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# Show Us Your Shorts!

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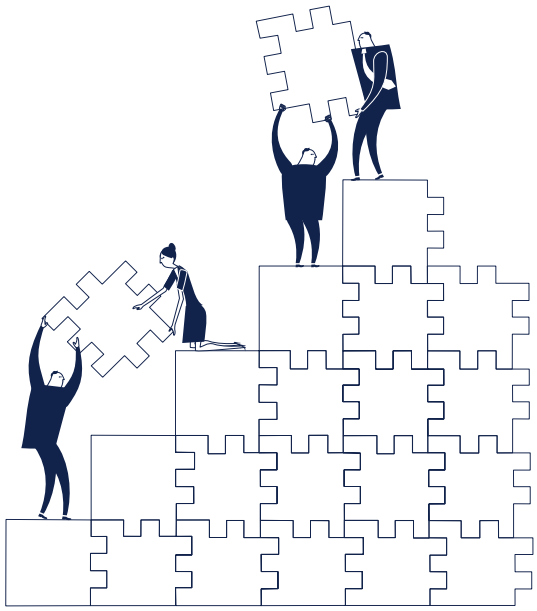

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# Show Us Your Shorts!

Bige Kahraman and Salil Pachare*

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Abstract

What is the impact of greater publicity in the shorting market on informational efficiency? To answer this, we exploit rule amendments in U.S. securities markets which increased the frequency of public disclosure of short interest. Theoretically, greater public disclosure can improve or deteriorate informational efficiency. We find that with more frequent disclosure, short-sellers' private information is incorporated into prices faster, improving informational efficiency. We also document significant market reactions to short interest announcements, suggesting investor learning, and furthermore, reductions in short-sellers' horizon risk and holding periods.

Keywords: Short Interest; Public Disclosure; Informational Efficiency

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# 1 Introduction

There is now overwhelming evidence that short-sellers are rational, informed traders who possess superior information.[1] Historically, regulators have imposed rules that restrict short-selling activity in spite of ample academic research suggesting that short-sale constraints do more harm than good.[2] Recently, this approach has been revisited. Regulators now seek to obtain desired outcomes by increased transparency of short-sales, particularly through using disclosure as a policy tool, as an alternative to restrictions and bans to short-selling.[3] The new policy approach increases the public disclosure requirements of short positions, making short-sellers' private information more accessible to the wider investing public. In this paper, we analyze the impact of greater public disclosure of short-sales on market outcomes. Specifically, we ask: Does greater public disclosure of short-sales improve or deteriorate informational efficiency?

The effects of increased public disclosure of short-sales on informational efficiency can be beneficial or harmful. Short-sellers are informed investors who possess superior information about company fundamentals, and due to frictions involved in short-selling, short-sellers' information diffuses slowly (Diamond and Verrecchia, 1987). Increased public disclosure of short positions could improve informational efficiency by allowing the rest of the investing public to learn from short-sellers more promptly, and furthermore, it could incentivize arbitrageurs to take on positions they otherwise would not take. Arbitrageurs can be hesitant to attack a mispricing because of horizon risk – the risk that the mispricing can take too long to correct so that potential profits of arbitrageurs are eroded due to accumulating transaction costs or their profits can become subject to early liquidation risk due to adverse price movements (Barberis and Thaler, 2003; Abreu and Brunnermeier, 2002). If increased public disclosure of short positions hastens the speed at which short-sellers' information is incor-

[1] See, for instance, Boehmer, Jones and Zhang (2008); Karpoff and Lou (2010); Fang, Huang, Karpoff (2015).

[2] These studies include Jones and Lamont (2002); Asquith, Pathak and Ritter (2005); Nagel (2005); Bris, Goetzmann and Zhu (2007); Diether, Lee and Werner (2009); Saffi and Sigurdsson (2011); Boehmer, Jones, and Zhang (2013); Beber and Pagano (2013); Boehmer and Wu (2013), Cornelli and Yilmaz (2015), among others.

[3] See Short Sale Position and Transaction Reporting (June 5, 2014), https://www.sec.gov/dera/reportspubs/special-studies/short-sale-position-and-transaction-reporting.pdf

porated into prices, then short-sellers' horizon risk would be reduced, giving them stronger incentives to attack an overpricing more readily. Therefore, increased public disclosure of short interest could increase the diffusion of short-sellers' private information into prices, thereby improving informational efficiency.

Greater public disclosure of short sales could be also potentially harmful to informational efficiency. With increased disclosure requirements for short positions, if short-sellers end up having to disclose these positions before they fully build them up, this may result in short-sellers revealing their private information prematurely. Outside investors could then free-ride off of their information without incurring the costs to acquiring this information themselves. This could result in moving the stock price before the trade is completed, thereby reducing short-sellers' profits (Grossman and Stiglitz, 1980; Huddart, Hughes, and Levine, 2001; Agarwal, Jiang, Thang, Yang, 2013). As a result, increased public disclosure may hurt short-sellers' incentives to gather private information in the first place and worsen market efficiency.

In light of the two competing hypotheses discussed above, the effect of increased public disclosure in the shorting market is ultimately an empirical question. This paper aims to analyze this question by studying the effects of amendments approved by the U.S. Securities and Exchange Commission ("SEC") to rules which increased the frequency of short interest reporting requirements from once-a-month to twice-a-month, effective September 7, 2007. Exchanges publicly disclose each stock's total short interest, which is defined as the total outstanding short positions in a given stock on the settlement date.

We examine the changes to informational efficiency due to the new regulatory regime using a differences-in-differences test. Prior to the amendments, investors received new information on short interest only after the settlement date on the 15th of each month. In the post-amendment period, investors receive additional new information on short interest after the settlement date at the end of each month. Our identification strategy comes from the fact that in the post-amendment period, additional information on short interest is publicly reported after the settlement date at the end of each month, while in the pre-amendment period, investors do not receive any new information on these dates.

We therefore generate "placebo dates", that is, dates where short interest would have been publicly reported had broker-dealers been required to report their short interest positions at the end of the month in the pre-amendment period. Using both the actual and placebo report dates, we analyze the impact of greater disclosure of short interest on informational efficiency. We measure informational efficiency between the two consecutive short interest report dates, which is approximately two weeks in the post-amendment period. Specifically, we test the differences in informational efficiency after the end-of-month report dates (including the placebo dates) between pre- and post-amendment periods, over and above the differences in informational efficeiency after the mid-month report dates between pre- and post-amendment periods. By estimating the effect as over and above the differences in informational efficiency measured after the mid-month short interest announcements, we control for the possible aggregate changes in informational efficiency from pre- to post-amendment periods. This methodology therefore allows us to isolate the impact of the extra short interest announcement from potential confounding effects arising from market-wide changes.

Following the related studies (e.g., Kim and Verrecchia, 1991; Peress, 2010; Kelly and Ljungqvist, 2012), we use market reactions around quarterly earnings news as our measure of informational efficiency. This measure allows us to develop predictions that are closely tied to these related studies, and capture changes in informational efficiency at a relatively higher frequency; for instance, in the two-week period between two short-interest announcements. Specifically, the existing academic literature shows that short-sellers have superior information on firms' fundamentals and short interest contain information on forthcoming earnings surprises (Christophe, Ferri and Angel, 2004; Francis, Venkatachalam and Zhang, 2005; Christophe, Ferri and Hsieh, 2010; Boehmer, Jones and Zhang, 2015). If the extra short interest disclosure that is publicized before an earnings announcement is informative to investors, the market can learn from this, and thus be less surprised with firms' earnings news arriving thereafter. This improved informational efficiency would imply smaller price reactions around earnings announcement surprises, less trading activity and volatility, and attenuated post-earnings announcement drift.

We calculate the abnormal returns around the announcement of earnings announcements

and find that after the extra short interest announcement in the post-amendment period is released, there is a significantly smaller price reaction to earnings announcements. In addition, we find significantly less trading activity, lower volatility around earnings announcement days, and smaller post-earnings announcement drift over longer-term horizons after these short interest announcements in the post-amendment period. The results are robust to a battery of tests that use alternative measures of abnormal returns, different estimation windows and control for a number of stock characteristics as well as stock fixed effects. Our results show that the new disclosure regime improves rather than worsens informational efficiency.

In extended analyses, we run a number of tests to shed light on the mechanism driving our results. We first examine market reactions to short interest announcements, by calculating abnormal stock returns around short interest announcements. Theoretical studies such as Diamond and Verrecchia (1987) and Cornelli and Yilmaz (2015) argue that, due to costly short-selling, short-sellers' information diffuses slowly; therefore, changes in short interest that is not yet public contains new information that can help the investing public improve their inferences, leading to a price adjustment on announcement days. Consistent with this prediction, we find significant market reactions to changes in short interest on short interest announcement days. Market reactions are much larger for stocks with increases in short interest, that is, stocks with more negative information.[4] This suggests that the new reporting regime helps with the diffusion of negative information, which tends to be revealed more slowly (Diamond and Verrecchia, 1987; Hong, Lim and Stein, 2000; Cohen, Lou and Malloy, 2014). Market reactions to short interest announcements are significantly larger for stocks in poorer informational environments (e.g., small stocks) and stocks that short-

[4]There are a number of studies which analyze the relationship between the levels of short interest and subsequent stock returns (e.g., Figlewski, 1981; Desai et al., 2002; Asquith, Pathak, and Ritter, 2005). A common finding is that there is a negative relationship between the degree of short interest and subsequent abnormal returns. A recent paper by Boehmer, Huszar and Jordan (2010) documents that this predictability is driven by the low levels of short interest predicting subsequent returns positively rather than high levels of short interest predicting returns negatively. As discussed by Boehmer, Huszar and Jordan (2010), this is puzzing because short-sales is expected to contain negative information, thus negatively predict future returns. In addition to providing a test of mechanism, our findings also help reconciling this puzzle. Our findings show that the relationship between short-selling and subsequent returns is as expected (higher short-selling activity predicting subsequent returns negatively) if we conduct the analysis using the changes in short interest (as opposed to levels). This is consistent with Diamond and Verrechia (1987), which predict that the market should react to changes, that is, new information in short positions.

sellers tend to target (e.g., stocks with high book-to-market ratios, as shown by Dechow et al, 2001 and Hanson and Sunderam, 2014). Complementing these results, we find that improvements in informational efficiency in the post-amendment period are also significantly greater for these groups of stocks. In addition to these findings, we examine price reactions to the announcement of short interest over long-run horizons and find that price reactions are long-lasting. This indicates that the effects we document are not driven by an investor overreaction, which may occur if investors believe short interest to be more informative than what it actually is or if short-sellers send a false signal to the public to drive down stock prices.[5]

For an additional mechanism test, we use data from Markit on securities lending, which reports the average length of time a securities lender has lent out their shares of a given stock. Using this data, we analyze the change in the holding horizon and risks of short-sellers' positions after the regulatory amendments. If negative information encapsulated in short interest is more quickly incorporated into prices in the post-amendment period, we would expect a decline in the holding horizon of short-sellers' positions. Consistent with this conjecture, we find a significant decline in the holding horizon of short-sellers' positions. Furthermore, we document that a strategy that goes long on lightly shorted stocks and short on heavily sorted stocks have significantly higher Sharpe ratios after the extra short interest announcement in the post-amendment period. Since short-sellers' information is diffusing faster with the new disclosure rules, the risk of experiencing an adverse price movement is reduced, which enables short-sellers earn alphas more reliably. These findings provide further support for the mechanism driving our findings.

