Industry fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes