Asian Review of Financial Research Vol. 30 No. 1 (February 2017)

When Does Insider Sales Predict a Crash?

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Abstract

This study documents that predictability of insider trading on future stock price crash varies according to the types of insiders and the timing of the sale. Using insider trading data from Korea between 2005 and 2014, we find that *largest shareholders* tend to sell far before a stock price crash, while *other types of insiders*, including other large shareholders and executives, are more likely to sell immediately prior to a crash. Such pattern is more pronounced in firms with low CSR scores and low R-squares, but not observed among firms with high CSR scores or high R-squares. We also find that our results are stronger amongst firms with higher litigation risk. These findings suggest that largest shareholders may be well aware of the potential legal or reputational risk associated with insider trading while the remaining insiders may be less concerned.

Keywords Insider Trading, Litigation Risk, Crash, Capital Market Act, Korea

Received 31 Oct. 2016
Revised 05 Dec. 2016
Accepted 06 Dec. 2016

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We would like to thank Woosung Kim and other seminar participants at Joint Conference Allied Korea Finance Associations, Chonan, Korea, May 2016, for helpful comments. We are also grateful to the Editor, Joon Chae, and two anonymous reviewers for valuable suggestions. This study was supported by the Institute of Management Research at Seoul National University. Financial support from the Institute of Finance and Banking of Seoul National University is also gratefully acknowledged. This paper is an extension of chapter 3 of Eunyoung Cho's doctoral dissertation at Seoul National University.

I. Introduction

"On April 25, a few days after Ms. Choi and her daughters completed their stock sale, Hanjin Shipping applied for a creditor-led debt restructuring. That was later rejected and the company filed for bankruptcy on Aug. 31" (The Wall Street Journal, September 21, 2016).[1)]

Investors have long been acquiring timely and value-relevant information from the patterns of insider trading. In this insight, a lengthy steam of the prior research has shown evidence that insider trading is informative. For instance, insider purchase portfolios earn above market returns (e.g., Finnerty, 1976). Traditional insider trading literature has mostly asked whether insider *purchases*, rather than *sales*, can predict future returns (Lorie and Niederhoffer, 1968; Jaffe, 1974; Finnerty, 1976; Seyhun, 1986, Lakonishok and Lee, 2001; Jeng, Metrick, and Zeckhauser, 2003, and many others).

Recently, finance literature started studying the pattern of insider trading around extremely bad corporate events, and suggests that insiders' unusual trading, such as sales or silence, has information content and thus predicts bad events (Seyhun and Bradley, 1997; Bagnoli, Kross, and Watts, 2002; Huddart, Ke, and Shi, 2007; Marin and Olivier, 2008; Hanley and Hoberg, 2012; Chen, Martin, and Wang, 2012; Han, Jagannathan, and Krishnamurthy, 2014; Billings and Cedergren, 2015; Gao, Ma, and Ng, 2015). The results of these studies are somewhat inconsistent with the results reported in previous studies that examine purchases during normal times. Some studies argue that insider selling is not informative (Lakonishok

1) Nam, I, S., "As Hanjin Foundered, Its Former Chairwoman Abandoned Shares," The Wall Street Journal (2016, September 21).

and Lee, 2001; Jeng et al., 2003; Fidrmuc, Goergen, and Renneboog, 2006). Studies based on Korean data mostly document that insider trading may predict future abnormal returns (Kang, 1994; Kim, 2000; Lee, 1994; Choi and Kho, 2002; Kim and Shin, 2014), but do not examine how it may predict a crash. A recent study by Kim (2016) argue that manager's opportunistic behavior is positively correlated with the probability of a crash.

In this study, we conjecture that trading patterns of insiders before the extreme event may vary according to the expected degree of legal or reputational risk that each type of insiders face. Specifically, the largest shareholder, who is typically the controlling shareholder and CEO of the company and as such more exposed to the general public and media, may face severe legal or reputational risk once found that she sold her company's stock just before a bad news, as we have pointed out in the aforementioned anecdote. If so, they may 'hide' their sale and make them far before an extreme event. On the other hand, remaining types of insiders such as other major shareholders or executives may perceive much less legal or reputational penalties. If so, they may well sell their company's stock immediately prior to an extremely bad event.

To answer this research questions, we analyze insider trading data in Korea from 2005 to 2014. We document that unusual insider trading patterns predict future stock price crashes, but it varies according to the identity of the insider and the timing of the sale. Specifically, we find that stock sales by largest shareholders in the distant past is positively correlated with the likelihood of a crash, while sales by largest shareholders in the recent past is not significantly associated with the probability of a crash. In a strict contrast, we find that sales by other types of insiders in the distant past are negatively correlated with the likelihood of a crash, while sales in the recent past are positively correlated

with the likelihood of a crash. We find similar results based on Cox proportional hazard model. These results are consistent with our conjecture that largest shareholders may care more about legal and/or reputational risk so that they 'hide' their sales far before the occurrence of a bad event.

Much of previous literature on insider trading around an extremely bad newsdid not distinguish among different types of insiders and how they may choose different points in time to sell their stock when faced with bad information. One exception is Han et al. (2014) who compare CEOs and other insiders. They do find that CEOs' selling has higher predictive power, but still do not find that different types of insiders may choose different points in time to sell. We add to the previous literature by explicitly taking into account that different types of insiders may face varying degrees of reputational or legal risk, which in turn influences them to sell at different points in time.

The rest of the paper is organized as follows. Section 2 describes the data and outlines the research design, and Section 3 presents the empirical results. Section 4 summarizes our main findings and concludes.

Ⅱ. Data and Estimation Specification

1. Data

Our sample is constructed from two data sources. First, Insider transactions data are retrieved from the Data Analysis, Retrieval and Transfer System (hereafter, DART). DART is an electronic disclosure platform, similar to EDGAR in U.S., that allows listed/unlisted firms to submit

disclosures electronically online. DART contains all insider transaction data that are subject to disclosure according to article 436 of the Financial Investment Service and Capital Market Act (FISCMA).[2] Our dataset covers period from 2005 to 2014. During this period, a total of 707,882 transactions by insiders in publicly traded firms in KOSPI and KOSDAQ market were reported. We classify all shareholders who hold more than 10% block holdingsas well as officers-including executives and board members-as insiders in our sample.[3] We also filter out transactions that involve less than 50 shares.

We next merge this insider trading data with stock return, price, trading volume, and other information from FN Guide, a local data vendor. At this stage, we further exclude 1) preferred stocks, 2) penny stocks (less than $1), and 3) stocks with missing monthly returns. We also require stocks to have a complete set of the control variables included in our estimation. The final sample includes a total of 253,310 insiders' transactions from 2005 to 2014. Note that in our regressions we use the most recent one-year's insider transactions, stock returns, and trading volume as independent variables. Since insider transaction data starts at the beginning of 2005, we report results of the regressions from 2006 to 2014.

The descriptive statistics of insider trading activity is presented in <Table 1>. We report the average number of firms with at least one insider trading activity during a given year and their relative proportion

2) Under the FISCMA, major shareholders must file a report on its direct and beneficial shareholdings within 10 days from the date when such investor becomes a corporate insider. Further, officers, major shareholders, and related-partiesmust disclose any subsequent changes in ownership by the 10th day of the month following the change in ownership. "ajor shareholders" are (i) a shareholder or investor who holds a large block of the total is-sued and outstanding stocks or (ii) controlling shareholders who exercises actual influence on the important matters concerning management of the firm. Officers include CEOs, CFOs, other executives, and all members of the board of directors.

3) This cut-off is based on previous studies including Maury and Pajuste (2005), Laeven and Levine (2008) and Faccio and Lang (2002), and many others.

among all publicly-traded firms. Our key variable of interest is INSNET, which represents net insider demand (buy minus sell imbalance as a percentage of the total shares issued) during a given period.[4] We classify all insiders into two disjoint groups: top shareholders and other insiders. Top shareholders include the largest shareholder and their family members. Other insiders include investors that own more than 10% of a firm's outstanding shares, other than the top shareholders, and executives and board members.

The fraction of insider trading firms ranges from 62% to 72% for the top shareholder group and between 22% and 48% for the other insiders group. Insiders' average net buys, or INSNET, are all positive for each year during the whole sample period, indicating that selling occurs less frequently than buying.