Although the academic literature on short-selling is extensive, there is surprisingly little discussion of appropriate disclosure policies in the shorting market, despite its relevance to

[5]There is an older literature arguing that public disclosure of short positions may lead to abusive behaviour and market manipulations (e.g., Fishman and Hagerty, 1995; John and Narayanan, 1997, Benabou and Laroque, 1992). Such abusive behavior aims to make profits by generating price swings around public disclosures of short positions. Our finding that there is no price reversals following public disclosures is inconsistent with this earlier theoretical literature, but in line with the recent empirical papers which analyze the issue of market manipulations around the public disclosures of short positions in detail but do not find any evidence for it (e.g., Ljungqvist and Qian, 2016, Jones, Reed and Waller, 2015). These results are also consistent with Huddart, Hughes, and Levine (2001), which show that the existence of manipulation in the older theoretical literature arises under somewhat restrictive parametric assumptions.

investors, regulators and the wider public alike. Disclosure policies have been particularly relevant in the aftermath of the recent financial crisis, since a more common policy is now to increase disclosure requirements in the shorting market, instead of imposing restrictions or bans on short-selling.

One paper that also aims to understand the impact of short-selling disclosure policies is by Jones, Reed and Waller (2015). Different than ours, their paper focuses on the disclosure rules implemented in the E.U., which require short-sellers with large short positions (above 0.5% of shares outstanding) to immediately disclose their trades to the public. Jones, Reed and Waller (2015) find that although there is not a very strong immediate market reaction to the disclosure of these large positions, the E.U.'s disclosure regime negatively affects the amount of shorting and informativeness of prices. In a related study, Jank, Roling, and Smajlbegovic (2016) suggest that this might be because some short-sellers may want to avoid crossing the threshold for disclosing their short positions, which reduces the overall level of short-selling activity.

Our focus in this paper is to exploit the policy approach adopted in the U.S., which has only changed the frequency of public disclosure of short interest. Different from their E.U. counterpart, U.S. regulators have focused their disclosure policies on the public disclosure of each stock's total short interest, as opposed to releasing trader-level information on particularly large short-sales. Also, in contrast with immediate disclosure requirements required in the E.U., U.S. regulators publicly disclose short interest information on a bi-monthly basis, on prescheduled announcement dates. An interesting finding that emerges from our analysis is that efficiency gains can be obtained by only increasing the frequency of public disclosure of stock-level short interest.

Our conclusion is in line with recent papers that highlight the benefits, rather than the costs, of heightened public disclosures on arbitrage activity and informed trading. Ljungqvist and Qian (2016) and Zuckerman (2011) document that short-sellers sometimes voluntarily reveal their information to the public. As in our paper, this triggers market reactions which help foster price discovery. In terms of theoretical work, Abreu and Brunnermeier (2002) characterizes the causes of horizon risk and argue that arbitrageurs can overcome horizon

risks by using public disclosure; Makarov and Plantin (2012) and Kovbasyuk and Pagano (2015) analyze the incentives to reveal private information in more detail and offer optimal strategies in publicizing positions. While it can certainly be harmful to immediately disclose after each transaction as this may reveal the traders' private information too early (Huddart, Hughes, and Levine, 2001; Agarwal et al 2015), this newly growing literature emphasizes the benefits that come with revealing completed trades. Another paper that also considers the role of disclosure policies in the shorting market is by Beber and Pagano (2011). Although the main focus of their paper is on the liquidity effects of short-selling bans imposed during the recent financial crises, they also document that the harmful affects of short-selling bans on stock liquidity is reversed by increased public disclosure policies.

This paper is organized as follows. Section 2 describes the data and methodology; Section 3 presents the results and robustness checks; Section 4 concludes the paper.

# 2 Methodology and Data Sources

## 2.1 Methodology

On March 6, 2007, the SEC approved amendments that revised the short interest reporting requirements of all major securities exchanges and the National Association of Securites Dealers ("NASD"), now known as the Financial Industry Regulatory Authority ("FINRA"). The amendments required that as of September 7, 2007, member firms of these securities exchanges and FINRA increase the frequency of short interest reporting from once-per-month to twice-per-month.[6] Prior to the amendments, member firms were required to submit a mid-month short interest report which was based on short positions held on settlement date, namely the 15th of each month. If the 15th happened to fall on a weekend, the designated settlement date was the previous business day on which the transactions settled. After the

[6]The entities that were affected by these SEC approved amendments include the Boston Stock Exchange ("BSE"), Chicago Board Options Exchange ("CBOE"), Chicago Stock Exchange ("CHX"), FINRA, International Stock Exchange ("ISE"), NASDAQ, National Stock Exchange ("NSX"), NYSE, NYSE Arca, American Stock Exchange (now known as NYSE MKT), and the Philadelphia Stock Exchange ("PSX"). See Notice to Members 07-24, "New Requirement for the Reporting of Consolidated Short Interest Positions to the Intermarket Surveillance Group (ISG)" (May 2007), available at https://www.finra.org/sites/default/files/NoticeDocument/p019161.pdf

amendments however, in addition to the mid-month short interest report, member firms are also required to submit an end-of-month short interest report based on short positions held on the last business day of the month on which transactions settle. Member firms have until 6:00 p.m. Eastern Time two business days after the settlement date to report their short positions. Short interest is then aggregated on a stock-by-stock basis across member firms and publicly disseminated after 4:00 p.m. Eastern Time, eight business days later, on pre-scheduled announcement days.[7] In this paper, we denote the date of public dissemination of short interest as $REPDATE$. Since the time of public dissemination of short interest is after the market close, the next business day after $REPDATE$ is the date of interest in this paper, since the next business day is when the market is able to react to this public information.

