Mutual Funds' Investment Horizon and Destabilizing Behavior [1]

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Abstract

We use a novel strategy to study the consequences of short investment horizon on institutional trading behavior and stock price inefficiency. Building on the previous literature that mutual funds' holdings disclosure is important for fund managers and their investors, we show that during a stock crash, mutual funds whose next mandatory SEC-required reporting dates are closer, identified with shorter investment horizon, are more likely to divest from the stock. To rule out the possibility of funds selling and then buying the crash stock again, we leverage a comprehensive dataset from Thomson Reuters, which incorporates both public mandatory reports and non-public voluntary reports, allowing us to compare positions of funds with different upcoming mandatory reporting dates promptly following the stock crashes. We further examine the consequences of this short-termism induced by mandatory disclosures on stock prices. We find that stocks held mostly by "short-term" funds, at the time of crash, experience a larger drop and a subsequent reversal. Our results shed light on how an exogenously extracted variation in investment horizon, associated with mandatory reporting, induces destabilizing behavior following crashes.

Keywords: Investment Horizon, Mutual Funds, Portfolio Disclosure

JEL Classification: G10, G12, G23

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1 Introduction

Do short-horizon investors sell more aggressively in response to a negative shock to stock prices? Does short-term trading behavior of these investors affect the efficiency of stock prices and destabilize markets? The evidence in the literature seems mixed; on the one hand, there is evidence that short-horizon investors tend to myopically price firms, overweighting short-term earnings potential and underweighting long-term earnings potential, and sell their holdings to a larger extent in response to a negative shock (Bushee 1998; Bushee 2001; Cella, Ellul, and Giannetti 2013). On the other hand, several studies find that investors, and in particular, institutional investors with short-term trading strategies promote price efficiency (Collins, Gong, and Hribar 2003; Ke and Ramalingegowda, 2005; Boehmer and Kelley, 2009).

A key challenge in studying the causal effect of investment horizon on trading behavior and market stability is identifying investment horizon. A number of studies use categories of institutional investors as proxies for investment horizon, with pension funds representing long-horizon investors, whereas mutual funds and hedge funds being classified as short-term investors (Cella, Ellul, and Giannetti 2013; Callen and Fang 2013). Despite the intuitive appeal of institutional investor type as a proxy for investment horizon, other notable differences between different categories of institutional investors exist, which makes causal inference challenging (Nohel, Wang, and Zheng 2010; Wermers 2011). Furthermore, there is considerable heterogeneity in terms of investment strategies and liquidity within each investor category. For example, hedge funds tend to invest in a wide range of strategies (Fung and Hsieh 2001; 2004), and active mutual funds differ significantly in their investment behavior from passive funds (Hsieh, Li, and Tang 2021).

Other studies employ portfolio turnover or churn ratio as a proxy for investment horizon. Examples include Cella, Ellul, and Giannetti (2013) who focus on institutional investors' response to market crashes and use portfolio turnover as a proxy for investor horizon. Other studies using turnover include Gaspar, Massa, and Matos (2005) and Gaspar et al. (2013), among others. While portfolio turnover can be argued to be related to investment horizon, several criticisms have been raised regarding its effectiveness as a reliable proxy for investment horizon. First, investment horizon is not the only factor affecting portfolio turnover; "Because the portfolio turnover ratio can only indirectly signal time horizons, the approach is incapable of digesting turnover drivers by net fund flows and pricing dilution to compare it with strategy-motivated transactions" (Tucker

2018; p. 593). Furthermore, high-turnover investors tend to be those that are better informed about firms' fundamental value, which is why they engage in short-term trading in the first place (Yan and Zhang 2009). This implies that also other factors than investment horizon affect portfolio turnover, including fund flows and the extent to which investors are informed about the fundamental asset values.

Funds also do not necessarily have a uniform approach to turnover across their entire portfolio; many funds tend to employ a core-satellite approach to investing, where the core part of their portfolio is relatively stable, while the satellite portion is actively traded (Amenc, Malaise, and Martellini 2004). Finally, funds typically report the portfolio turnover ratio (PTR) as the lesser of purchases or sales excluding round trip trades that occur in the same measurement period (Champagne, Karoui, and Patel 2018; Tucker 2018). This distorts the measure as a proxy of investment horizon, as funds may frequently engage in trading activities such as round-trip transactions that are not observable by outsiders (Kacperczyk, Sialm, and Zheng 2008).

This study aims to introduce a novel strategy for addressing the difficulty of identifying the impact of investment horizon on investment behavior. The focus will be specifically on a particular group of institutional investors, namely mutual funds. In particular, we identify the effect of investment horizon on mutual fund behavior by exploiting the differences in their distance to the next mandatory reporting date (defined as reporting dates, unless specified otherwise) across funds holding the same stock. The validity of our identification strategy hinges on the assumption that mutual fund holding disclosure matters to investors and as a result, funds try to avoid disclosing holdings with bad recent performance by selling those holdings prior to their upcoming reporting date. Numerous studies provide evidence that institutional investors, and in particular, mutual funds engage in "window dressing" closely before reporting dates by selling losers and adding winners to their portfolios (Agarwal, Gay, and Ling 2014; Lakonishok et al. 1991; Oritz, Sarto, and Vicente 2012). Other studies provide evidence that investors indeed pay attention to fund holdings disclosure and use it to assess fund manager investment skills or copycat their trading strategies (Solomon, Soltes, and Sosyura 2014; Verbeek and Wang 2013). Therefore, funds care for the returns of portfolio stocks by the next reporting date and the distance until the next reporting date has a positive impact on the holding horizon for stocks.

At the time of a stock crash, funds holding the crash stock will have different reporting dates on which they are regulated to disclose their holdings. Variations in the forthcoming mandatory reporting dates arise from differences in funds' reporting schedules, typically tied to their fiscal years established at inception. These scheduling differences are likely unrelated to their holdings and occurrences of stock market crashes. This implies that differences in distance-to-the-next-reporting-date cause exogenous variation in funds' investment horizons at the time of a stock crash, enabling us to identify the effect of investment horizon on investment behavior.

A number of theoretical papers suggest that short-horizon investors tend to focus more on predicting the short-run trades of other market participants, rather than long-run movements in asset values driven by fundamentals (Allen, Morris, and Shin 2006; Dow and Gorton 1994; Froot, Scharfstein, and Stein 1992; Stein 2005). Our hypothesis posits that funds with short terms until next reporting dates are less likely to witness a rise in stock prices and will conduct "window dressing" before their next reporting date due to the shorter time interval. This probably holds true even if the stock is undervalued. Fearing to sell the stock at a lower price, funds tend to sell it promptly at the crash time. In contrast, funds with more distant reporting dates are likely to perceive a higher probability of a stock rebound. Consequently, they are less inclined to sell these stocks before their reporting date and thus less motivated to sell at the crash time.

We first compare funds' behavior as a function of their investment horizon in response to a large idiosyncratic shock to a stock price. To maximize variation in the investment horizon, we primarily focus on the period before May 2004 when the SEC regulation increased the reporting frequency of portfolio holdings by mutual funds from semiannual to quarterly. Next, we explore the effect of short-horizon behavior on price efficiency. We distinguish between stocks primarily held by funds with short distance-to-reporting-date and funds with long distance-to-reporting-date and compare their abnormal returns at the crash time. We additionally conduct an event study to compare the cumulative abnormal average returns during the period surrounding crashes of stocks with highest and lowest short-horizon mutual fund ownership.

A key challenge in our identification strategy is the unobserved behavior of funds between reporting dates (Kacperczyk, Sialm, and Zheng 2008). Specifically, in the event of a stock market crash, for funds with an upcoming reporting date in close proximity, the data available from their previous reporting date—used to assess their pre-crash holdings—might extend back up to 6

months. This suggests the potential for changes in the fund's stock holdings between the prior reporting date and the occurrence of the crash. Conversely, for funds whose prior reporting date is immediately before the crash, their upcoming mandatory reporting date is approximately 6 months after the crash, and we will not be able to observe their trading behavior between the crash time and their next reporting date. This introduces a potential scenario where the fund may have sold the stock affected by the crash after the event but subsequently repurchased it during a recovery in the stock price.

To address this challenge, we utilize a unique feature of the Thomson Mutual Fund Holdings database, where some funds provide voluntary reports in addition to their mandatory reports to the database. These voluntary reports are not disclosed on EDGAR, but rather are reported directly to the database. More specifically, for mutual funds whose fiscal year-ends do not align with the calendar quarter-ends, many of them report portfolio holdings to Thomson on non-SEC-mandated calendar quarter-end months. This practice is likely driven by the convenience of simultaneously reporting holdings for all funds within the same fund family (Schwarz and Potter, 2016). We leverage these voluntary reports which are not available to the public for free, to fully observe holdings adjustment right at the crash time for funds with varying identified investment horizons. It's important to acknowledge that while voluntary reports are not freely available to the public, they may still be accessible to certain institutional capital providers. If fund managers are aware of these reports, it could influence trading behaviors, similar to mandatory reports, potentially leading to an underestimation of the impact of investment horizon on funds' trading behavior. Given this premise, the real-world impact of investment horizon variation resulting from different mandatory reporting dates may be more substantial than what is detected in this paper.

The empirical results provide considerable support for the effectiveness of the exogenous identification strategy of investment horizon and offer reliable evidence for the adverse impact of short-horizon mutual funds on the stock price efficiency during a particular crash. We find that mutual funds with short investment horizon, as identified by short distance to the upcoming mandatory reporting date, exhibit a higher likelihood of reducing or completely liquidating the positions of the crash stock shares following the crash. Short-horizon mutual funds also sell a larger proportion of their initial holdings in the crash stock. The uninformative selling of short-horizon mutual funds leads to further price decline following the crash. Stocks primarily held by short-horizon mutual funds experience lower abnormal return during the crash month, with the

ownership of mutual funds with zero distance to the next mandatory reporting date exerting the most pronounced effect. Finally, our event study on stock performance surrounding market crashes indicates that stocks with the highest ownership by short-horizon mutual funds, identified by zero distance to the upcoming mandatory reporting date, undergo a more significant price reversal after the crash. This underscores that the observed price inefficiency is more significant for stocks with greater short-horizon mutual fund ownership.

Our main contribution is to exploit mutual funds' variation in distance to reporting date following a stock crash as a plausible source of exogenous variation in investment horizon. The study that comes closest to ours is Dimmock et al. (2018) who use differences in mutual funds' accrued capital gains and investors' tax-sensitivity as a source of exogenous variation in funds' investment horizon and hence, their choice of exit or voting in the context of proxy votes. Our study introduces a different proxy for investment horizon, namely distance to next reporting date, and explores its impact on mutual fund trading behavior. Another related study is Bourveau et al. (2022) who examine the effect of the 2004 SEC regulation for mutual funds' quarterly disclosure on firms' repurchases and short-term behavior. While their focus is on exploring the change in funds' horizon following the regulatory change using a difference-in-differences approach, our focus is on the variation in investment horizon within mutual funds holding the same stock at the same time.

Another distinguishing feature of our study is that the existing literature has largely ignored variation in investment horizon over time and focused on cross-sectional differences in investment horizon (see e.g. Cella et al. 2013). Our paper recognizes the potential for a shifting investment horizon over time due to the variation in time to the upcoming reporting date of the funds.

Our paper is also broadly related to the recent debate on investor short-termism and its impact on firms' behavior. Some scholars and industry leaders argue that institutional investors' narrow focus on quarterly results force corporate managers toward corporate actions with near-term benefits, sacrificing long-term value (Dallas 2011; Dimon and Buffett 2018; Davies et al. 2014; Bourveau et al. 2022). Others maintain that in competitive markets, long-term beneficial actions tend to be reflected in current prices and short-term investors tend to make prices more efficient (Dent 2010; Yan and Zhang, 2009).

The rest of the paper is organized as follows. In Section 2, we provide a survey of related literature. Section 3 describes the data we use and the way to construct samples. Section 4 lays out our empirical model and in Section 5 we present our estimation results. Section 6 concludes.

2 Related Literature and Hypotheses

Institutional investors are dominant stock traders and have a pronounced impact on stock price efficiency (Boehmer and Kelley, 2009). A difference in their investment horizon leads to a different trading decision and thus affects stock prices. A number of studies have provided theoretical evidence that traders with short trading horizons contribute to price inefficiency (Dow and Gorton, 1994; Allen et.al, 2006). This is because short-horizon traders base their actions on their anticipation of price changes in the near future, which is restricted to the actions of other market participants. Thus, during market turmoil, short-horizon investors, identified as speculators, react to declining asset prices by liquidating their holdings (Maggio, 2016).

However, there has been a persistent debate in empirical studies as to whether the short investment horizon of institutional investors increase or decrease price efficiency. On the one hand, short-horizon institutions seem to be overconfident and more behaviorally minded, with stronger momentum returns and subsequent returns reversal among stocks largely held by short-term institutional investors (Cremers and Pareek, 2015). Considering the monitoring function of long-term institutional investors, as discussed by Attig et al. (2013), greater stability in institutional ownership reduces the likelihood of stock crashes by mitigating the tendency to withhold negative news (Callen and Fang, 2013). During periods of market turmoil, short-horizon institutional investors sell more than long-horizon investors and thus amplify market-wide crashes (Cella et.al, 2013).

Conversely, Yan and Zhang (2009) affirm the role of short-term institutions in promoting market efficiency, attributing this to their superior information and active trading to capitalize on their informational advantage. The divergence of findings about the impact of investment horizon on institutional investors' trading behavior may come from the endogeneity of the proxy measurement. Most previous studies proxy investment horizon with portfolio turnover. The rationale behind the usage of turnover is that investors with a shorter investment horizon may trade more frequently. However, other factors also affect portfolio turnover. For example, information advantage and behavioral tendencies both lead to high portfolio turnover. However, the short-

concentrated institutions, characterized by information advantage, exhibit significant return predictability while the short-diversified institutions prefer stocks with positive price momentum. (Kim et.al, 2021). As the price of stocks in the near future is primarily determined by the expectations of the whole market rather than the intrinsic value of the firm itself, short-horizon institutional investors may divest from securities that they anticipate will underperform in the near future to those with favorable expectations. Consequently, short-horizon investors tend to frequently adjust the holdings in their portfolio, resulting in a high portfolio turnover. It is important to note that the observed high portfolio turnover is a characteristic of short-horizon investors, rather than an equivalent identification.

In theoretical models, investment horizon refers to a predetermined duration within which investors plan to engage in trading a security, aiming to maximize their gains from the trades. However, in reality, the investment horizon is endogenous and influenced by various factors. First, the way in which flows respond to performance can have a significant effect on an institutional investor's investment horizon if they need to prevent withdrawals due to short-run underperformance (Stein, 2005). Second, investment strategies adopted by institutional investors to generate returns may also help to determine investment horizon. Momentum strategies, for instance, aim to produce strong risk-adjusted returns over periods as short as four months while value strategies focus on risk-adjusted gains over horizons of more than a year (Vayanos and Woolley, 2011). Third, compensation based on short-term performance force institutional investor managers to pursue short-term satisfying performance (Wagner, 2012). Further, a short managerial tenure also induces fund managers to focus on short-term returns (Goldman and Slezak, 2003).

Among the numerous factors influencing the investment horizon of institutional investors, a well-explored aspect is the consideration of career concerns under portfolio disclosure regulations. This applies especially to mutual funds and investment companies serving as agents acting on behalf of their principals. Prat (2005) offers fundamental theoretical insight suggesting that career-oriented agents, aware that their actions are being observed, are motivated to exhibit conformist behavior. In a situation of information asymmetry, agents lack credible commitment to communicate their ability and private information quality, so principal investors primarily rely on information about the agents' actions and their consequences. Hence, agents are incentivized to serve their principals by aligning their actions with the expectations of being "good" agents. As a

result, the likelihood rises that an agent may choose to abstain from investing securities in the face of a short-term decline, despite the potential for long-term returns based on private signals.

Hermalin and Weisbach (2012) also develop a principal-agent model and demonstrate that increased regulated reporting frequency heightens the agent's short-term performance focus to avoid termination. Empirically, the widespread observation of window dressing serves as evidence that institutional equity fund managers are mindful of the portfolio information they are obligated to reveal to investors (He et.al, 2004; Gormley et.al, 2018; Lakonishok et.al, 1991; O'Neal 2001; Meier and Schaumburg, 2004), especially for mutual funds with poor past performance before public disclosure date (Agarwal et.al, 2014). Window dressing is a behavior stimulated by career concerns and emerges in response to mandatory portfolio disclosure. Shortly before the mandated public disclosure dates, mutual funds strategically adjust their portfolios by consistently purchasing stocks that have performed well or selling those that have fared poorly, aiming to conceal mistakes or portray seemingly shrewd selections. Thus, for a particular portfolio stock, career concerns force mutual fund managers to care about their performance until the upcoming mandatory disclosing date. The shorter the distance to upcoming mandatory reporting date is, the shorter the relative investment horizon of a mutual fund would be.

At the same time, mutual fund investors in a specific shock, with differing time gaps to upcoming mandatory portfolio reporting dates, focus on stock performance over distinct horizons, contributing to a diversity of investment horizons. The Investment Company Act of 1940 mandates mutual funds to publicly disclose all portfolio positions on reporting dates aligned with fiscal year-ends. Considering that fiscal year-ends are typically regarded as externally predetermined, it is plausible to view the random disparities across mutual funds holding the same stock at the same time in distances to subsequent mandatory reporting dates as a source of exogenous variation in investment horizons. This study examines how exogenously identified investment horizons influence the immediate trading behavior of mutual funds when an idiosyncratic shock unexpectedly affects a specific stock.

In the event of an idiosyncratic shock affecting a particular stock within a mutual fund's portfolio, a short temporal distance from the shock to the mutual fund's next mandatory reporting date implies a relatively brief investment period. The mutual fund manager is attentive to the expected return of the stock suffering a shock until the upcoming mandatory reporting date and

would liquidate the holdings if the stock underperforms, to avoid sending a negative signal about the manager's skill. If the stock depreciates further by the impending obligatory reporting date, the mutual fund manager would be better off choosing to sell the stock promptly. Otherwise, the fund manager may have to sell it at a lower price to avoid reporting the holding of the "loser" stock on the regulated portfolio disclosure date, thereby preventing the transmission of a negative signal about his management ability. If the stock price reverses by the next mandatory reporting date, even if only slightly, the fund manager would not need to sell the stock immediately when the shock occurs, as he can wait for a suitable price to trade, even if their intention is to sell it for window dressing in the report. In the short term, the stock price is less likely to recover and may even experience a further decline due to selling by other market participants. Consequently, the optimal decision for the mutual fund manager is to liquidate the position of this stock at crash promptly.

Conversely, with a long distance to the mutual fund's next mandatory reporting date, the mutual fund operates under a relatively extended investment period. In this scenario, there is a higher chance for the price of the stock affected by the crash to rebound by the next mandatory reporting date, allowing the mutual fund manager to wait until the stock has weathered the storm. Therefore, there is no urgent need for the mutual fund manager to liquidate its position in the crash stock right at the incident. We arrive at the following hypothesis:

H1: When a stock crashes, mutual funds with a shorter investment horizon, as measured by the distance to their next reporting date, would be more likely to sell and sell a greater quantity of the stock shares.

Due to the increased incentive for mutual funds with shorter investment horizons to promptly liquidate their holdings of a particular stock following a crash, their selling activity could exert additional pressure on the stock's price. Should mutual funds with shorter investment horizons hold a significant ownership stake in the crash stock, it could result in heightened selling pressure, causing a more pronounced decline in its price during the crash period.The selling behavior of mutual funds with short investment horizons might even exacerbate stock crashes. The relatively short investment horizon caused by obligatory portfolio disclosure has a negative impact on price efficiency. This insight is encapsulated in our second hypothesis:

H2: Crash stocks with higher short-horizon mutual fund ownership experience larger price decline.

Since the selling actions of short-horizon mutual funds in response to an unforeseen stock crash stem from career concerns rather than changes in company-level fundamental value, the trading activity becomes less informative. Stocks predominantly held by short-horizon mutual funds during a market crash may witness their prices driven below their justifiable intrinsic value. Subsequent to the crash, these stocks may experience a more significant price reversal. Consequently, our third hypothesis is articulated as follows:

H3: Crash stocks with higher short-horizon mutual fund ownership experience larger price reversal after the crash.

3 Data and Sample Construction

3.1 Disclosure rules for mutual funds

Under the Investment Company Act of 1940, a mutual fund is required to report all its portfolio positions to both the SEC and individual fund shareholders at reporting dates that coincide with its fiscal year-end. The mandatory portfolio disclosures occurred in the semi-annual SEC Form N-30D[2] before May 2004. After that time, Form N-Q was additionally required for quarterly holdings disclosures. These disclosures must be mailed to the SEC and shareholders within sixty days after the reporting date.

The 1934 Securities Act stipulates that investment companies, holding over $100 million in 13(f) securities, are required to submit the SEC Form 13F. This form discloses holdings at the management company level, which means the reported holdings is the aggregate number from all mutual fund portfolios belonging to the management company. More importantly, Form 13F reports holding information as of each calendar quarter-end and must be filed within forty-five days after the reporting date.

3.2 Thomson Mutual Fund Holdings Database

We focus on mutual funds within the United States and gather mutual fund holdings data from the Thomson Mutual Fund Holdings database, i.e. the Thomson s12 datafile. The Thomson Mutual

[2] Form N-CSR replaced Form N-30D starting in 2003.

Fund Holdings database (Thomson hereafter) contains mandatory portfolio disclosures by the 1940 Investment Company Act, as well as voluntary portfolio disclosures. In particular, 98% of portfolios reported to Thomson are either on SEC-mandated months or voluntary disclosures on calendar quarter-end months (Schwarz and Potter, 2016). Many mutual funds whose fiscal year-ends do not align with the calendar quarter-ends report portfolio holdings to Thomson on non-SEC-mandated calendar quarter-end months. This is likely motivated by convenience (Schwarz and Potter, 2016). **Fig.1** provides detailed information about the monthly distribution of mandatory and voluntary fund portfolio reports of domestic equity mutual funds accessible via Thomson from 1997 to 2003. It delineates a pronounced concentration of reports accessible in Thomson, with a predominant presence of mandatory reports or voluntary reports in calendar quarter-end months. Meanwhile, it shows that a substantial portion of voluntary reports are disseminated specifically within these calendar quarter-end months. These features of mutual fund portfolio reports in Thomson are consistent with the findings of Schwarz and Potter (2016).

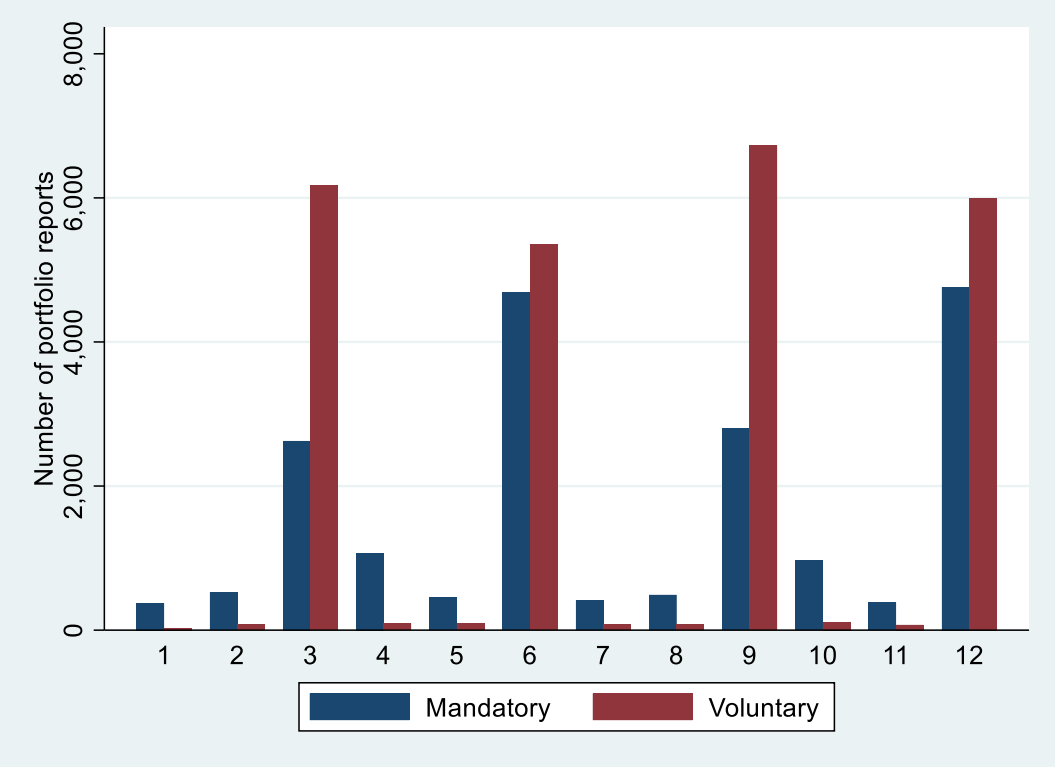

Fig.1. Monthly distribution of mandatory and voluntary portfolio reports in Thomson Reuters

Notes: This figure exclusively focuses on domestic equity funds during the period 1997 to 2003. Mandatory portfolio reports, mandated by the SEC, are released semi-annually aligning with funds' fiscal years. Meanwhile, voluntary portfolio reports, not mandated by the SEC, can be provided in any month, excluding the middle and end of fiscal years.

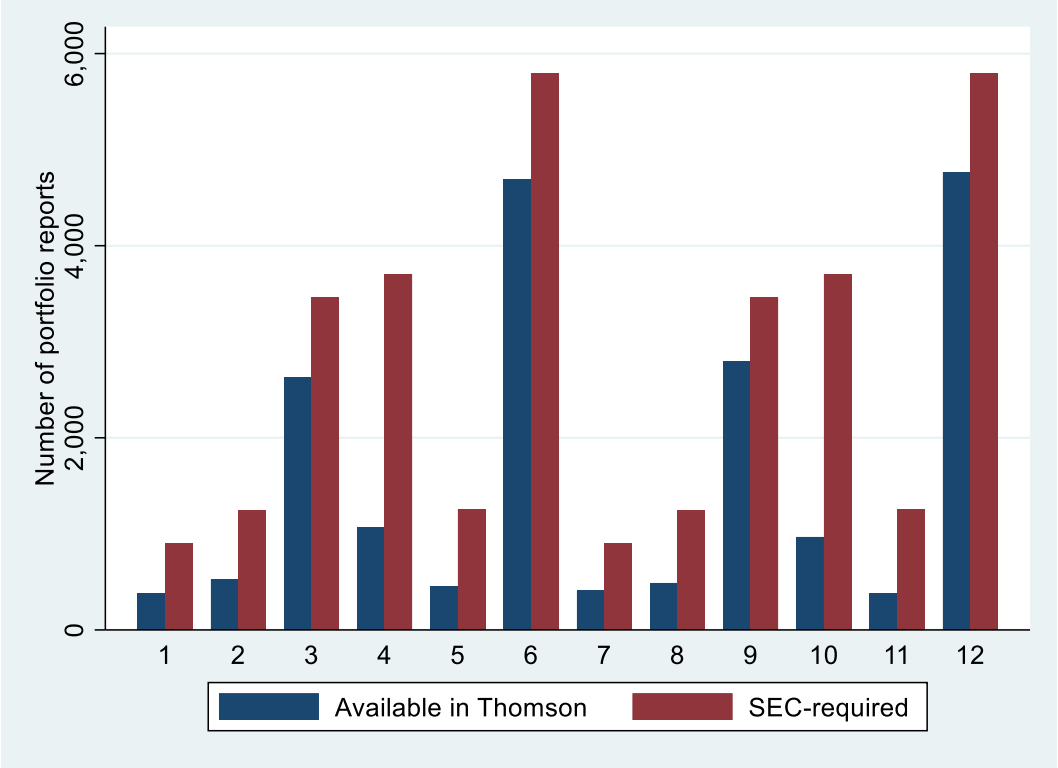

Fig.2. Monthly distribution of SEC-required portfolio reports and the coverage count in Thomson

Notes: This figure exclusively focuses on domestic equity funds during the period 1997 to 2003. SEC-required reports encompass all reports mandated by SEC intended for public accessibility. Reports available in Thomson represent the subset of SEC-required reports compiled by Thomson Reuters during the specified timeframe.

Given that all mutual funds are required to report portfolio holdings on dates aligned with fiscal year-ends under the 1940 Investment Company Act, and investment companies typically own mutual funds with different fiscal year ends, many investment companies would need to submit portfolios of some of their funds to Thomson almost every month. Therefore, investment companies find it more administratively efficient to report portfolio holdings of all mutual funds on calendar year-ends, concurrently fulfilling the mandatory Form 13F provision. As a result, for certain mutual funds with fiscal year-ends not synchronized with calendar quarter-ends, Thomson obtains their calendar-quarterly portfolio information instead of the mandatory semi-annual reports (prior to May 2004). According to our statistical summary of this Thomson database, of all domestic equity funds submitting portfolio information to Thomson from 1997 to 2003, approximately 60.63% of their SEC-required mandatory portfolio reports are available in Thomson. **Fig.2** illustrates the monthly distribution of SEC-required portfolio reports for domestic

equity mutual funds from 1997 to 2003. While these reports are disseminated throughout the calendar year, there is a pronounced concentration around calendar quarter-end months, as well as in April and October. Notably, the coverage of SEC-required portfolio reports in Thomson Reuters is significantly elevated during these calendar quarter-end months, likely attributed to the alignment with the fiscal year-end schedules of mutual funds.

In **Table 1**, we provide more comprehensive information about domestic equity funds' mandatory reports and voluntary reports compiled by Thomson. In Panel A, among 44434 fund portfolio reports from 1997 to 2003, more than half of them (54.58%) are voluntary reports as of the calendar-year-end months. Separately among funds with fiscal quarters aligning with calendar quarters, say funds with fiscal year-ends of March, June, September or December, around 60% of their portfolio reports are SEC-required mandatory reports; among unaligned funds whose fiscal quarters do not overlap with calendar quarters, the value falls to 24% while the percentage of calendar-quarter-end (CQE) voluntary reports reach to about 75%. This difference results from the stronger systemic motivation of funds with non-calendar fiscal quarters to report portfolio holdings of specific funds together with required fund-company-level 13F forms, for administrative convenience. For unaligned mutual funds, a majority of them convert semi-annual reports corresponding to fiscal years into reports as of calendar-quarter-ends. This practice results in a substantial proportion of CQE reports, constituting 75% of the submissions. The remaining mandatory portion of portfolio reports is supplied by unaligned funds that adhere to the original SEC-required reporting schedule to Thomson. Panel B provides information of domestic equity funds' reports to Thomson in each year in the period. On average, funds report two to three times to Thomson every year. In most of years in the sample period, on average, around half of portfolio reports of a fund are voluntarily as of calendar-quarter-end months. Additionally, the sum of the percentage of SEC-required reports and the percentage of voluntary calendar-quarter-end reports is approximately 98%, consistent with the finding of Schwarz and Potter (2016).

The supplementary portfolio holding information on calendar year-ends provides two advantages for our study of mutual funds trading behavior at stock crashes. First, as we focus on stock crashes that occur before May 2004, during which the mandatory reporting frequency is semi-annual, with voluntary disclosures, the portfolio reporting frequency increases from semi-annual towards quarterly. Measurement of the change in crash stock holdings is therefore more accurate.

(1) Voluntary reports are less accessible to the public compared to mandatory reports. Only investors who subscribe to Thomson can access and observe the voluntary filings. These subscribers are likely to be institutional investors, while a large proportion of mutual fund shareholders are likely non-institutions (Admas et.al, 2012; Kostovetsky, 2015). Hence, most fund shareholders probably observe portfolios exclusively through the SEC mandated disclosures. As a result, fund managers are primarily concerned about the holdings revealed in mandatory reports and the performance of the stocks within the portfolio.

(2) Voluntary reports, being less timely than SEC-mandated reports, are less likely to be utilized by investors as a source of information for evaluating fund managers' capabilities. Thomson updates are provided shortly after the end of calendar quarters. Given the unlikely scenario of funds uploading their portfolios to Thomson within a few days of the calendar quarter's end, almost all voluntary disclosures will experience a delay of at least approximately three months.

Table 1
Summary of funds' voluntary and mandatory portfolio reports in Thomson.

Panel A: Breakdown of portfolios reported to Thomson

	Total	Mandatory	Voluntary	
			CQE	Non-CQE
All	44,434	19,549	24,253	632
		44.00%	54.58%	1.42%
Aligned funds	24,953	14,874	9,670	409
		59.61%	38.75%	1.64%
Unaligned funds	19,481	4,675	14,583	223
		24.00%	74.86%	1.14%

Panel B: Average ratio of calendar-quarter-end reports

Year	Number of funds	Number of reports	Ratio of CQE reports	Ratio of mandatory reports	Ratio of both reports
1997	1,659	2.42	25.24%	71.60%	96.83%
1998	1,920	2.57	39.61%	58.17%	97.78%
1999	2,176	2.60	49.01%	49.54%	98.55%
2000	2,470	2.83	51.76%	46.87%	98.63%
2001	2,582	2.66	53.19%	45.36%	98.55%
2002	2,663	2.92	55.65%	43.48%	99.14%
2003	2,652	3.09	51.57%	46.84%	98.41%
Total	16,122	2.76	48.06%	50.31%	98.37%

Notes: This table describes the reporting dates of equity-domestic mutual funds in Thomson over the period from 1997 to 2003. Panel A presents the breakdown of portfolios. *Aligned funds* are mutual funds whose calendar and fiscal quarters align, say funds with fiscal-year-end months of March, June, September or December. *Unaligned funds* are mutual funds whose calendar and fiscal quarters do not align. The information of funds' fiscal years is from CRSP and matched to funds in Thomson through MFlinks file. *Total* is the total number of portfolios reported in Thomson in the period from 1997 to 2003. *Mandatory* is the number of Thomson portfolios that overlap with annual and semi-annual SEC disclosed portfolios, which coincide with funds' fiscal years. *Voluntary* is the number of Thomson portfolios reported on non-SEC-required dates. Voluntary Thomson portfolios are further classified into two types: *CQE* is the number of portfolios voluntarily reported to Thomson as of calendar quarter-end months; *Non-CQE* is the number of portfolios voluntarily reported to Thomson in non-calendar quarter-end months. Panel B reports the distribution of funds reporting to Thomson over the same period. *Number of funds* is the number of funds that report to Thomson at least once in a particular year. *Number of reports* is the average number of reports uploaded to Thomson within a particular year by one mutual fund in the corresponding sample. *Ratio of CQE reports* is the average ratio of reports as of calendar quarter-end months to all reports among all reporting funds within a particular year. *Ratio of mandatory reports* is the average ratio of SEC-required reports to all reports among all reporting funds within a particular year. *Ratio of both reports* is the sum of the two ratios above.

3.3 Crash identification

Our sample combines a variety of data sources. From CRSP daily stock files, we obtain data of stock returns for idiosyncratic shock identification as well as stock transaction characteristics

for stock-level analysis. We filter the dataset as follows: (i) we exclude months containing fewer than 19 trading days; (ii) we exclude monthly stock returns with unidentifiable industry categories; (iii) we omit months in which the average daily stock price falls below 2.5 dollars.

Following Hutton, Marcus and Tehranian (2009), we determine crash months using firm-specific monthly returns in the period from 1997 to 2003 for U.S. stocks in the CRSP database. The reason we focus on this period is to maximize the variation in investment horizons since mutual funds are only required to report semi-annually before May 2004. We employ an expanded index model rolling regression to calculate the residual returns for each stock month between January 1997 and December 2003:

$$r_{j,t} = \alpha_j + \beta_{1j} r_{m,t-1} + \beta_{2j} r_{i,t-1} + \beta_{3j} r_{m,t} + \beta_{4j} r_{i,t} + \beta_{5j} r_{m,t+1} + \beta_{6j} r_{i,t+1} + \varepsilon_{j,t} \quad (1)$$

where r_{jt} is the return on stock j in month t, $r_{m,t}$ is the CRSP value-weighted market index monthly return, $r_{i,t}$ is the Fama-French 49 value-weighted industry portfolio index monthly return. Our variable of interest is $\varepsilon_{j,t}$, the residual return for stock j at time t. We include lead and lag monthly returns of the market index and the industry index to allow for nonsynchronous trading. The rolling window spans 36 monthly observations.

The residuals from Equation (1) are highly skewed. Thus, we formulate the firm-specific monthly return as the logarithm of one plus the residual return, which exhibits a predominantly symmetrical distribution. For each regression in the rolling window process, we calculate the mean and standard deviation of firm-specific monthly returns across all instances within the defined window. We identify the terminal month within a given rolling window as a stock crash month when its firm-specific monthly return surpasses a threshold of 1.96 standard deviations below the mean value.

In total, we identify 10,967 stock-crash months for 5,264 stocks spanning from 1997 to 2003. Figures 1 and 2 depict their distribution across years and calendar months. Stock crashes take place in every month, with a higher concentration in January, March, October, and December, each accounting for more than 10% of the total number of stock crashes. Furthermore, stock crashes are distributed across each year of the sample period, with a relatively higher concentration in the year 1999, accounting for nearly 25% of the total number of stock crashes.

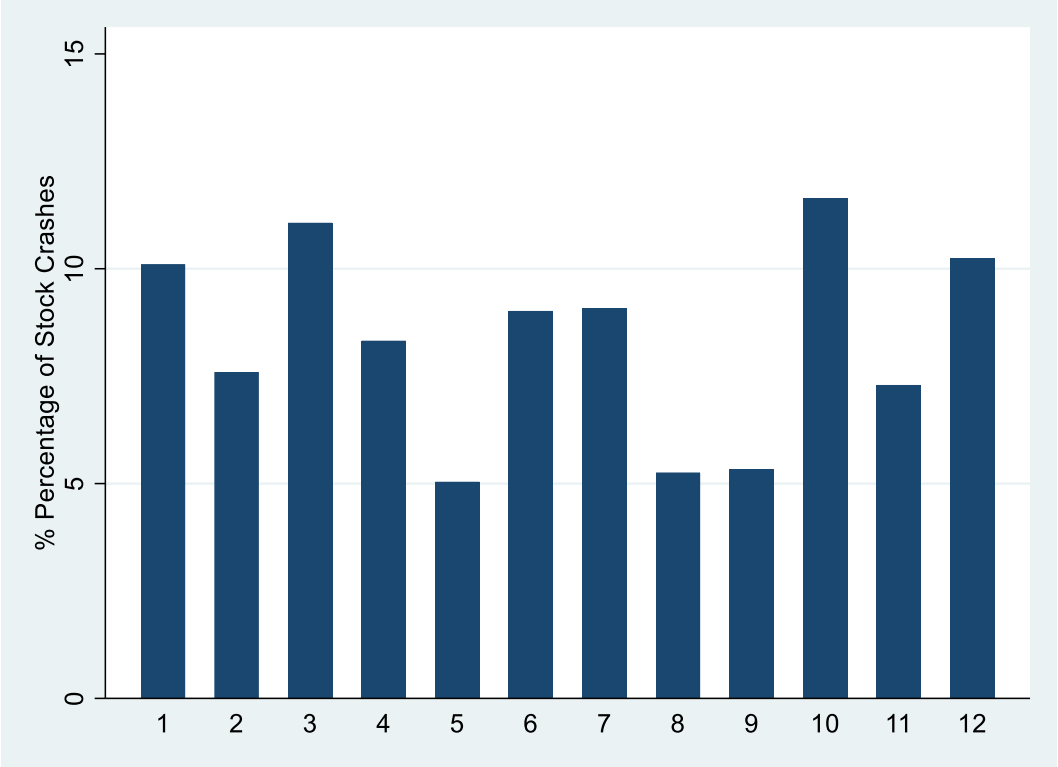

Fig.3. Stock Crash Distribution over months

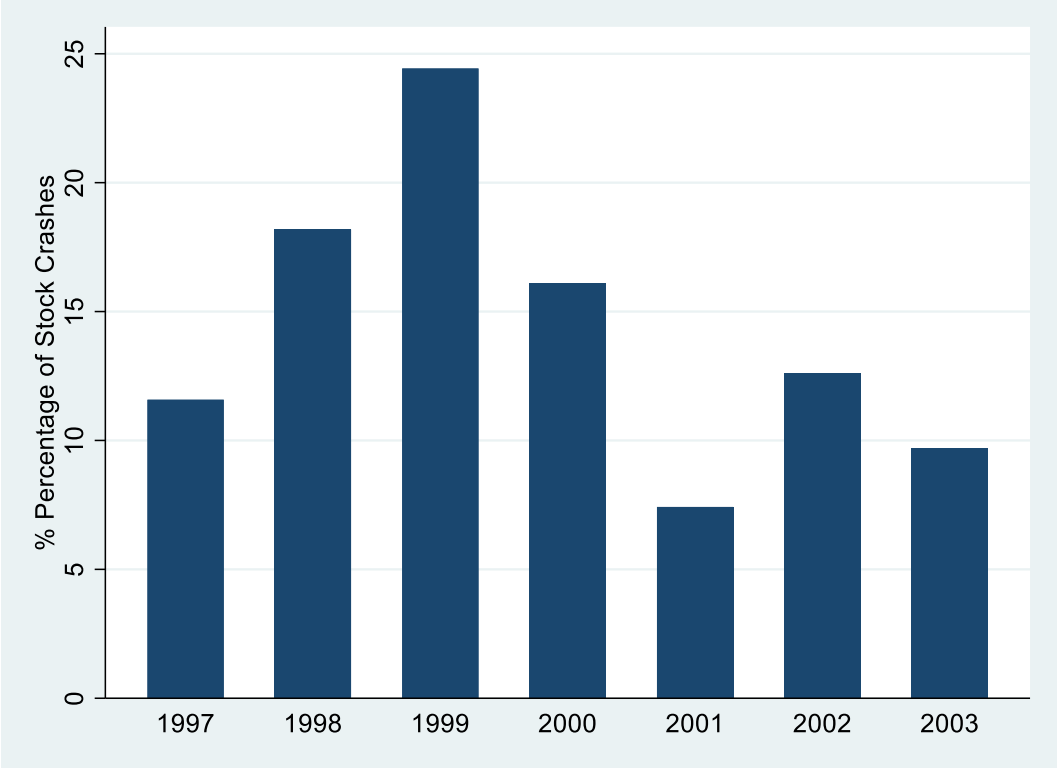

Fig.4. Stock Crash Distribution over months

3.4 Mutual fund sample construction

In the identified stock crash month pool, we first exclusively retain 7262 instances without any additional crashes pertaining to the stock within six months either before or after the identified crash month to avoid multiple crashes within two reporting dates for any funds.

Second, we gather mutual fund holdings data from the Thomson Mutual Fund Holdings database, i.e. the Thomson s12 datafile, which includes both mandatory mutual fund portfolio reports to the SEC and voluntary reports to the data vendor. In order to examine the response of mutual funds crash stockholders immediately at the stock crash, we select mutual funds whose newest reporting date following crash month is exactly at the end of the crash month and that disclose holdings of a crash stock in the most recent portfolio report. We compile 79512 observations characterized by crash stock, crash month, and mutual funds.

Third, we collect data of mutual fund characteristics, including fiscal year end from the CRSP Survivorship Bias-Free Mutual Fund database. Then we link selected mutual fund portfolios in Thomson to portfolios in CRSP using the *MFLinks* file available in WRDS. We exclude mutual funds without fiscal year recordings from the sample. We further refine the sample by concentrating on domestic equity funds and filtering the sample of mutual funds based on CRSP style code, resulting in 59255 retained records. In **Table 2**, we present the distribution of fiscal-year-end months for mutual funds in the current sample. Of all the records in the sample, around 57% of their mutual funds have fiscal year-ends overlapping with the calendar quarter-ends—March, June, September, December. In **Table 2**, we additionally provide the count of sample records that are determined by mutual funds submitting mandatory reports to the SEC in a particular month, along with the corresponding percentage of the sample records. Notably, at the end of June or December, mutual funds with fiscal year-end months of both June and December are required to submit mandatory portfolio reports to the SEC. Consequently, in June or December, among the 59255 sample records, 20984 (4382 plus 16602) are determined by mutual funds with semi-annual mandatory reports in the respective month, constituting 35.41% of the total sample records.

Table 2
Distribution of fund fiscal year-end months and SEC-required reporting dates.

	Fiscal year-end		SEC-required reports	
Month	Frequency	Percent	Number of mutual funds	Percentage
1	794	1.34%	3,822	6.45%
2	722	1.22%	3,520	5.94%
3	6,010	10.14%	12,629	21.31%
4	1,837	3.1%	13,782	23.26%
5	1,170	1.97%	4,518	7.62%
6	4,382	7.4%	20,984	35.41%
7	3,028	5.11%	3,822	6.45%
8	2,798	4.72%	3,520	5.94%
9	6,619	11.17%	12,629	21.31%
10	11,945	20.16%	13,782	23.26%
11	3,348	5.65%	4,518	7.62%
12	16,602	28.02%	20,984	35.41%
Total	59,255	100%		

Notes: This table displays the distribution of mutual funds' fiscal year-end months in 59255 sample records identified by mutual funds, crash stocks, crash months as well as the number and percentage of total sample records that are determined by mutual funds submitting SEC-required mandatory reports in a particular month. These mutual funds in sample are domestic equity funds, holding crash stocks, and having post-crash reports at the end of crash months after the third filtering step.

Fourth, we require the recent reporting date of funds in the sample is three months prior to the crash month. We regard them as mutual fund owners of the crash stock. The sample size diminishes to 37521 after the filtering. **Table 3** presents the distribution of temporal gap between the last pre-crash reporting date and the crash month after the third step in process. Approximately 94% of all sample funds fall into two categories: those with a three-month gap and those with a six-month gap. This observation aligns with the common practice among mutual funds submitting either SEC-mandated reports or voluntary reports to Thomson. We measure the holdings of funds at the same time to mitigate the influence of the gap between reporting dates on the observed trading behavior. Therefore, we exclusively analyze funds with a three-month gap. These funds represent the majority (63.32%) in the sample, and their preceding holdings of the crash stock are relatively accurate compared to funds with a six-month gap. We assume stock holdings remain stable within the two months leading up to the crash.

Table 3
Distribution of gap between reports around crash months.

Gap between reports	Frequency	Percent
1	1,145	1.93%
2	407	0.69%
3	37,521	63.32%
4	959	1.62%
5	851	1.44%
6	18,372	31%
Total	59,255	100%

Notes: This table reports the distribution of temporal gaps between portfolio reporting dates of the sample funds in the proximity of the crash month following the third step in the process. The gap varies from one month to six months. Since we have required that the post-crash reporting date aligns with the end of the crash month, a one-month gap signifies that the pre-crash reporting date of the sample fund is one month preceding the crash month.

Finally, we assemble a dataset comprising mutual funds that hold crash stocks, delineated by stock, crash month, and the respective mutual fund owners. Following the elimination of observations with missing values in the variables under examination, the sample is comprised of 27,973 records representing mutual fund ownership during 1,580 stock crash months.

In the final sample of mutual funds, we provide the distribution across calendar months of stock crashes that these mutual funds' portfolios encounter in **Table 4**. Given our filtering criteria, which involve concentrating on mutual funds with reports aligning with the end of crash months and restricting the temporal gap between the latest pre-crash report and the crash time to three months, 99.54% crash months for the retained mutual fund owners in the sample concentrate in March, June, September, and December—corresponding to the end of calendar quarters. This is consistent with the fact that 98% of portfolios reported to Thomson are either on SEC-mandated months or voluntary disclosures on calendar quarter-end months (Schwarz and Potter, 2016). Therefore, we essentially narrow down our focus to a subsample from all mutual funds that initially invest in the crash stocks. This allows for a more effective examination of the impact of the investment horizon associated with portfolio disclosure regulations on the trading behavior of mutual funds for stocks during crashes.

Table 4
Distribution of stock crashes over months.

Month	Freq.	Percent
1	31	0.11%
2	1	0.00%
3	7,689	27.49%
4	9	0.03%
5	12	0.04%
6	8,004	28.61%
7	20	0.07%
8	6	0.02%
9	5,935	21.22%
10	52	0.19%
11	0	0.00%
12	6,214	22.21%
Total	27,973	100%

Notes: This table shows distribution of stock crashes in the records of the filtered mutual fund sample across calendar months. The mutual fund sample records are defined based on mutual funds, stocks, and crash months.

3.5 Stock crash sample construction

To investigate the distinct impact of mutual funds with varying investment horizons on the performance of a particular stock during its crash month, we construct a sample of stock crashes. Within the pool of stock crash months, we consistently exclude instances where additional crashes related to the stock occur within six months before or after the identified crash month. Subsequently, we preserve crash months for stocks held by a minimum of one mutual fund, provided that the last reporting date is within three months prior to the crash month. This filtration process is based on the premise that mutual funds' holdings reported within a three-month period are relatively more stable[3].

We collect data on Fama-French factors and market index monthly returns from CRSP to calculate monthly abnormal stock returns in the crash month. Additionally, we gather data on firm characteristics, including ROA, market-to-book ratio, and size, from the financial ratios file in

[3] Round-trip transactions between two holding reports may introduce bias to the measurement of holding changes. Elton et.al (2010) found that semiannual holdings miss 34.2% of trades compared to monthly holdings, while quarterly holdings miss only 18.5%. Quarterly holding reports with a three-month gap offers more accurate holding change measurement than semiannual holding reports with a six-month gap.

WRDS. After removing observations with missing values in the variables under analysis, we acquire a total of 3,578 stock crash months.

4 Variable Construction and Empirical Design

4.1 Investment horizon

We use the temporal gap between a crash month and a mutual fund's upcoming mandatory reporting date as a proxy variable representing the mutual fund investment horizon. Specifically, considering the six-month mandatory reporting period preceding May 2004, we define the mutual fund investment horizon, denoted with $Distance_{i,j,t}$, as the remaining number of months from the crash month to the upcoming mutual fund reporting date. This measure equals 0 when the subsequent mandatory reporting date of mutual fund i coincides with the crash month t of stock j, and equals 5 when the next mandatory reporting date of mutual fund i is in the fifth month after crash month t of stock j.

Figure 1 illustrates the construction of the investment horizon variable. The first crash occurs directly after *Reporting Date1*. Because it takes five months until *Reporting Date2*, *Distance* equals 5. The second crash occurs in the same month as, but just before *Reporting Date2*. In this situation, *Distance* equals 0. *Reporting Date1* and *Reporting Date2* both represent mandatory reporting dates.