<Table 1> Insider Trading Activity

This Table summarizes the statistics of insider trading activity from 2005 to 2014. ALL is the number of firms in the sample, and N is the number of firms with at least one insider trade during each year. Fraction is the relative proportion of firms with at least one insider trade, and INSNET is the average of net insider trade imbalance for each firm calculated at annual frequency (in percentages). There are two mutually-exclusive insider groups: *top* shareholders and *other* insiders. Top shareholders include the largest shareholder and their family members. Other insiders include investors that own more than 10% of a firm's outstanding shares, other than the top shareholders, and executives and board members.

		Top shareholders			Other insiders		
	ALL	N	Fraction	INSNET (%)	N	Fraction	INSNET (%)
2005	1,273	871	0.68	0.64	275	0.22	2.08
2006	1,470	1,026	0.70	2.41	348	0.24	4.47
2007	1,556	1,123	0.72	2.69	442	0.28	3.30
2008	1,551	1,044	0.67	2.49	395	0.25	4.02
2009	1,518	1,003	0.66	1.47	725	0.48	1.39
2010	1,526	983	0.64	1.24	578	0.38	0.56
2011	1,528	1,011	0.66	1.13	562	0.37	1.13
2012	1,555	1,011	0.65	0.99	548	0.35	1.24
2013	1,544	967	0.63	0.88	593	0.38	1.68
2014	1,541	962	0.62	1.13	565	0.37	1.40

4) In <Table 1>, INSNET is calculated at annual frequency. In subsequent regressions, we utilize one-month INSNET as well as 11-months INSNET.

2. Measures of Crash

To capture a stock price crash, we define two event dummy variables, MMCRASH and RAWCRASH, constructed at monthly frequency. MMCRASH is defined as:

$$\text{MMCRASH}_{i,t}=\begin{cases} 1, & if\ r_{i,t}^{MM}-\overline{r_{i,t}^{MM}} < -2\sigma_{i,t}^{MM} \\ 0, & otherwise \end{cases} \quad (1)$$

where $r_{i,t}^{MM} \equiv r_{i,t}-(r_{f,t}+\widehat{\beta_{i,t}}(r_{mkt,t}-r_{f,t}))$, $r_{i,t}$ is the raw return of stock i in month t, $r_{f,t}$ is the risk-free rate, and $\widehat{\beta_{i,t}}$ is the beta of the stock estimated over the previous 60-month. We update beta every month on a rolling basis. $\overline{r_{i,t}^{MM}}$ and $\sigma_{i,t}^{MM}$ represent the sample mean and standard deviation estimated using a 60-month rolling window, respectively.

RAWCRASH is defined as:

$$\text{RAWCRASH}_{i,t}=\begin{cases} 1, & if\ r_{i,t}^{RAW}-\overline{r_{i,t}^{RAW}} < -2\sigma_{i,t}^{RAW} \\ 0, & otherwise \end{cases} \quad (2)$$

where $\overline{r_{i,t}^{RAW}}$ and $\sigma_{i,t}^{RAW}$represent the sample mean and standard deviation estimated using a 60-month rolling window, respectively.

We require each stock to have a minimum of 30 observations within the 60-month window. <Table 2>, Panel A, presents how frequently MMCRASH and RAWCRASH occur in our sample firms. 36.2% of the stocks in our sample experience at least one MMCRASH, and 45.6% experience at least one RAWCRASH during the whole sample period. Panel B of <Table 2>provides the mean and median of raw monthly returns and market-adjusted monthly returns during the crash months and non-crash months. The mean monthly raw return for MMCRASH is

-28.9% while the corresponding number for non-MMCRASH months is 1.64%. Similarly, the mean monthly raw return for RAWCRASH is -32.8%, while the corresponding number for non-RAWCRASH months is 1.80%. These results suggest that our definition of crashes are economically substantial.

<Table 2> Summary Statistics for Crashes

Panel A reports the number of firms that experience different numbers of crashes during the whole sample period. The Table is reported for the following definitions of a crash:

$$\text{MMCRASH}_{i,t} = \begin{cases} 1, & if\ r_{i,t}^{MM} - \overline{r_{i,t}^{MM}} < -2\sigma_{i,t}^{MM} \\ 0, & otherwise \end{cases}$$

$$\text{RAWCRASH}_{i,t} = \begin{cases} 1, & if\ r_{i,t}^{RAW} - \overline{r_{i,t}^{RAW}} < -2\sigma_{i,t}^{RAW} \\ 0, & otherwise \end{cases}$$

where $r_{i,t}^{MM} \equiv r_{i,t} - (r_{f,t} + \widehat{\beta_{i,t}}(r_{mkt,t} - r_{f,t}))$, $r_{i,t}$ is the raw return of stock i in month t, $r_{f,t}$ is the risk-free rate, and $\widehat{\beta_{i,t}}$ is the beta of the stock estimated over a 60-month rolling window. $\overline{r_{i,t}^{g}}$ and $\sigma_{i,t}^{g}$, $g = RAW, MM$ represent the sample mean and standard deviation estimated using a 60-month rolling window. Panel B reports the mean and median of stock returns for crash months and all other months. The first set of columns presents statistics for raw returns. The last set of columns report statistic for market-adjusted returns.

Panel A: Crash Frequency

Frequency of firm-specific crashes	MMCRASH		RAWCRASH	
	N(stocks)	Percent	N(stocks)	Percent
0	1,345	63.8	1,146	54.4
1	503	23.9	522	24.8
2	169	8.0	269	12.8
3	60	2.8	111	5.3
4	18	0.9	42	2.0
≥ 5	12	0.6	17	0.8
Total (#stocks)	2,107		2,107	

Panel B: Return in Crash months versus all other months

		Raw ret		MKT adj.ret	
	N	Mean	Median	Mean	Median
MMCRASH months (1)	1,161	−28.9	−26.4	−28.2	−25.2
RAWCRASH months (2)	1,659	−32.8	−31.2	−24.7	−22.1
All Other Months (NON−(1))	140,489	1.64	−0.25	2.21	0.17
All Other Months (NON−(2))	139,991	1.80	−0.19	2.28	0.21

3. Estimation Specification

Our estimation specification follows Marin and Olivier (2008) who develop a theoretical model for insider trading patterns around crashes. Marin and Olivier (2008) argue that OLS estimation with a binary dependent variable produces heteroskedasticity and autocorrelation. To avoid this econometric issue, we resort to conditional logit with fixed effects (CLFE), as proposed by Chamberlain (1980). This procedure allows one to estimate how characteristics of the dependent variable, rather than the independent variable, might affect the choice. We use both OLS with p-values computed by Newey-West standard errors and conditional logit regression with fixed effects (hereafter, CLFE).

We test our hypothesis using variations of the following specification:

$$\begin{aligned} \mathrm{CRASH}_{i,t} = \alpha_0 + \beta_1 \mathrm{INSNET}^{k}_{i,t-1} + \beta_2 \mathrm{INSNET}^{k}_{i,(t-2,t-12)} + \beta_3 \mathrm{PRE1Yret}_{i,t} \\ + \beta_4 \mathrm{VT}_{i,t-1} + \beta_5 \mathrm{VT}_{i,(t-2,t-12)} + \textit{Fixed effects} + \epsilon_{i,t} \end{aligned} \tag{3}$$

Crash is a dummy variable set equal to one based on either RAWCRASH or MMCRASH for each firm-month observation. $\mathrm{INSNET}^{k}_{i,t-1}$ is the previous month's insider order imbalances for insider type k, while $\mathrm{INSNET}^{k}_{i,(t-2,t-12)}$ is the insider order imbalances from month t-12 to t-2 for insider type k, and k is an index for either the top shareholders, or the remaining other insiders. We also control for recent stock price movement and overall trading activity by including the following variables. $\mathrm{PRE1Yret}_{i,t}$ is the previous one-year excess return over equally-weighted market index for firm i at month t. $\mathrm{VT}_{i,t-1}$is the previous month's turnover (trading volume divided by shares outstanding), while $\mathrm{VT}_{i,(t-2,t-12)}$ is turnover from month t-12 to t-2. We also include firm-year fixed effects.