The objective of this paper is to understand whether increased public disclosure of short interest has a causal impact on informational efficiency. The SEC approved amendments provide a particularly useful setting for analyzing the impact of short interest disclosure, since in the pre-amendment period, the short interest announcement occurred on a fixed date in the middle of the month, and in the post-amendment period, due to the the change in the frequency of disclosure, there is an extra short interest announcement occurring on a fixed date at the end of the month. Our analysis therefore focuses on whether this extra short interest announcement at the end of the month is valuable to investors, and whether it enhances how information is incorporated into stock prices and affects informational efficiency.

Our identification strategy comes from generating "placebo dates", that is, dates where short interest would have been publicly reported had broker-dealers been required to report their short interest positions at the end-of-month in the pre-amendment period. We generate the placebo dates in the pre-amendment period following the disclosure rules explained above. Using both the actual and placebo $REPDATE$, we estimate the causal impact of more frequent reporting of short interest on informational efficiency. While investors do not receive publicly disseminated information on short interest on the placebo $REPDATE$, they

[7]Publication schedules for short interest dissemination are available at http://www.nasdaqtrader.com/Trader.aspx?id=ShortIntPubSch.

do so on the actual $REPDATE$.

Following previous studies, we use the market reaction around quarterly firm's earnings announcements as a proxy for informational efficiency (e.g. Kim and Verrecchia, 1991; Peress, 2010; Kelly and Ljungqvist, 2012). More specifically, we use the market reactions to firms' earnings announcements that occur after the actual or placebo $REPDATE$. There are a number of advantages of using earnings announcements as a proxy for informational efficiency in our empirical setting. First, this measure allows us to capture changes to informational efficiency in the period between two successive $REPDATEs$ (which is approximately two weeks).[8] Second, this measure helps us directly link our hypotheses to the findings in related studies on short-sellers. A number of studies find that short interest contains information about forthcoming earnings surprises (e.g. Christophe, Ferri and Angel, 2004; Francis, Venkatachalam and Zhang, 2005; Christophe, Ferri and Hsieh, 2010; Boehmer, Jones and Zhang, 2015). Short interest announcements are then expected to provide an informed signal to investors from which they can learn about company news more readily. To that effect, we estimate the following regression model:

$$CAR[m,n]_{i,q} = \alpha_i + \beta_0 e_{i,t} + \beta_1 POST_{i,t} + \beta_2 [e \times POST]_{i,t} + \gamma X_{i,t} + \varepsilon_{i,t} \quad (1)$$

$CAR[m,n]$ is the *absolute value* of cumulative abnormal returns measured in either the [0,1] or [2,61] day window after the firm's earnings announcement; $e$ is a dummy variable which equals 1 when the firm's earnings announcement occurs after the end-of-month $REPDATE$ and before the mid-month $REPDATE$ the following month, and $e$ equals 0 when the firm's earnings announcement occurs after the mid-month $REPDATE$ and before the end-of-

[8] Another commonly-used measure of informational efficiency is the price delay measure of Hou and Moskowitz (2005). This is a low-frequency measure of efficiency that captures the speed of adjustment to market-wide information. Price delay is estimated using 12-month rolling regressions, thus is available only at annual frequency. Another low-frequency efficiency measure is the R-square from a market model regression as suggested in Morck, Yeung, and Yu (2000). Morck, Yeung, and Yu (2000) argue that a lower R-square indicates more firm-specific information can explain variation in prices, and thus can be used as a measure of information efficiency of stock prices. However, recent work casts doubt on this interpretation and suggests that R-square does not capture the incorporation of information into stock prices well (e.g. Hou, Peng, and Xiong, 2006).

month $REPDATE$. The variable, $POST$, is a dummy variable that equals 1 for firms' earnings announcements in the post-amendment period, that is, after September 7, 2007, and zero otherwise; and the variable $[e \times POST]$ is an interaction variable that considers the impact of earnings announcements occuring after end-of-month short interest announcements in the post-amendment period. Our baseline specification includes year, month and day-of-week fixed effects, and standard errors are double-clustered by stock and earnings announcement day.

Our metholodogy is essentially a differences-in-differences test in which we test the differences in market reactions to earnings announcements after the end-of-month $REPDATE$ between pre- and post-amendment periods, over and above the differences in market reactions to earnings announcements after the mid-month $REPDATE$ between pre- and post-amendment periods. While mid-month short interest announcements take place in both the pre- and post-amendment periods (thus, no treatment effect), end-of-month short interest announcements take place only in the post-amendment period. By calculating the effect as over and above the differences in market reactions to earnings announcements after the mid-month short interest announcements, we control for the possible aggreate changes in market reactions in earnings announcements from the pre- to post-amendment periods. Thus, this methodology allows us to isolate the impact of the extra short interest announcement from potential confounding effects arising from market-wide changes. We provide a graphical representation of our empirical methodology in Figure 1.