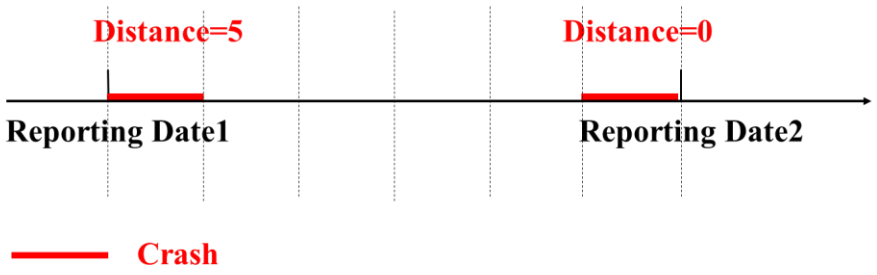

Fig. 5. Definition of Distance

This measure has the advantage of capturing the exogenous variation of mutual funds' investment horizons. First, the prevailing consensus underscores the inherent unpredictability and exogenous nature of abrupt disturbances at the firm level. Second, mutual fund reporting dates are pre-determined at the establishment stage of the mutual fund, so we presume they are exogenous as well. Thus, we extract the exogenous variation of investment horizons in the context of stock crashes.

4.2 Short-horizon fund ownership

Having defined our measure of investment horizon, we formulate the measurement of short-horizon fund ownership at the stock level in three different ways. First, we introduce the relative ownership of mutual funds with *Distance* zero for stock *j* at crash month *t*, referred to as $UltraShortRatio_{jt}$, using Equation (2). Mutual funds with distance zero presumably have the strongest incentive to promptly sell positions at the crash, potentially exerting the most significant price pressure on the crash stock.

$$UltraShortRatio_{jt} = \frac{Number\ of\ shares\ held\ by\ mutual\ funds\ with\ zero\ distance_{jt}}{Number\ of\ shares\ held\ by\ all\ mutual\ funds_{jt}} \quad (2)$$

Second, we consider the recent relative ownership of mutual funds with distance ranging from zero to two for stock *j* before crash month *t*, referred to as $ShortRatio_{jt}$, using Equation (3). We undertake a broad classification based on their investment horizons, distinguishing between those with short investment horizons and those with long investment horizons. Mutual funds with a distance of no more than two months from the crash month to the next mandatory reporting date exhibit a shorter investment horizon compared to those with a distance ranging from three to five months. Therefore, these mutual funds have relatively heightened incentives to sell original positions of stocks right at the crash and negatively affect the price of the sold stock.

$$ShortRatio_{jt} = \frac{Number\ of\ shares\ held\ by\ mutual\ funds\ with\ distance\ from\ zero\ to\ two_{jt}}{Number\ of\ shares\ held\ by\ all\ mutual\ funds_{jt}} \quad (3)$$

Third, we compute the weighted average of distances for all mutual funds by crash month *t* and stock *j*, denoted as WAD_{jt}. In line with Equation (3), for a specific crash stock, we calculate the average distances from the crash month to the next mandatory reporting date for all mutual funds that originally held stock shares before the crash, with the distance of each mutual fund weighted by the number of crash stock shares. The weighted average of distances for a crash stock serves as a more comprehensive measure of the investment horizon at the stock level. A shorter

weighted average of distances signifies a condensed collective shorter investment horizon among all mutual funds owning a specific crash stock, indicating a higher level of short-horizon ownership.

$$WAD_{jt} = \frac{\sum_{i=1}^{N} Number\ of\ shares\ held_{ijt} \times Distance_{ijt}}{Number\ of\ shares\ held\ by\ all\ mutual\ funds_{jt}} \tag{4}$$

All mutual funds included in the calculation of stock ownership reported the holding of the specific crash stock no more than three months before the crash, and we regard these mutual funds as those holding the stock shares at the moment of the crash. This filtration process is based on the premise that mutual funds' holdings reported within a three-month period are reasonably stable.

4.3 Fire Sale by Short-Horizon Mutual Funds

To evaluate Hypothesis 1, we begin by comparing the immediate trading behavior of funds in relation to their investment horizon at a stock crash. First, we quantify mutual funds' response to a stock crash by assessing the likelihood of liquidating their entire positions. We utilize a logit model to investigate whether there are statistically significant differences in the probability of position liquidation among mutual funds with varying investment horizons.

$$\begin{aligned} ln\left(\frac{P_{ijt}}{1-P_{ijt}}\right) = {} & \beta_1 + \beta_2 Horizon_{ijt} + \beta_3 PercentOutShares_{ijt} + \beta_4 FundSize_{ijt} \\ & + \beta_5 PortionFund_{ijt} + \beta_6 NumStock_{ijt} + \beta_7 RatioCrashStock_{ijt} \\ & + \beta_8 FundAge_{ijt} + \beta_9 PastFundReturn_{ijt} \end{aligned} \tag{5}$$

In Equation (5), P_{ijt} denotes the conditional probability of mutual fund i completely liquidating its position of crash stock j at time t, $P_{ijt} \equiv Prob(Liquidation_{ijt} = 1|\boldsymbol{X}_{ijt})$. We also substitute the dependent variable with another conditional probability of mutual fund i selling its position of crash stock j at time t, $P_{ijt} \equiv Prob(Sell_{ijt} = 1|\boldsymbol{X}_{ijt})$, to examine the influence of investment horizon on mutual funds' trading direction. The explanatory variable $Horizon_{ijt}$ assumes different measures of investment horizon. In the base case, it is a dummy variable, $UltraShortHorizon_{ijt}$, which equals one if the upcoming mandatory reporting date of mutual fund i coincides with crash month t of stock j, and 0 otherwise. Alternatively, it is equal to $Distance_{ijt}$.

In Hypothesis 1, we expect the coefficient of the explanatory variable $ShortHorizon_{ijt}$ to be positive. This would imply that short-horizon mutual funds are more inclined to liquidate their position in a stock immediately after it experiences a crash. We also expect the coefficient of the explanatory variable $Distance_{ijt}$ to be negative, implying that mutual funds with longer investment horizon are less likely to liquidate their position in a stock immediately after a stock crash.

Additionally, our regression model incorporates a set of control variables associated with fund characteristics and initial holdings. In particular, we control for the percentage of shares originally held in relation to the total stock shares outstanding ($PercentOutShares_{ijt}$), mutual fund size as measured by the logarithm of total net assets ($FundSize_{ijt}$), the value of the crash stock position as a fraction of the total mutual fund value ($PortionFund_{ijt}$), the number of stocks in the mutual fund ($NumStock_{ijt}$), the ratio of crash stocks to the total number of stocks in the mutual fund ($RatioCrashStock_{ijt}$), the mutual fund age ($FundAge_{ijt}$), and the mutual fund's past six-month cumulative return ($PastFundReturn_{ijt}$).

In Equation (6) we consider a variation of Equation (5). We employ a linear regression with selling volume ($SellVol_{ijt}$) as the dependent variable. The model retains the same explanatory and control variables as the model in equation (5). With Equation (6), we examine whether mutual funds with shorter investment horizon sell more of the stock shares during a crash. Additionally, we include dummies indicating investment style categories of mutual funds (φ_i). We employ two specifications for selling volume. First, the dependent variable is relative selling volume percentage, $DiffPosition_{ijt}$, calculated as the difference between the number of crash stock shares reported before the crash and the number of crash stock shares reported after the crash. In the second case, the dependent variable is selling volume, $DiffPercent_{ijt}$, calculated as the difference between the number of crash stock shares reported before the crash and the number of shares reported after the crash, normalized by the total number of crash stock shares reported before the crash.

Furthermore, we include fixed effects for the crash year-month level (γ_t), the stock level (η_j), and the interaction of the two ($\gamma_t \times \eta_j$). We employ the unique CUSIP number of individual stocks to create dummies for stock-level fixed effects.

$$
\begin{aligned}
SellVol_{ijt} = {} & \beta_1 + \beta_2 Horizon_{ijt} + \beta_3 PercentOutShares_{ijt} + \beta_4 FundSize_{ijt} \\
& + \beta_5 PortionFund_{ijt} + \beta_6 NumStock_{ijt} + \beta_7 RatioCrashStock_{ijt} \\
& + \beta_8 FundAge_{ijt} + \beta_9 PastFundReturn_{ijt} + \varphi_i + \gamma_t + \eta_j + \gamma_t \times \eta_j \\
& + \varepsilon
\end{aligned} \tag{6}
$$

Through this specification, we assess how much a mutual fund will adjust its original position in a crash stock as a function of the time between the crash month and the next mandatory reporting date. In our hypothesis, the shorter this temporal distance, the more a mutual fund is inclined to sell its position in the crash stock, and the more of the original positions a mutual fund would like to sell.

4.4 Stock price decline

To assess Hypothesis 2, we employ the sample of crash stocks and engage in analyses at stock level. Initially, we calculate monthly abnormal stock return during the crash to assess the extent of stock price decline. This involves utilizing both the Fama-French five-factor model with momentum and the market model for calculating abnormal returns. We use the monthly return of the value-weighted CRSP stock market index as a proxy for market return. Specifically, for each crash month, we use the preceding 36 monthly returns to estimate the coefficients of factors contributing to total stock return, and subsequently use these coefficients along with the total monthly return and factors of the crash month to compute the residual term. Next, we employ the cross-sectional regression model in Equation (7) to examine the impact of mutual funds' short investment horizon on stock price decline.

$$
\begin{aligned}
& AbnormalReturn_{jt} \\
& \quad = \beta_1 + \beta_2 SHO_{jt} + \beta_3 FundOwnTotal_{jt} + \beta_4 MarketCap_{jt} \\
& \quad + \beta_5 StockTurnover_{jt} + \beta_6 ReturnStockVolatility_{jt} \\
& \quad + \beta_7 BidAskSpread_{jt} + \beta_8 MarketToBook_{jt} \\
& \quad + \beta_9 PastStockReturn_{jt} + \beta_{10} ROA_{jt} + \beta_{11} Leverage_{jt} \\
& \quad + \beta_{12} FirmSize_{jt} + \gamma_t + \delta_j + \varepsilon
\end{aligned} \tag{7}
$$

The dependent variable in the model is the estimated monthly abnormal return of a stock *j* at crash month *t*. Given that we are assessing the effects of immediate trading, the price decline driven by mutual funds' selling may continuously follow the initial price decline at the onset of the crash,

make it challenging to distinguish between these two components of the price decline. Since the investment horizons of mutual fund owners of crash stocks are exogenously identified, we assume that the stocks in groups categorized by short-horizon mutual fund ownership are randomly distributed. Hence, the variation in abnormal return over the entire period of price decline among stocks exhibiting different levels of short-horizon mutual fund ownership can be considered as an indicator of the magnitude of price decline resulting from the additional selling by mutual funds.

The explanatory variable SHO_{jt} takes on one of the three measures for short-horizon ownership for a crash stock, $UltraShortRatio_{jt}$, $ShortRatio_{jt}$ or WAD_{jt}, as described in section 4.4. We control for characteristics at both the stock and firm levels. $FundOwnTotal_{jt}$ denotes the total ownership of mutual fund owners of stock j at crash month t. $MarketCap_{jt}$ is the logarithm of the total value of outstanding shares of stock j at crash month t. $StockTurnover_{jt}$ denotes the average daily turnover of stock j in the 90 trading days preceding crash month t with daily turnover calculated as daily trading volume divided by the total number of outstanding shares. $ReturnStockVolatility_{jt}$ denotes the standard deviation of daily returns of the stock j within the preceding 90 trading days before the crash month t. $BidAskSpread_{jt}$ is the average of daily bid-ask spread of stock j within the 90 trading days preceding crash month t. $PastStockReturn_{jt}$ is the cumulative return of stock j over the past 90 trading days before crash month t. $MarketToBook_{jt}$ designates the ratio of market equity value to book equity value of the firm corresponding to stock j before crash month t. ROA_{jt} indicates the latest return of assets of the firm corresponding to stock j before crash month t. $Leverage_{jt}$ indicates the debt-to-asset ratio of stock j before crash month t. $FirmSize_{jt}$ is the logarithm of total assets value of the firm corresponding to stock j before the crash month t.

Furthermore, we include fixed effects respectively at the crash year-month level (γ_t) and the firm's industry level (δ_j).