Ⅲ. Results

1. Main Results

<Table 3> presents the results of binary dependent variable regressions. The results from Panel A of <Table 3> indicate that insider trading is significantly related to the probability of MMCRASH, but the timing of the sell has different effects according to the types of the seller. Specifically, coefficient of $\mathrm{INSNET}_{t-2,t-12}^{top}$ for the top shareholders is negative and significant at the 1% level in models (1) and (2). However, the coefficient of $\mathrm{INSNET}_{t-1}^{top}$ not significant in models (1) and (2). We obtain similar results in Panel B when we use RAWCARSH as our measure of stock crash.

On the other hand, the results for other insiders reported in models (3) and (4) exhibit rather an opposite pattern. Specifically, we find that the coefficient of $\mathrm{INSNET}_{t-1}^{other}$ for other insiders is negative and significant at the 1% level. However, the coefficient of $\mathrm{INSNET}_{t-2,t-12}^{other}$ is positive and significant at the 10% level. In Panel B, we obtain similar results where we replace the dependent variable to RAWCRASH.

Overall, the results in <Table 3> are consistent with the conjecture that the largest shareholders who are more exposed to the media are more concerned about potential legal and reputational risk. Regardless of the estimation specification, a crash is more likely to occur when top shareholders sell their company's stock in the distant past and remain silent just before the crash. Furthermore, a crash is more likely to occur when other insiders sell their stocks immediately prior to the crash. These asymmetric trading patterns of the top shareholders and other insiders are consistent with our conjecture.

<Table 3> Insider order Imbalance and Crashes

This Table represents regression analysis relating stock crashesto past insider trading in KOSPI and KOSDAQ from January 2006 to December 2014. In models(1) and (3), we report OLS regression results with firm and year fixed effects. P-values are computed using Newey-West standard errors to control for autocorrelation and heteroskedasticity. In models (2) and (4), we report results using conditional logit with firm fixed effects (CLFE) including a full set of year dummy variables. The dependent variables $MMCRASH_{i,t}$ and $RAWCRASH_{i,t}$ are as defined in <Table 2>. Panel A reports the results for MMCRASH while Panel B reports those for RAWCRASH. $INSNET^{k}_{t-1}$ is the previous month's insider order imbalances, $INSNET^{k}_{t-2,t-12}$ is insider order imbalances from month t-12 to t-2, k indices either the top shareholders, or other insidersas defined in <Table 1>. PRE1Yret is previous one year's excess returns over the equally weighted market index, VT_{t-1} is the previous month's turnover (trading volume divided by shares outstanding), $VT_{t-2,t-12}$ is the turnover during the period t-12, t-2. ***, **, and * indicate p-values of 1%, 5%, and 10%, respectively.

Panel A: MMCRASH

Estimation Technique:	k = Top shareholders		k = Other insiders	
	(1) OLS	(2) CLFE	(3) OLS	(4) CLFE
$INSNET^{k}_{t-1}$	0.012 (0.530)	1.114 (0.488)	**−0.073** (0.023)	**−7.447** (0.000)
$INSNET^{k}_{t-2,t-12}$	**−0.012** (0.005)	**−1.760** (0.004)	**0.013** (0.039)	**1.191** (0.075)
PRE1Yret	**0.000** (0.000)	**0.831** (0.000)	**0.000** (0.000)	**0.842** (0.000)
VT_{t-1}	**0.002** (0.000)	**0.077** (0.001)	**0.002** (0.000)	**0.074** (0.002)
$VT_{t-2,t-12}$	**−0.001** (0.020)	**−0.075** (0.059)	**−0.001** (0.018)	**−0.083** (0.035)
Firm and Year FE	YES	YES	YES	YES
N	141,640	141,640	141,640	141,640

Panel B: RAWCRASH

Estimation Technique:	k = Top shareholders		k = Other insiders	
	(1) OLS	(2) CLFE	(3) OLS	(4) CLFE
$INSNET^{k}_{t-1}$	−0.027 (0.246)	−1.271 (0.444)	**−0.080** (0.005)	**−6.860** (0.001)
$INSNET^{k}_{t-2,t-12}$	**−0.023** (0.000)	**−1.774** (0.002)	−0.002 (0.802)	0.11 (0.875)
PRE1Yret	**0.004** (0.000)	**0.661** (0.000)	**0.004** (0.000)	**0.679** (0.000)
VT_{t-1}	**0.002** (0.001)	**0.121** (0.000)	**0.002** (0.000)	**0.118** (0.000)
$VT_{t-2,t-12}$	**−0.001** (0.000)	**−0.172** (0.001)	**−0.001** (0.000)	**−0.179** (0.000)
Firm and Year fixed	YES	YES	YES	YES
N	141,640	141,640	141,640	141,640