The coefficient on the interaction variable, $\beta_2$, is the key variable of interest in our analysis. This coefficient quantifies the impact of the extra short interest announcement at the end of the month that investors receive in the post-amendment period. Related academic literature suggests that short-sellers are informed investors and have superior information on a firm's fundamentals (e.g. Desai, et al., 2002; Asquith, Pathak and Ritter, 2005; Nagel, 2005; Cohen, Diether and Malloy, 2007; Boehmer, Jones and Zhang, 2008), and that they anticipate future news related to earnings surprises (e.g. Christophe, Ferri and Angel, 2004; Francis, Venkatachalam and Zhang, 2005; Christophe, Ferri and Hsieh, 2010; Boehmer, Jones and Zhang, 2015). Short interest announcements are therfore expected to provide an

informed signal to investors from which they can learn, and therefore investors may not be as surprised by earnings announcements when they arrive. This would reduce the market reaction to the announcements. We therefore expect $\beta_2 < 0$, that is, we expect to observe a significant reduction in the market reaction to earnings announcements that occur after the end-of-month $REPDATE$ in the post-amendment period.

There may be alternative ways through which investors can access information on short-selling activity. For instance, short-sellers who are subscribed to the Markit database (to be explained in Section 2.2) receive updates on total short positions of Markit's subscribers on a next-day basis. Although this may go against finding a large effect due to the new disclosure regime, it is not expected to have an important impact on our findings since the majority of investing public do not have access to Markit data. In addition to this, starting from the fourth quarter of 2009, FINRA started publishing aggregate short volume data by security in each day. Short volume is the amount of short-sales trades executed within a trading day, and short interest is the total outstanding open positions at the end of the day. While part of short volume is likely to be due to intra-day short selling for market-making purposes and by high-frequency traders, short interest is likely to capture negative information relevant over longer horizons. More importantly, our empirical strategy is designed to isolate the impact of short interest announcements (short-volume data is publicized daily). For instance, if there is some aggregate effect due to the daily disclosure of short volume after 2009, this would also affect observations where a firm's quarterly earnings news are released after the mid-month short-interest announcements in the post-amendment period. We find that our results exist over and above these effects, suggesting that that the disclosure of short volume does not drive our findings.

In robustness tests, we include a vector of control variables, $X_{it}$, which the previous literature shows to be related to earnings reactions (e.g., Chambers and Penman, 1984; Bernard and Thomas, 1989; DellaVigna and Pollet, 2009; Hirshleifer, Lim and Teoh, 2009). Control variables include the number of analysts following the stock, institutional ownership, median forecast error, earnings persistence, earnings volatility, and the number of earnings announcements on the given day of a firm's own earnings announcement (definitions are

provided in the next section). In robustness checks, we also include industry and stock fixed effects in our analyses.[9]

## 2.2 Data Sources and Variables

The sample consists of all common stocks (with share codes of 10 or 11) from the CRSP-Compustat-I/B/E/S universe. Market data is obtained from the CRSP Daily Files, and financial-statement related information is obtained from the Compustat Merged Security Monthly File. In order to characterize the market reaction to earnings announcements, we use quarterly earnings announcement data from the CRSP-Compustat Merged Database and I/B/E/S. Following Hirshleifer, Lim and Teoh (2009) and DellaVigna and Pollet (2009), when the earnings announcement date is included in both these databases and the I/B/E/S date is different from the Compustat date, we use the earlier date as the date of the earnings announcement date.[10] Earnings announcements released after 4:00 p.m. Eastern Time are moved to the next trading day. Short-term and long-term market reactions to earnings announcements are measured using different windows, namely, [0,1] and [2,61] days after the earnings announcement. For the long-term market reaction, we focus primarily on 60 days for the post-announcement window as the academic literature commonly follows Bernard and Thomas (1989), who report that most of the drift occurs during the first 60 days after the announcement. We obtain similar results when we use 75 days as the post-announcement window.

We measure market reactions to earnings announcements by the *absolute value* of cumulative abnormal returns around earnings announcements. We use the absolute value of cumulative abnormal returns since we are interested in comparing the size of earnings reactions after short interest announcements. When defining the cumulative abnormal returns, we use two methods. First, similar to Hirshleifer, Lim and Teoh (2009), we compute the difference between the buy-and-hold return of the firm and that of a size and book-to-market

[9]We use the Fama-French 10 industry classification from Kenneth French's website, available at http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/Data_Library/det_10_ind_port.html.

[10]DellaVigna and Pollet (2009) report that the earlier of the two dates is almost always the correct announcement date in the post-1994 period, when the announcement date is also available in I/B/E/S but is different from the reported date in Compustat.

(B/M) matched portfolio,[11] and then take the absolute value:

$$CAR[m,n]_{i,q} = \left| \left[ \prod_{k=t}^{t+n} (1 + R_{i,k}) - 1 \right] - \left[ \prod_{k=t}^{t+n} (1 + R_{p,k}) - 1 \right] \right| \tag{2}$$

$R_{i,k}$ is the return of stock $i$ on day $k$, and $R_{p,k}$ is the return of the matching size and B/M portfolio on day $k$, where $t$ is the earnings announcement date of quarter $q$'s earnings. Second, similar to DellaVigna and Pollet (2009), we compute the difference between the buy-and-hold return of the firm and beta multiplied by the buy-and-hold return of the market, and then take the absolute value:

$$CAR[m,n]_{i,q} = \left| \left[ \prod_{k=t}^{t+n} (1 + R_{i,k}) - 1 \right] - \hat{\beta}_{i,q} \left[ \prod_{k=t}^{t+n} (1 + R_{m,k}) - 1 \right] \right| \tag{3}$$

Once again, $R_{i,k}$ is the return of stock $i$ on day $k$, and $R_{m,k}$ is the return on the market on day $k$, and $\hat{\beta}_{i,q}$ for stock $i$ in quarter $q$ is obtained from the regression $R_{i,u} = \alpha_{i,q} + \beta_{i,q} R_{m,u} + \varepsilon_{i,u}$ for the days $u \in [t - 300, t - 46]$, where $t$ is the date of the earnings announcement. Since our objective is to analyze the effect more frequent disclosure of short interest has on the market, we divide the sample into two sub-periods around the regulatory amendments. The first part of our sample runs from January 1, 2003 to September 6, 2007, which we refer to as the "pre-amendment period", and the second part of our sample runs from September 7, 2007 to December 31, 2012, which we refer to as the "post-amendment period". In deciding our sample period, we aim to choose a period that is long enough to provide empirical power for our tests (since firms announce their earnings news quarterly, we have only four observations per firm in each year), but also narrow enough to capture the effect due to regulatory amendments. Later in the paper, we show that our results are robust to alternative estimation periods (Section 3.2.4).