4.5 Event study

Given that mutual funds may sell crash stocks due to portfolio disclosure concerns rather than information about the intrinsic value of the firm itself, trading activity becomes noisy and can push the price of the traded stock below its fundamental value during a market crash. Following the crash, informed traders engage in trading activities, leading the stock price to gradually align with

the level that accurately reflects the fundamental value of the firm. In accordance with Hypothesis 3, crash stocks predominantly influenced by the non-informative selling of mutual funds during the crash are anticipated to undergo a more noticeable price reversal compared to less-affected stocks. To delve deeper into the repercussions of short-horizon mutual funds' trading on stock price inefficiency, we conduct an event study, examining the potentially divergent price trajectories around the crash for groups of crash stocks with the highest and lowest short-horizon ownership. This empirical approach is in accordance with Mitchell, Pulvino, and Stafford (2004) who study price pressure around mergers, and Coval and Stafford (2007) who focus on price pressure around fund-outflow-driven asset fire sales.

This analysis also serves to disentangle the price pressure resulting from short-horizon mutual funds' fire sales from the inherent price decline at the outset of the crash itself. As detailed earlier, the empirical strategy for testing Hypothesis 2 may not distinctly attribute the additional price decline to the uninformative selling by short-horizon mutual funds. It is plausible that stocks predominantly owned by these funds coincidentally undergo larger-scale crashes initially, thereby displaying lower abnormal returns throughout the entire crash month. By observing a period of positive abnormal returns post-crash month for stocks primarily held by short-horizon mutual funds, coupled with a weaker price rebound for stocks with minimal short-horizon mutual fund ownership, we can confidently affirm that the selling activity of short-horizon funds contributes to an additional uninformative price decline during the particular stock crash.

Specifically, in the initial step, we compute the monthly abnormal return of crash stocks by employing the Fama-French five-factor model with momentum. This computation spans a period from six months preceding the crash month to twelve months after the crash month. Designating the crash month as the event as time zero, the event study window is defined as [-6, 12]. We only retain crash stocks with complete observations over the specified window.

In the second step, we sort all stock crashes by the absolute ownership of mutual funds with distance zero as a proportion of the total outstanding shares, $OwnershipDistance0_{jt}$, as this variable directly and accurately reflects the level of short-horizon mutual fund ownership. We define the stock crash group with the highest short-horizon mutual fund ownership as the subsample where $OwnershipDistance0_{jt}$ exceeds the 90th percentile, and similarly, identify the group with lowest short-horizon mutual fund ownership by isolating values below the 10th

percentile. We calculate the average abnormal returns and cumulative average abnormal return for each month in the event study window for both groups, and then use the time-series of mean abnormal returns for statistical inference.

5 Empirical Results

5.1 Summary Statistics

Table 5 provides summary statistics for all variables employed in the empirical analysis. Panel A describes the trading behavior, investment horizon as well as other characteristics of the sample of mutual funds at the time of crash. On average, 15.9% of mutual funds liquidate all the initial positions of a crash stock in the crash month. Crucially, there exists significant variation in the selling volume of mutual funds as a proportion of their initial positions. On average, mutual funds divest 3.4% of their originally held shares in the crash stock. Notably, mutual funds with the highest selling activity liquidate their entire original positions, while those with the least selling activity acquire shares amounting to 3.3 times their initially held shares in the crash stock. In the event of a stock crash, the average duration between the crash month and the upcoming mutual funds' mandatory reporting date is 1.97 months, spanning a range from 0 to 5 months. Notably, 32% of mutual fund investors in crash stocks exhibit a short horizon, with their mandatory reporting date coinciding with the crash month.

In Panel B, we outline the abnormal performance during crash months, short-horizon ownership, and other characteristics of crash stocks. The average abnormal return for stocks during the identified crash month is -22.6%. Mutual funds hold approximately 9.7% of the outstanding shares of crash stocks. Mutual funds with a distance of zero between crash month and the upcoming mandatory reporting date hold on average, 12.5%, while mutual funds with distances ranging from 0 to 2 months hold 33.6%. Further, the mean value of the average distance weighted by holding positions for all mutual fund investors in a single crash stock is 2.95 months.

Table 5
Summary statistics.

	N	Mean	Min	P50	Max	SD
Panel A: Mutual Funds						
Liquidation	27,973	0.159	0	0	1	0.366
DiffPositionRate	27,973	-0.034	-1	0	3.330	0.686
DiffPercentage	27,973	-0.021	-0.914	0	0.469	0.145
Distance	27,973	1.974	0	2	5	1.678
ShortHorizon	27,973	0.320	0	0	1	0.466
PercentOutShares	27,973	0.216	0.000	0.027	3.536	0.534
FundSize	27,973	1.298	0.005	0.371	18.680	2.748
PositionFund	27,973	0.009	0.000	0.005	0.055	0.011
NumStock	27,973	5.214	3.296	4.927	7.932	1.134
NumCrashStock	27,973	10.850	1	5	89	14.400
FundAge	27,973	8.015	5.838	8.000	10.110	0.863
FundPastReturn	27,973	0.073	-0.265	0.062	0.886	0.175
Panel B: Firm Chracteristics						
Abnormal Return	3,578	-0.226	-0.708	-0.195	0.047	0.149
UltraShortRatio	3,578	0.125	0	0.035	0.933	0.194
ShortRatio	3,578	0.336	0	0.294	1	0.273
WAD	3,578	2.947	0.198	3	5	0.981
FundOwnTotal	3,578	0.097	0.000	0.084	0.321	0.075
OwnershipDistance0	3,578	0.012	0	0.003	0.099	0.019
OwnershipDistance1	3,578	0.009	0	0.002	0.087	0.016
OwnershipDistance2	3,578	0.011	0	0.002	0.107	0.020
OwnershipDistance3	3,578	0.022	0	0.010	0.128	0.029
OwnershipDistance4	3,578	0.019	0	0.008	0.119	0.026
OwnershipDistance5	3,578	0.022	0	0.010	0.140	0.030
MarketCap	3,578	19.770	4.500	19.750	24.870	2.441
StockTurnover	3,578	0.006	0.000	0.004	0.040	0.007
ReturnStockVolatility	3,578	0.034	0.009	0.030	0.096	0.017
Bid-AskSpread	3,578	0.018	0.000	0.014	0.071	0.014
Market-to-Book	3,578	3.159	0.432	2.022	22.010	3.457
PastStockReturn	3,578	0.090	-0.571	0.063	1.130	0.276
ROA	3,578	0.115	-0.514	0.123	0.470	0.143
Leverage	3,578	0.211	0	0.186	0.734	0.180
FirmSize	3,578	20.100	16.510	19.950	24.980	1.805

Notes: This table describes characteristics of mutual fund owners of crash stocks (Panel A) and characteristics of the sample crash stocks (Panel B) over the period from 1997 to 2003. All the variables have been individually winsorized respectively at 1% and 99% percentiles.

Table 6 presents the distribution of identified investment horizons for the mutual funds in the sample. Approximately 60% of mutual fund owners of crash stocks in the sample have distances of zero or three when a particular portfolio stock experiences crashes. This concentration is primarily attributed to the large-degree alignment of fiscal year-ends for mutual fund owners with the calendar quarter ends—March, June, September, and December. The distance of these mutual funds encountering stock crashes happening in the calendar quarter-ends is either zero or three. As shown in **Table 2**, around 57% of all mutual funds investors for crash stocks have fiscal year-ends overlapping with the calendar quarter-ends, and this value is almost as the same as the proportion of mutual funds with distances zero or three in the sample.

Table 6
Distribution of defined investment horizons.

Distance	Freq.	Percent
0	8,948	31.99%
1	3,616	12.93%
2	1,972	7.05%
3	8,011	28.64%
4	3,494	12.49%
5	1,932	6.91%
Total	27,973	100%

Notes: This table displays the distribution of investment horizons among mutual funds in the sample records.

5.2 Fire Sales in Mutual Funds

Utilizing model conducted in Equation (5) and Equation (6), we assess Hypothesis 1, investigating whether the mutual funds characterized by the exogenously defined short investment horizon are more inclined to sell and sell more than mutual funds with long investment horizon.

The results of implementing the model specified in equation (5) which examine the difference in mutual fund selling propensity are presented in **Table 7**. In Column (1), the positive and significant coefficient of the ultra-short-horizon dummy indicates that mutual funds with the shortest relative investment horizon—specifically, those who need to report their portfolio at the end of the crash month—have a higher probability of liquidating all of their original positions in the crash stock immediately compared to mutual funds with a longer relative investment horizon. The negative coefficient of the distance in Column (2) supportively implies that mutual funds with longer investment horizon are less likely to liquidate their original position of the crash stock.

Additionally, regarding the probability of selling the position of the crash stock, the outcomes in Column (3) and Column (4) imply that mutual funds with shorter investment horizon have heightened incentives to sell the original positions of crash stocks. Note that the significance of the coefficients for $Sell$ is 5%, which is lower than the 1% significance level observed for the coefficients of $Liquidation$. The underlying rationale for this unintuitive finding could be that the apprehensions regarding revealing crash stocks to investors via mandatory portfolio disclosure predominantly induce mutual funds' decisions to liquidate all positions in crash stocks. By eliminating the crash stock from their portfolio, mutual funds can effectively sidestep investor doubts regarding their management abilities arising from the crash stock. In contrast, it will not make much difference to alleviate their concerns if mutual funds just transform buying or non-transaction into selling since investors can still observe their holding of the crash stock in the portfolio report.

Table 8 reports the results of comparison of selling volume among mutual funds with varying relative investment horizons. In Column (1) and Column (3), the coefficient of ultra-short-horizon dummy is negative and significant at 1% confidence level, suggesting that mutual funds with the shortest investment horizon not only immediately sell a higher percentage of their original positions in the crash stock but also sell more in proportion to the total outstanding shares. The negative and significant coefficients of distance in Column (2) and Column (4) further confirm the increase in the selling volume percentage and absolute selling volume of original crash stock positions among mutual funds as the investment horizon decreases.

Results in **Table 7** and **Table 8** verify Hypothesis 1 that mutual funds with a shorter investment horizon, identified by the distance between crash month and the upcoming mandatory reporting dates, have higher propensity to sell the crash stock shares and tend to sell more of their positions in the crash stock. Prompted by the mandatory portfolio report, mutual funds demonstrate a heightened inclination to completely liquidate their positions in crash stocks, surpassing their inclination to adjust their trading direction toward selling. When it is close to the impending mandatory portfolio report, fearing that the price of the crash stock may not recover to a favorable level or even deteriorate, mutual funds may choose to divest all original positions in the crash stock, strategically avoiding its adverse inclusion in the forthcoming report to investors, or opt to sell a substantial portion of the original positions in the crash stocks to mitigate the attention drawn to the adverse stocks from investors.

Table 7
Mutual fund selling decision regressions of investment horizons.

Variables	(1) Liquidation	(2) Liquidation	(3) Sell	(4) Sell
UltraShortHorizon	0.178***		0.060**	
	(0.036)		(0.027)	
Distance		-0.037***		-0.017**
		(0.010)		(0.007)
PercentOutShares	-0.173***	-0.171***	-0.130***	-0.130***
	(0.035)	(0.035)	(0.025)	(0.025)
FundSize	-0.056***	-0.057***	0.004	0.003
	(0.012)	(0.012)	(0.009)	(0.009)
PortionFund	-66.469***	-66.556***	-0.382	-0.393
	(2.903)	(2.905)	(1.525)	(1.524)
NumStock	-0.799***	-0.800***	-0.148***	-0.148***
	(0.035)	(0.035)	(0.021)	(0.021)
NumCrashStock	-0.031***	-0.031***	-0.008***	-0.008***
	(0.004)	(0.004)	(0.001)	(0.001)
FundAge	-0.005	-0.003	0.116***	0.117***
	(0.024)	(0.024)	(0.017)	(0.017)
FundPastReturn	0.367***	0.354***	-0.503***	-0.509***
	(0.105)	(0.105)	(0.076)	(0.076)
Constant	3.737***	3.870***	-0.523***	-0.472***
	(0.234)	(0.235)	(0.161)	(0.162)
Observations	27,973	27,973	27,973	27,973
Crash Time Control	NO	NO	NO	NO
Stock Control	NO	NO	NO	NO
Stockid×Timeid	NO	NO	NO	NO
FundStyle Control	NO	NO	NO	NO

Notes: This table displays the results of logit regressions of mutual funds' Selling behavior on horizon. For each sample constructed by mutual fund, crash stock, crash month, the after-crash reporting date is exactly at the end of the crash month, which means there is no delay of the newest reporting date subsequent to the crash time. The temporal gap between the two reporting dates before and after the crash for each observation is three months. *Liquidation* is a dummy variable equaling one if the mutual fund Sells all positions of the crash stock by the end of the crash month, otherwise zero. *Sell* is a dummy variable which equals one if the mutual fund decreases its position of the stock after the crash. *UltraShortHorizon* is a dummy variable which equals one if the upcoming reporting date of the mutual fund is at the end of the crash month, otherwise zero. *Distance* is the temporal gap between the crash month and the upcoming mutual fund mandatory reporting date, measured in months. *PercentOutShares* is the crash stock shares initially held by the mutual fund as a percentage of total outstanding shares. *FundSize* is the logarithm of total net asset value of the mutual fund. *PortionFund* is the value of initial held crash stock as a proportion of the total portfolio stock value. *NumStock* is the number of portfolio stocks of the mutual fund on the latest reporting date before the crash month. *NumCrashStock* is the number of crash stocks in the mutual fund' portfolio in the particular crash month. *FundAge* is the logarithm of the days from the inception of the mutual funds until the first day of the crash month. *FundPastReturn* is the accumulative return of the mutual fund in the past six months before the crash month. The sample period of crash time ranges from 1997 to 2003. Standard errors are White-corrected for heteroskedasticity. P-values are in parentheses. * indicates significance at 1% (***), 5% (**), 10% (*).