2. Robustness Test: Excluding Earnings Announcements

One possibility behind our results reported so far is that they may be driven by insiders' trading activity prior to earnings announcements. Previous research documents that firms implement a strict restriction on insiders' trades a few weeks before the earnings announcement (Huddart et al., 2007; Billings and Cedergren, 2015). Second, studies also document a relation between abnormal trading volume and stock return around the earnings announcement (Karpoff, 1986; Kim and Verrecchia, 1994; Frazzini and Lamont, 2007). To test whether our results are mainly driven by earnings announcement effects, we exclude those firm-months observations during which earnings announcements are released.

In unreported tables, we repeat the regressions in <Table 3> after excluding earnings announcement months. We find that the results are qualitatively similar to those reported in <Table 3>. For example, the top shareholders'sales in the distant past are positively correlated with the probability of a stock crash, while other insiders' sales in the recent past are positively correlated with the probability of a large price drop. Overall, pattern reported for the full sample seems to hold even after excluding earnings announcement months.

We also repeat the analysis using only those firm-months where earnings announcements are made. Since many firms restrict insiders from trading their company's stocks around the earnings announcements, trading patterns of insiders around earnings announcements should not predict stock price crash. Consistent with this conjecture, most of the insider trading coefficients are statistically insignificant during earnings announcement periods.

3. Subsample Analysis: Corporate Social Responsibility and Private Information

To provide further evidence on the relationship between the timing of insider sales and crashes, we consider two sets of subsample analysis. Subsamples are created by potential level of transparency or degree of information asymmetry. Specifically, we resort to an index of corporate social responsibility (hear after, CSR) and R-square from time-series regressions as a measure of transparency or information environment. Prior studies document that R-square is related with the degree of firm-specific information environment. For example, Morck, Yeung, and Yu (2000) provide evidence that R-square is an inverse measure of stock price informativeness. We first divide our sample into three groups according to the R-square values,[5] and report the results for low R-square (below 33%) firms and High (above 66%) R-square firms in Panel A of <Table 4>.

The results indicate that predictability of insider trading as reported in our main analysis only holds in firms with low R-square values and is not observed among firms with high R-square values. This suggests that insider trading predicts crashes only in firms with relatively more firm-specific information or more information asymmetry.

In Panel B of <Table 4>, we classify all firms into two groups based on a CSR score compiled by Citizens'Coalition for Economic Justice, a local civil organization, at the end of each year. Their index consists of six dimensions: fairness integrity consumer protection; social contribution environment protection, employee satisfaction. High CSR score firms are those that are in the top 100, and all other firms are assigned to the low CSR score firms.

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5) We estimate R-square using weekly data following the method of by Teoh, Yang, and Zhang (2006), Jin and Myers (2006), and Stowe and Xing (2001).

<Table 4> Additional Tests

This Table repeats the main analysis in 〈Table 3〉 for different subsamples. In Panel A, we divide the sample into three groups according to each stock's time-series R-square values, and run the regressions for Low R-square firms (below 33%) and High R-square firms (above 66%). In panel B, we split our sample into high CSR firms and low CSR firms based on a corporate social responsibility index provided by a local civil organization. The dependent variable is MMCRASH as defined in 〈Table 2〉. ***, **, and * indicate p-values of 1%, 5%, and 10%, respectively.

Panel A: R-square

	LOW R-square				HIGH R-square			
Estimation Technique	Top shareholders		Other insiders		Top shareholders		Other insiders	
	(1) OLS	(2) CLFE	(3) OLS	(4) CLFE	(5) OLS	(6) CLFE	(7) OLS	(8) CLFE
$INSNET^{k}_{t-1}$	0.009 (0.781)	1.067 (0.693)	**-0.112**** (0.032)	**-6.715**** (0.012)	-0.005 (0.909)	0.295 (0.940)	0.008 (0.885)	-1.556 (0.742)
$INSNET^{k}_{t-2,t-12}$	**-0.015*** (0.078)	**-1.997**** (0.049)	0.014 (0.207)	**2.398**** (0.029)	-0.008 (0.273)	-2.054 (0.149)	0.006 (0.537)	0.174 (0.901)
Controls	YES	YES	YES	YES	YES	YES	YES	YES
Firm and Year fixed	YES	YES	YES	YES	YES	YES	YES	YES
N. Obs.	40,399	40,399	40,399	40,399	47,314	47,314	47,314	47,314