Shortly after the SEC approved amendments, stock markets experienced dramatic turbulence and the SEC implemented temporary prohibitions and bans to short selling. Although

[11] Each stock is matched with one of 25 size and B/M portfolios at the end of June each year based on the market capitalization at the end of June and B/M, book equity of the last fiscal year end in the prior calendar year divided by the market value of equity at the end of December of the prior year. The daily returns of size and B/M portfolios are obtained from Kenneth French's website, available at http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

our differences-in-differences test would take into account the impact of market-wide changes between the pre- and post-amendment periods, we exclude the 2008 calendar year and financial stocks to prevent some extreme observations during this period from affecting our findings. Additionally, following the literature, we exclude stocks with price less than $1 (before split-adjustment) to minimize the possibility of data errors.

In robustness tests, we control for numerous variables when conducting our analysis of the market reactions to earnings announcements. Using the I/B/E/S Detail History File, we define $NUMEST$, which is the natural logarithm of one plus the number of analysts giving earnings-per-share (EPS) forecasts for the given stock in a quarter; $EARNINGS\_PERSIST$, which is is the first-order autocorrelation coefficient of quarterly earnings per share during the past four years; $EARNINGS\_VOL$, which is the standard deviation of quarterly EPS in the past four years; $FE$ which is the absolute analyst forecast error, defined as the absolute value of the difference between the announced earnings and the consensus EPS forecast normalized by stock price at the end of the corresponding quarter;[12] and $NUMANN$ is the natural logarithm of one plus the number of concurrent earnings announcements that occur on the same day as the given stock. Using the Thomson Financial Institutional Holdings (13F) database, we define institutional ownership, $IO$, as the fraction of all shares outstanding held by institutional investors for a given stock at the end of the quarter (in %).

As we expect our results on the market reactions to earnings announcements to also affect trading outcomes, we construct additional measures of the dependent variable, namely $TURNOVER$, defined as the average daily trading volume in the [0,1] days around the earnings announcement divided by shares outstanding at the end of the month; $VOLATILITY$, the difference between the highest and the lowest share prices over the [0,1] days around the earnings announcement, normalized by the average of the two; and $SPREAD$, the daily average bid-ask spread over the [-4,-2] days before the earnings announcement. We measure

[12]The consensus forecast is defined as the median of the most recent forecasts from individual analysts. In order to exclude stale forecasts, when we calculate the consensus forecast, we only include one- or two-quarter ahead forecasts issued or reviewed in the last 60 calendar days. If an analyst made multiple forecasts during that period, we take the most recent forecast. To minimize potential errors with I/B/E/S data, we delete observations when earnings or forecasts are greater than the stock price, or when the stock price is less than $1 before split-adjustment. These data cleaning techniques we use to construct forecast error are following Hirshleifer, Lim and Teoh (2009).

$SPREAD$ prior to the earnings announcements since trading by informed investors, and thus asymmetric information, intensifies before earnings announcements. If public disclosure of short interest prior to an earnings announcement reduces informational asymmetry, this would therefore be captured in the spread measured in the period prior to the earnings announcement. To deepen our understanding of the mechanisms driving the main results, we complement our dataset with data on securities lending from Markit.[13] We use this data starting from July 2006, as Markit starts reporting this variable at a daily frequency starting from this date onwards. Prior to July 2006, the data are available either at a weekly or monthly frequency. In our study, $LOANLENGTH$ is loan tenure, measured as the average length of time a securities lender has lent out the security between two consecutive short interest announcements.

# 3 Results

## 3.1 Descriptive Statistics

In Table 1, we present descriptive statistics on firm characteristics. Panel A presents the descriptive statistics for the sample of firms where $e = 0$, that is, if the firm's earnings announcement occurs after the mid-month $REPDATE$ and before the end-of-month $REPDATE$; Panel B presents the descriptive statistics for the sample of stocks where $e = 1$, that is, if the firm's earnings announcement occurs after the end-of-month $REPDATE$ and before the mid-month $REPDATE$ the following month. Since our identification strategy hinges on the timing of the earnings announcement relative to the end-of-month $REPDATE$, we report the descriptive statistics for $e = 0$ and $e = 1$ separately and draw comparisons between them. We examine firm characteristics that the previous literature shows to be related to the size of earnings reactions.

[13]The data on securities lending from Markit are sourced from a variety of customers including beneficial owners, hedge funds, investment banks, lending agents, and prime brokers. It provides useful information about the equity loan market such as loan fees, utilization rates (quantity of shares loaned out as a percentage of total quantity of shares available to be borrowed), and loan tenure (the average number of days that a short position is open). Other papers which also use Markit data include Engelberg, Reed, and Ringgenberg (2014), Saffi and Sigurdsson (2010), among others. Markit data reports the sum of the short positions taken by its subscribers in each stock, which constitute about half of all short positions taken in a typical stock.