Table 8
Mutual fund selling volume regressions of investment horizons.

Variables	(1) DiffPositionRate	(2) DiffPositionRate	(3) DiffPercentage	(4) DiffPercentage
UltraShortHorizon	-0.027***		-0.005***	
	(0.009)		(0.002)	
Distance		0.008***		0.001**
		(0.002)		(0.000)
PercentOutShares	0.034***	0.034***	-0.051***	-0.051***
	(0.008)	(0.008)	(0.005)	(0.005)
FundSize	-0.003	-0.002	-0.004***	-0.004***
	(0.003)	(0.003)	(0.001)	(0.001)
PortionFund	-1.125*	-1.139*	0.302**	0.299**
	(0.601)	(0.601)	(0.132)	(0.132)
NumStock	0.043***	0.042***	0.012***	0.012***
	(0.008)	(0.008)	(0.002)	(0.002)
NumCrashStock	0.003***	0.003***	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
FundAge	-0.014**	-0.014**	0.005***	0.005***
	(0.006)	(0.006)	(0.001)	(0.001)
FundPastReturn	0.336***	0.335***	0.066***	0.066***
	(0.051)	(0.051)	(0.011)	(0.011)
Constant	-0.157**	-0.179***	-0.070***	-0.074***
	(0.066)	(0.066)	(0.013)	(0.013)
Observations	27,719	27,719	27,719	27,719
R-squared	0.226	0.226	0.196	0.196
CrashTime Control	YES	YES	YES	YES
Stock Control	YES	YES	YES	YES
Stock×CrashTime Control	YES	YES	YES	YES
FundStyle Control	YES	YES	YES	YES

Notes: This table shows the results of regressions of mutual funds' selling scale on horizon. For each sample constructed by mutual fund, crash stock, and crash month, the after-crash reporting date is exactly at the end of the crash month, which means there is no delay of the newest reporting date subsequent to the crash time. The temporal gap between the two reporting dates before and after the crash for each observation is three months. *DiffPositionRate* is the changed number of crash stock shares in portfolio in the after-crash report as a proportion of the initial number of shares. *DiffPercentage* is the changed number of crash stock shares in portfolio in the after-crash report as a percentage of the total number of outstanding shares. *UltraShortHorizon* is a dummy variable which equals one if the upcoming reporting date of the mutual fund is at the end of the crash month, otherwise zero. *Distance* is the temporal gap between the crash month and the upcoming mutual fund mandatory reporting date, measured in months. *PercentOutShares* is the crash stock shares initially held by the mutual fund as a percentage of total outstanding shares. *FundSize* is the logarithm of total net asset value of the mutual fund. *PortionFund* is the value of initial held crash stock as a proportion of the total portfolio stock value. *NumStock* is the number of portfolio stocks of the mutual fund on the latest reporting date before the crash month. *NumCrashStock* is the number of crash stocks in the mutual fund' portfolio in the particular crash month. *FundAge* is the logarithm of the days since the inception of the mutual funds until the first day of the crash month. *FundPastReturn* is the accumulative return of the mutual fund in the past six months before the crash month. The sample period of crash time ranges from 1997 to 2003. Standard errors are White-corrected for heteroskedasticity. P-values are in parentheses. * indicates significance at 1% (***), 5% (**), 10% (*).

5.3 Price Decline

To examine whether the larger-scale of selling of short-horizon mutual funds exerts greater price downward pressure on stocks during a crash, we utilize the model specified in Equation (7) in section 4.5. The results are reported in **Table 9**. Column (1) and Column (2) report the impact of relative ownership of mutual funds with shortest investment horizon on the stock's abnormal return during the crash month. The coefficient of the explanatory variable is negatively significant at 1% confidence level, without controlling for the crash time of year-month and industry. The significance level becomes 5% after controlling them. In Column (3) and Column (4), we use the relative ownership of mutual funds with broadly defined short horizon (distance ranging from zero to two) as a substitute for the explanatory variable. The coefficient remains negative and significant at the 1% level, whether or not controlling for crash time of year-month and industry. These results suggest that stocks with higher ownership by mutual funds with a relatively short investment horizon undergo more substantial additional price decline during the crash, supporting Hypothesis 2. We also replace the explanatory variable with an indirect measure for short-horizon mutual fund ownership, namely, the weighted average distance of all mutual fund owners of the crash stock. Lower weighted average distance corresponds to higher relative ownership of short-horizon mutual funds. The results using this alternative measure are reported in Column (5) and Column (6). The coefficient remains positive and significant at the 1% level, regardless of controlling for crash time of year-month and industry. The results shown in **Table 9** are consistent with Hypothesis 2.

Table 9
Crash stock regressions of short-horizon mutual fund ownership.

Variables	(1) Abnormal Return	(2) Abnormal Return	(3) Abnormal Return	(4) Abnormal Return	(5) Abnormal Return	(6) Abnormal Return
UltraShortRatio	-0.034***	-0.031**				
	(0.011)	(0.013)				
ShortRatio			-0.038***	-0.032***		
			(0.008)	(0.009)		
WAD					0.010***	0.009***
					(0.002)	(0.002)
FundOwnTotal	-0.103***	-0.085**	-0.100***	-0.083**	-0.103***	-0.085**
	(0.034)	(0.036)	(0.034)	(0.036)	(0.034)	(0.036)
MarketCap	-0.004***	-0.002	-0.004***	-0.002	-0.004***	-0.002
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
StockTurnover	-1.912***	-1.988***	-1.979***	-2.001***	-1.953***	-2.008***
	(0.431)	(0.439)	(0.430)	(0.438)	(0.430)	(0.438)
ReturnStockVolatility	-2.622***	-2.252***	-2.571***	-2.244***	-2.593***	-2.248***
	(0.182)	(0.206)	(0.182)	(0.206)	(0.182)	(0.206)
BidAskSpread	0.521***	0.172	0.466**	0.157	0.468**	0.145
	(0.201)	(0.216)	(0.201)	(0.216)	(0.201)	(0.216)
Market-to-Book	0.002**	0.002***	0.002**	0.002***	0.002**	0.002***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
PastStockReturn	0.084***	0.073***	0.081***	0.072***	0.082***	0.072***
	(0.009)	(0.010)	(0.009)	(0.010)	(0.009)	(0.010)
ROA	0.045***	0.053***	0.044***	0.051***	0.045***	0.052***
	(0.016)	(0.018)	(0.016)	(0.018)	(0.016)	(0.018)
Leverage	-0.062***	-0.075***	-0.060***	-0.073***	-0.060***	-0.073***
	(0.013)	(0.014)	(0.013)	(0.014)	(0.013)	(0.014)
FirmSize	0.023***	0.019***	0.022***	0.019***	0.022***	0.019***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Constant	-0.506***	-0.480***	-0.497***	-0.472***	-0.540***	-0.512***
	(0.032)	(0.036)	(0.032)	(0.036)	(0.032)	(0.036)
Observations	3,578	3,577	3,578	3,577	3,578	3,577
Adjusted R-squared	0.211	0.272	0.214	0.273	0.214	0.274
CrashTime Control	NO	YES	NO	YES	NO	YES
Industry Control	NO	YES	NO	YES	NO	YES

Notes: This table presents the results of analysis about the impact of mutual funds' investment horizon during crash time on the price of stocks. The dependent variable (*Abnormal Return*) is the stock monthly abnormal return during the crash month obtained by Fama-French-5-factor model plus momentum factor. We take mutual funds which hold the crash stocks on the latest reporting date before the crash with the gap between the reporting date and the crash month lower than three months into account for ownership calculation. In Column (1) and (2), we use the ownership of mutual funds with zero distance to the upcoming mandatory reports, as a proportion of the total mutual fund ownership (*UltraShortRatio*) to capture the mutual funds' horizons. In Column (3) and (4), we alternatively use the ownership of mutual funds with distance lower than two months to the upcoming mandatory reports, as a as a proportion of the total mutual fund ownership (*ShortRatio*) as the measurement of mutual funds' horizons. In Column (5) and (6), we alter the gauge into the average distances of all mutual fund owners, weighted by each fund's ownership relative to the total mutual fund ownership (*AvgDistance*). Control variables include: *FundOwnTotal*, the total mutual

fund ownership as a ratio of total outstanding stock shares; *MarketCap*, the market value of total outstanding stock shares; *StockTurnover*, the average daily turnover ratio in the past 90 days before the crash month; *ReturnStockVolatility*, the standard deviation of the stock daily return in the past 90 days before the crash month; *BidAskSpread*, the average of daily bid-ask spread in the past 90 days before the crash month; *Market-to-Book*, the latest value of the firm's market-to-book ratio reported prior to the stock's crash month; *PastStockReturn*, the cumulative stock return in the past 90 days before the crash month; *ROA*, the latest value of the firm's return of assets reported prior to the stock's crash month; *Leverage*, the ratio of debt to total assets; *FirmSize*, the logarithm of the firms' total assets value. The sample period of crash time ranges from 1997 to 2003. Standard errors are White-corrected for heteroskedasticity. P-values are in parentheses. * indicates significance at 1% (***), 5% (**), 10% (*).

To gain deeper insights into the absolute ownership of mutual funds with different investment horizons, we substitute the short-horizon mutual fund ownership measurements in **Table 9** with six separate measurements of mutual fund ownership for various investment horizons ranging from distance zero to five. **Table 10** presents the results using these six absolute ownership variables. In Column (1), the coefficients of both the zero-distance fund ownership and the one-distance fund ownership are negative, significant at the 1% level, without controlling for the crash time of year-month and industry. In Column (2), while controlling for the two aspects, the coefficients of both zero-distance and one-distance mutual fund ownership variables remain negative, but the significance of coefficients for the latter decreases. The coefficient of the zero-distance fund ownership remains significant at the 1% level, while the coefficient of the one-distance fund ownership is no longer significant at the 10% level. The findings in **Table 10** provide supplementary evidence regarding the diverse impacts of selling behavior exhibited by mutual fund owners with distinct investment horizons on stock prices during crashes. These results suggest that the selling behavior of mutual funds with relatively short horizon exerts the negative effect on the price of stocks during the crash month, but the impact is most pronounced for mutual funds with the shortest investment horizon, which is identified by zero distance between crash month and mandatory portfolio reporting month, both significantly or economically.

Table 10
Crash stock regressions of distinct ownership for mutual funds with various investment horizon.

Variables	(1) Abnormal Return	(2) Abnormal Return
OwnershipDistance0	-0.415***	-0.391***
	(0.122)	(0.131)
OwnershipDistance1	-0.381***	-0.161
	(0.145)	(0.157)
OwnershipDistance2	-0.085	-0.034
	(0.119)	(0.128)
OwnershipDistance3	0.020	-0.087
	(0.082)	(0.089)
OwnershipDistance4	-0.046	-0.004
	(0.091)	(0.098)
OwnershipDistance5	-0.027	0.018
	(0.081)	(0.089)
MarketCap	-0.004***	-0.002
	(0.001)	(0.001)
StockTurnover	-1.946***	-2.018***
	(0.433)	(0.441)
ReturnStockVolatility	-2.580***	-2.227***
	(0.183)	(0.207)
Bid-AskSpread	0.489**	0.165
	(0.202)	(0.217)
Market-to-Book	0.002**	0.002***
	(0.001)	(0.001)
PastStockReturn	0.083***	0.073***
	(0.009)	(0.010)
ROA	0.044***	0.053***
	(0.016)	(0.018)
Leverage	-0.061***	-0.074***
	(0.013)	(0.014)
FirmSize	0.023***	0.019***
	(0.002)	(0.002)
Constant	-0.512***	-0.486***
	(0.032)	(0.036)
Observations	3,578	3,577
Adjusted R-squared	0.211	0.271
CrashTime Control	NO	YES
Industry Control	NO	YES

Notes: This table presents the results of analysis about the respective impact of mutual funds' different investment horizons during crash time on the price of stocks. The dependent variable (*Abnormal Return*) is the stock monthly abnormal return during the crash month obtained by Fama-French-5-factor model plus momentum factor. We take mutual funds which hold the crash stocks on the latest reporting date before the crash with the gap between the reporting date and the crash month lower than three months into account for ownership calculation. Variables *OwnershipDistance0* to *OwnershipDistance5* respectively represent the ownership of mutual funds with zero, one, two, three, four, five months to the upcoming mandatory reports, as a proportion of the total outstanding shares. Control variables include: *MarketCap*, the market value of total outstanding stock shares; *StockTurnover*, the average

daily turnover ratio in the past 90 days before the crash month; *ReturnStockVolatility*, the standard deviation of the stock daily return in the past 90 days before the crash month; *BidAskSpread*, the average of daily bid-ask spread in the past 90 days before the crash month; *Market-to-Book*, the latest value of the firm's market-to-book ratio reported prior to the stock's crash month; *PastStockReturn*, the cumulative stock return in the past 90 days before the crash month; *ROA*, the latest value of the firm's return of assets reported prior to the stock's crash month; *Leverage*, the ratio of debt to total assets; *FirmSize*, the logarithm of the firms' total assets value. The sample period of crash time ranges from 1997 to 2003. Standard errors are White-corrected for heteroskedasticity. P-values are in parentheses. * indicates significance at 1% (***), 5% (**), 10% (*).