Panel B: CSR

	CSR100				NON-CSR100			
	Top shareholders		Other insiders		Top shareholders		Other insiders	
Estimation Technique:	(1) OLS	(2) CLFE	(3) OLS	(4) CLFE	(5) OLS	(6) CLFE	(7) OLS	(8) CLFE
$INSNET^{k}_{t-1}$	-0.049 (0.642)	-6.953 (0.303)	-0.147 (0.180)	-9.361 (0.376)	0.007 (0.708)	0.586 (0.756)	**-0.069**** (0.036)	**-7.305***** (0.001)
$INSNET^{k}_{t-2,t-12}$	0.01 (0.709)	-0.861 (0.746)	**0.087**** (0.027)	3.179 (0.120)	**-0.011**** (0.012)	**-1.328**** (0.033)	0.008 (0.188)	0.790 (0.277)
Controls	YES	YES	YES	YES	YES	YES	YES	YES
Firm and Year fixed	YES	YES	YES	YES	YES	YES	YES	YES
N. Obs.	19,486	19,486	19,486	19,486	122,154	122,154	122,154	122,154

Similar to the results reported in Panel A of <Table 4>, we only observe a distinct pattern consistent with the main results among low CSR score firms. Again, this finding suggests that predictability of insider trading on future crashes is more pronounced among firms that are less transparent.

4. Duration Analysis

A possible empirical extension of our previous analysis is to examine the duration until a crash occurs and compare the time between different types of insider sales.[6] We report the results of duration analysis in <Table 5>. Panel A provides the raw distribution of the time between an insider sale and a subsequent crash. We define an insider sale event as those firm-months where insiders'net buys (or sales) are more than two standard deviations away from the sample period mean. Insider sale events are identified separately for top shareholders and other insiders. We consider up to 24 months subsequent to an insider sale, and the reported numbers are cumulative frequencies of firms that exhibit a crash within each specified.

Panel A suggests that the percentage of firms that experience a faster crash is higher following other insiders' sales than top shareholders' sales. For example, in columns one and two, the proportion of stocks that experience a crash within 3 months of top shareholder's sale is 16.3%, while the corresponding proportion for other insiders' sales is 20.1%. We observe a stronger contrast between the two groups in columns three and four. These findings are consistent with our earlier results that crashes tend to occur far after top shareholders' sales, but immediately after other insiders' sales. We also note that the discrepancy in cumulative frequency gradually converges over time.

6) We would like to thank an anonymous referee for pointing this out.

Panel B presents the estimated parameters for the Coxproportional hazard model. In the this framework, a negative (positive) coefficient on the independent variable implies that higher values of the predictors are associated with lower (increased) risk and longer (shorter) survival times. The first two columns of Panel B, denoted as (1), presents estimated results conditional on insider sales as defined in Panel A, where betas are coefficients for a dummy variable representing top shareholders sales (as opposed to other insiders'sales). As in Panel A, insider sales are identified based on both net buys (in column one) and sales (in column two).

The results indicate that estimated coefficients are negative (and significant in column two) and hazard ratios are less than 1. This result implies that top shareholders' sales are associated with lower risk and longer survival times than sales by other insiders. This is consistent with our earlier results that top shareholders' sales are associated with a crash in a more distant future compared to other insiders' sales.

In the remaining columns we utilize the full sample, where betas are coefficients for dummy variables representing insider sales during given period. Specifically, the dummy equals one if insiders' net buys for each period (t-1 or from t-2 to t-12 months) is below the median, and zero otherwise. In columns three and four, denoted as (2), insiders sales include only those by top shareholders, and in columns five and six, denoted as (3), only those by other insiders.