The main result from Table 1 is that there are no meaningful differences in the mean and median for each of the variables between firms that issue their quarterly earnings announcements after the mid-month or end-of-month short interest announcement. For instance, the number of analysts giving EPS forecasts, the analyst forecast error, earnings persistence and earnings volatility are almost identical between the two samples. While some variables, such as institutional ownership as a fraction of shares outstanding and the number of concurrent earnings announcements, are slightly higher when $e = 1$ (60.57% and 4.67 respectively) than when $e = 0$ (56.93% and 4.09 respectively), the differences appear to be small. The fact that the difference in magnitude in the means and medians between these two samples appears to be small indicates that our results cannot be explained merely by the characteristics of the two samples; however, in robustness tests, we control for these variables in our empiricial specifications. Overall, the findings in Table 1 help validate our empirical strategy.

## 3.2 Main Results

### 3.2.1 Short-Term Price Reactions

As discussed earlier, our identification hinges on the fact that in the post-amendment period, short interest is publicly disseminated after the settlement date at the end of each month in addition to the middle of each month. Therefore, if more frequent disclosure of short interest impacts informational efficiency, these differences should be noticeable around the end-of-month $REPDATE$. More specifically, in the post-amendment period, we hypothesize that the market reaction to earnings announcements that occur after the end-of-month $REPDATE$ should be smaller than in the pre-amendment period.

In Table 2, we estimate (1) using the absolute value of the cumulative abnormal returns in [0,1] day period around earnings announcements. Panel A shows the results when cumulative abnormal returns are estimated as in DellaVigna and Pollet (2009), and Panel B shows the results when cumulative abnormal returns are estimated as in Hirshleifer, Lim and Teoh (2009). Column 1 in both panels show the baseline results. We note that $POST$ is significant and positive, perhaps due to increased aggregate uncertainty in the post-amendment period. More importantly, our main variable of interest,$[e \times POST]$, is significantly negative.

The coefficient on $[e \times POST]$ in Panel A shows that in the post-amendement period, the market reaction to earnings announcements that occur after the end-of-month $REPDATE$ is 30 bps lower than after mid-month $REPDATE$ in the pre-amendment period. Since the mean and median reaction to earnings announcements (in absolute value) in our sample are 4.3% and 2.8%, respectively, the economic magnitude of a 30 bps reduction translates to an approximately 7% reduction in mean and 11% reduction in median market reaction to earnings announcements.

An interesting observation to note is that in the pre-amendement period, the market reaction to earning announcements that take place after the placebo $REPDATE$ is 32 bps higher than market reactions that take place after the mid-month $REPDATE$ ($e = 0.0032$). This result supports our hypothesis that the public dissemination of short interest allows investors to learn about firm fundamentals more readily. Thus, lack of information on short interest at the end of the month in pre-amendment period leads to larger market reactions to earnings announcements that come after. The estimates also imply that differences in market reactions between earnings announcements that take place after the end-of-month $REPDATE$ and before the mid-month $REPDATE$ the following month dissipate in the post-amendment period.[14] Thus, investors receive information about short interest in both the middle of the month and at the end of the month, and we find that there are no longer substantial differences in the reactions to earnings announcements after the increase in frequency of short interest disclosure mandated by the SEC approved amendments.

In column 2 of both panels, we include several stock characteristics which are shown to be related to reactions to earnings announcements such as $NUMEST$, $IO$, $FE$,$EARNINGS\_PERSIST$, $EARNINGS\_VOL$, and industry fixed effects. Consistent with the academic literature, we find that these characteristics are related to reactions to earnings announcements; however, the inclusion of these variables in our empirical specification does not change our conclusion. This is consistent with the descriptive statistics we provide in Table 1 showing that there are no meaningful differences in stock characteristics for firms which have their earnings an-

[14] In the post-amendment period, the difference in market reactions to earnings announcements after the mid-month $REPDATE$ and the end-of-month $REPDATE$ is the coefficient on $e$ plus the coefficient on $[e \times POST]$, which is only 2 bps.

nouncement at different times within the month. In column 3 of both panels, we control for the potential impact of total number of earnings announcements in a day ($NUMANN$), as it has been shown that the total number of earnings announcements in a day has a negative impact on reactions to earnings announcements (Hirshleifer, Lim and Teoh, 2009). Consistent with Hirshleifer, Lim and Teoh (2009), the coefficient on $NUMANN$ is significant and negative, yet our results remain robust. Finally, in column 4 of both panels, we follow Michaely, Rubin and Vedrashko (2012) and include firm fixed effects to control for the potential impact of unobserved stock characteristics on market reactions to earnings news and find that our results still remain robust.

The results in Table 2 indicate that the coefficient on the interaction term $[e \times POST]$ is negative and statistically significant across all specifications. What this shows is that with more frequent reporting of short interest, the market is less surprised after end-of-month short interest announcements in the post-amendment period. This is consistent with short interest announcements serving as an signal for investors, a signal that helps them anticipate future news related to earnings, which therefore reduces the market reactions to earnings announcements and improves informational efficiency.