5.4 Event Study

Table 11 displays monthly average abnormal returns around stocks crashes. Both of the patterns in series of average abnormal returns around the crash of stocks with the highest short-horizon mutual fund ownership and with the minimal short-horizon mutual fund ownership exhibit a notable price jump during the crash month following a preceding modest ascent. However, the former demonstrates a substantially more profound and statistically significant post-crash recovery period (See **Fig.6** for a graphical representation). In Panel A, the average price of stocks primarily held by short-horizon mutual funds experiences a decrease of 23.07% during the crash month, supported by a t-statistic of -25.45. Subsequently, post the crash month, the declining trend transitions into a consistently upward trajectory. Over the three months following the crash, the average abnormal return reaches 7.11%, accompanied by a t-statistic of 4.25. Further, within six months after the crash month, this value almost doubles to 13.16%, with a t-statistic of 5.32.

In Panel B, we replicate the calculations outlined in Panel A, focusing on the subset of stocks with minimal short-horizon mutual fund ownership. Notably, the average abnormal return during the crash month registers a substantial negative value of -18.59%, accompanied by a t-statistic of -38.75. This value is higher than the corresponding figure for stocks primarily held by short-horizon mutual funds. However, despite the fact that the average abnormal return for this subset of crash stocks is positive within three months, six months, or twelve months following the crash month, it is evident that both the magnitude and statistical significance are evidently lower compared to the corresponding values in Panel A. During the three months subsequent to the crash month, stocks with minimal short-horizon mutual fund ownership exhibit a price increase of 3.74%. While this increase is significantly higher than zero, as indicated by a t-statistic of 4.24, the magnitude is less than half of the corresponding value observed for stocks with highest short-horizon ownership. This pattern is also reflected in the average abnormal return within six months following the crash month, which stands at 4.96%. Within 12 months after the crash month, the

average abnormal return further diminishes to 3.46%, supported by a t-statistic of only 1.70—both lower in magnitude and significance compared to the corresponding figures for stocks with highest short-horizon ownership.

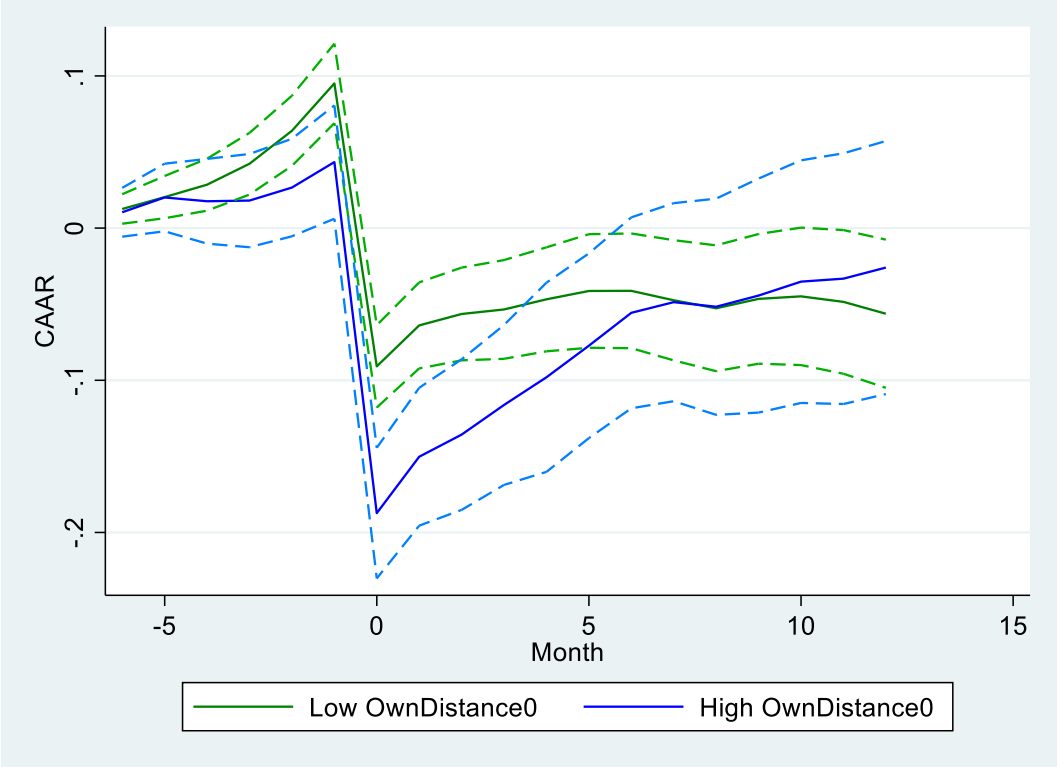

Fig.6. Cumulative average abnormal returns around stock crashes

Notes: The crash month is set at time zero on the horizontal axis. CAAR depicts cumulative residual returns relative to the five-factor asset pricing model with momentum, calculated from six months prior to the crash month, averaged across all crash stocks within each monthly subsample. OwnDistance0 signifies the number of shares originally held by mutual funds with a distance of zero. Stocks with OwnDistance0 exceeding the 90th percentile constitute the subgroup with high short-horizon mutual fund ownership, while those below the 10th percentile form the subgroup with low short-horizon mutual fund ownership. Dashed lines represent the 95% confidence level.

Table 11
Monthly cumulative average abnormal returns for stocks around the crash.

Month	AAR(%)	T Statistics	CAAR(%)	T Statistics	N
A: Stocks with ownership ratio of zero-distance mutual funds higher than the 90% percentile					
-6	1.04	(1.27)	1.04	(1.27)	316
-5	0.97	(1.34)	2.01	(1.78)	316
-4	-0.25	(-0.32)	1.76	(1.24)	316
-3	0.04	(0.05)	1.81	(1.16)	316
-2	0.86	(1.18)	2.67	(1.63)	316
-1	1.67	(2.16)	4.34	(2.28)	316
0	-23.07	(-25.45)	-18.73	(-8.56)	316
1	3.71	(3.6)	-15.02	(-6.5)	316
2	1.46	(1.64)	-13.57	(-5.38)	316
3	1.95	(2.15)	-11.62	(-4.33)	316
4	1.82	(1.41)	-9.80	(-3.09)	316
5	2.07	(1.99)	-7.73	(-2.5)	316
6	2.16	(2.59)	-5.57	(-1.74)	316
7	0.70	(0.77)	-4.87	(-1.47)	316
8	-0.30	(-0.33)	-5.17	(-1.43)	316
9	0.74	(0.79)	-4.43	(-1.13)	316
10	0.91	(0.99)	-3.52	(-0.86)	316
11	0.19	(0.18)	-3.32	(-0.79)	316
12	0.73	(0.77)	-2.59	(-0.61)	316
	Event Period [-6,0]			-18.73	(-8.56)
	Event Period [-3,0]			-20.49	(-12.12)
	Event Period [1,3]			7.11	(4.25)
	Event Period [1,6]			13.16	(5.32)
	Event Period [1,12]			16.14	(4.42)
B: Stocks with ownership ratio of zero-distance mutual funds lower than the 10% percentile					
-6	1.26	(2.54)	1.26	(2.54)	709
-5	0.78	(1.55)	2.04	(2.88)	709
-4	0.82	(1.64)	2.85	(3.27)	709
-3	1.38	(2.6)	4.23	(4.09)	709
-2	2.16	(4.09)	6.39	(5.44)	709
-1	3.11	(5.3)	9.51	(7.14)	709
0	-18.59	(-38.75)	-9.08	(-6.58)	709
1	2.69	(5.16)	-6.39	(-4.43)	709
2	0.75	(1.34)	-5.64	(-3.63)	709
3	0.30	(0.54)	-5.34	(-3.23)	709
4	0.67	(1.14)	-4.68	(-2.68)	709
5	0.55	(0.67)	-4.13	(-2.17)	709
6	0.01	(0.02)	-4.12	(-2.14)	709
7	-0.62	(-1.02)	-4.74	(-2.35)	709
8	-0.53	(-0.89)	-5.27	(-2.5)	709
9	0.62	(1.12)	-4.65	(-2.14)	709
10	0.16	(0.27)	-4.48	(-1.95)	709

11	-0.36	(-0.61)	-4.85	(-2.01)	709
12	-0.78	(-1.25)	-5.63	(-2.26)	709
	Event Period [-6,0]			-9.08	(-6.58)
	Event Period [-3,0]			-11.94	(-11.36)
	Event Period [1,3]			3.74	(4.24)
	Event Period [1,6]			4.96	(3.68)
	Event Period [1,12]			3.46	(1.70)

Notes: This table reports the monthly cumulative average abnormal returns for stocks around crash months. In order to mitigate the influence of absolute mutual fund ownership, we employ a subsample of crash stocks for the event study. This subsample includes stocks for which the total fund ownership by the crash month surpasses the median value among all sample crash stocks. Cumulative average abnormal returns (*CAAR*s) are monthly returns exceeding those attributed to Fama-French five factors as well as the momentum factor. The coefficients of these factors are estimated using past monthly returns over a 36-month period before the initial point of the event study. Panel A reports the results for stocks mainly held by short-horizon mutual funds. Stocks with *OwnDistance0* above the 90th percentile are determined to be stocks mainly held by short-horizon mutual funds. *OwnDistance0* is the number of stock shares priorly held by mutual funds with a distance of zero to the next mandatory reporting date, divided by the number of total outstanding shares. Panel B reports results for stocks minimally held by short-horizon mutual funds. *OwnDistance0* below the 10th percentile are determined to be stocks minimally held by short-horizon mutual funds. Test Statistics are calculated using the standard error of the mean and are in parentheses. * indicates significance at 1% (***), 5% (**), 10% (*).

Up to now, we have already verified that the selling of mutual funds, compelled by concerns about the mandatory disclosure of portfolio holdings, exerts a substantial downward price pressure on the portfolio stock which is confronted with an external shock. Those crash stocks with higher ownership level of short-horizon mutual funds, which face impending mandatory reporting date within one month in our strict definition, are more susceptible to the impact of short-horizon mutual fund selling. The price declines, driven by necessity rather than information, are destined to be reversed afterward. In line with Hypothesis 3, this comparative event study offers empirical evidence indicating that these stocks consequently tend to undergo more substantial price reversals.

6 Conclusion

This study examines how the investment horizon affects institutional investors' trading behavior and how their trading behavior consequently affects the stock price efficiency when the stock suffers an idiosyncratic shock. We identify investment horizon of institutional investors by focusing on mutual funds with homogenous investor type and from the aspect of career concerns associated with portfolio disclosure regulation for mutual funds. Specifically, we utilize the variation in the distance between the crash that occurring to a particular stock and the impending mandatory portfolio reporting date of mutual fund investors to extract the exogenous variation of investment horizons. Shorter distance corresponds to shorter investment horizon.

We find that mutual funds with shorter investment horizons are more likely to liquidate all their initial positions of stocks immediately when a crash occurs. They also sell more of the held stock shares at the crash. As a result, the stock prices during the crash are further affected by the additional selling of mutual funds with a short investment horizon. Stocks with a higher level of short-horizon mutual fund ownership exhibit lower abnormal returns during the month of the crash. At last, we conduct an event study on the average abnormal return of stocks around the crash. Through the event study, we provide evidence that the stocks primarily owned by short-horizon mutual funds experience a larger price reversal during the post-crash period than stocks minimally owned by short-horizon mutual funds. Our findings verify that the selling behavior of short-horizon mutual funds in stocks when a shock suddenly strikes, is uninformative. Consequently, this behavior will destroy the price inefficiency and amplify the individual stock crash by driving the price of crash stock below the firm's intrinsic value.

7 References

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