The results from columns three and four of Panel B indicate that coefficient estimate is insignificantly negative for top shareholders' sales in the past month (t-1), while it is significantly positive for their sales during the previous one year, excluding past one month (t-2, t-12). On the other hand, in columns five and six of Panel B where sales reflect those by other insiders, coefficient estimate is significantly positive in the past month (t-1), while it is significantly negative during the previous one year,

<Table 5> Duration Analysis

This table represents the results of duration analysis. We define failure event as MMCRASH (eq. (1)). Panel A provides the raw distribution of the time between an insider sale to a crash. Panel A shows the distribution of the period from insider trading shock to stock price crash. We define an insider sale event as those firm-months where insiders' net buys (or sales) are more than two standard deviations away from the sample period mean. We consider up to 24 months subsequent to an insider sale, and the reported numbers are cumulative frequencies of firms that exhibit a crash within each specified. Panel B presents the estimated parameters for the Cox proportional hazard model. The first two columns of Panel B, denoted as (1), presents estimated results conditional on insider sales as defined in Panel A, where betas are coefficients for a dummy variable representing top shareholders sales (as opposed to other insiders' sales). As in Panel A, insider sales are identified based on net buy (in column one) and sales (in column two). In the remaining columns we utilize the full sample, where betas are coefficients for dummy variables representing insider sales during given period. The dummy equals one if insiders' net buys for each period is below the median, and zero otherwise. In columns three and four, denoted as (2), insiders sales include only those by top shareholders, and in columns five and six, only those by other insiders.

Panel A: Cumulative Proportion

Duration	$Netbuy_{i,t} - \overline{Netbuy_{i,t}} < -2\sigma(netbuy)_{i,t}$		$Sales_{i,t} - \overline{Sales_{i,t}} > 2\sigma(sales)_{i,t}$	
	Top Shareholders	Other insiders	Top Shareholders	Other insiders
[0, 3]	0.163	0.201	0.186	0.270
[0, 6]	0.280	0.270	0.309	0.362
[0, 9]	0.342	0.345	0.369	0.456
[0, 12]	0.401	0.397	0.446	0.503
[0, 15]	0.463	0.448	0.512	0.538
[0, 18]	0.531	0.477	0.578	0.588
[0, 21]	0.593	0.546	0.629	0.648
[0, 24]	0.655	0.575	0.682	0.686

Panel B: Cox Proportional Hazard Model

	(1) Insider sales		(2) Top shareholders		(3) Other insiders	
	Net buy	Sale	Trading (t-1)	Trading (t-2, t-12)	Trading (t-1)	Trading (t-2, t-12)
Beta	-0.099	-0.145	-0.110	0.200	0.537	-0.251
Stderr	0.095	0.073	0.094	0.066	0.101	0.061
p-value	0.297	0.046	0.244	0.003	0.000	0.000
Hazard ratio	0.906	0.865	0.896	1.221	1.711	0.778
Total obs	2,623	5,508	3,981	3,981	3,981	3,981
Total Failed	481	787	1,161	1,161	1,161	1,161
Total censored	2,142	4,721	2,820	2,820	2,820	2,820
% of censored	81.66	85.71	70.84	70.84	70.84	70.84
Start time	insider sales event		first available date			

excluding past one month (t-2. t-12). These results clearly indicate that sales by top shareholders in the distant past or sales by other insiders in the recent past increase the likelihood of a crash, consistent with our main findings.

Ⅳ. Conclusion

In this paper, we examine trading patterns of different types of insiders prior a large price drop. We conjecture that concerns with respect to legal and/or reputational risk may be more severe for largest shareholders and their family members, compared to other types of insiders, who may try to 'hide' their sales well before a bad event actually occurs. We find that largest shareholders and their family members selling in the distant past and remaining silent in the recent past increases the likelihood of stock price crash. To the contrary, for other insiders, including executives, board members, and other major shareholders, selling in the recent past increases the likelihood of stock price crash. Moreover, these results remain valid after excluding earnings announcements. Similar results are found in a duration analysis framework. Cross-sectionally, we find that such pattern is more pronounced in firms with low CSR scores and low R-square values, but not observed among firms with high CSR scores or high R-squares.

Our work is an extension of previous studies exploring the effect of various dimensions of insider trading patterns future stock returns. We contribute to the literature by suggesting that different incentives of different types of insiders may influence them to strategically choose when to divest their stock.

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