#### 3.2.2 Short-Term Reactions (Turnover, Volatility, Information Asymmetry)

If more frequent disclosure of short interest improves the informational efficiency of stock prices, we would expect that gains to informational efficiency are also manifested through trading activity. Furthermore, we would also expect that the end-of-month short interest disclosure reveals additional private information by short-sellers, reducing information updating on earnings announcement days and decreasing asymmetric information between investors prior to earnings announcements. To that effect, we estimate the regression model in (3); however instead, we use $TURNOVER$, $VOLATILITY$ and $SPREAD$ as the dependent variables:

$$CHAR[a,b]_{i,t} = \alpha_i + \delta_0 e_{i,t} + \delta_1 POST_{i,t} + \delta_2 [e \times POST]_{i,t} + \gamma X_{i,t} + \varepsilon_{i,t} \tag{4}$$

where $CHAR[a,b]_{it} = \{TURNOVER_{it}, VOLATILITY_{it}, SPREAD_{it}\}$ and $[a,b]$ is the interval in which the characteristic is measured, that is [0,1] days after the earnings announcement for $TURNOVER$ and $VOLATILITY$. $SPREAD$ is the average bid-ask spread in the [-4,-2] days before the earnings announcement. Since more frequent disclosure of short interest reduces the market reaction to earnings announcements, the market would not be as surprised by the earnings announcement and this reaction would manifest itself as lower turnover and stock volatility. Additionally, revelation of private information by short-sellers through increased public disclosure of short interest would reduce asymmetric information, and therefore lower the bid-ask spread. We measure spread prior to the earnings announcements because informed trading is expected to rise before earnings announcements (Copeland and Galai, 1983; Glosten and Milgrom, 1985; Chae, 2005). Together, we expect that more frequent disclosure of short interest would reduce each of these characteristics, that is, we expect $\delta_2 < 0$.

In Table 3, we begin with estimating (4) using $TURNOVER$ as the dependent variable. In these regressions, we control for $NUMEST$, $IO$, $FE$,$EARNINGS\_PERSIST$, $EARNINGS\_VOL$, $NUMANN$, and time, industry and stock fixed effects. As hypothesized, the coefficient on the interaction term $[e \times POST]$ is negative (-0.0011) and statistically significant. This estimate implies that in the post-amendment period, there is on average a 7.2% reduction in turnover around earnings announcements that occur after the end-of-month $REPDATE$. Similarly, we estimate (4) using $VOLATILITY$ as the dependent variable and find that the coefficient on the interaction term $[e \times POST]$ is negative (-0.0209) and statistically significant, suggesting that volatility around earnings announcements after the end-of-month $REPDATE$ is significantly lower (approximately 6.8%, on average) than in the pre-amendment period. Together, these results are in congruence with the pricing results presented in Table 2; that is, in the post-amendment period, the earnings announcements that occur after the end-of-month short interest announcements are less of a surprise to the market, and thus, the lower price reactions are complemented by lower trading activity (turnover) and lower volatility.

We would also expect the regulatory amendments to impact information asymmetry and

liquidity. Greater disclosure of short interest would reveal short-sellers' private information more quickly to the market. This would reduce information asymmetry between investors about the inherent value of the security and thus increase liquidity. Using the bid-ask spread as a measure of liquidity (e.g. Roll, 1984; Glosten and Milgrom, 1985), we estimate (4) using $SPREAD$ as the dependent variable. The results show that the coefficient on the interaction term $[e \times POST]$ is negative (-0.0126) and statistically significant, indicating that in the post amendment period, there is on average a 7% reduction in the bid-ask spread around earnings announcements that occur after the end-of-month $REPDATE$. Intuitively, these results indicative that more frequent disclosure of short interest expedites the incorporation of short-sellers' private information into the public domain. The market learns about their private information and this reduces asymmetric information between investors prior to earnings announcements. These results complement the rest of our analysis focusing on short-term price reactions.

### 3.2.3 Long-Term Price Reactions

As returns tend to be positive after positive earnings surprises and negative after negative earnings surprises (Ball and Brown, 1968), this suggests that post-earnings announcement drift may be a sign of market inefficiency, as investors fail to recognize information embedded in earnings surprises and therefore prices seemingly do not fully incorporate earnings related information at the time of the announcement (Bernard and Thomas, 1989). In addition to analyzing the short-term price reactions in the two-day window after earnings announcements, we examine whether long-term price reactions after earnings announcements are also mitigated once there is more frequent disclosure of short interest.

In Table 4, we estimate (3) using the [2,61] day period after earnings announcements as the measure of cumulative abnormal returns. Panel A of Table 4 shows that when cumulative returns are calculated as in DellaVigna and Pollet (2009), across all specifications, the coefficient estimates on the interaction term $[e \times POST]$ are negative and statistically significant, ranging between -66 bps and -83 bps. Panel B of Table 4 shows that when cumulative abnormal returns are calculated as in Hirshleifer, Lim and Teoh (2009), across all specifications, the coefficients on the interaction term $[e \times POST]$ are negative and statisti-

cally significant, ranging between -60 bps and -75 bps. Overall, these estimates from both panels suggest that in the post-amendment period, there is on average a 7-9% reduction in long-term price reactions to earnings announcements after the end-of-month $REPDATE$. These results further buttress our short-term price reaction results suggesting that there is less post-earnings announcement drift and therefore greater informational efficiency after the regulatory amendments.

#### 3.2.4 Robustness: Alternative Sample Periods

As discussed in Section 2, our sample period runs from January 2003 to December 2012, excluding 2008. In this section, we re-estimate our results using alternative sample periods where: (i) the pre- and post-amendment periods are of equal distance from the date of the regulatory amendments (i.e. 48 months before and after September 7, 2007, excluding 2008); and (ii) the pre- and post-amendment periods contain an equal number of short interest announcements, including placebo short interest announcements (i.e. 48 months before September 7, 2007 and 60 months after September 7, 2007, excluding 2008).

Panel A of Table 5 re-estimates column 4 from Tables 2-4, using a sample period with an equal 48-month window in the pre- and post-amendment period, excluding all observations from 2008. Panel B of Table 5 re-estimates column 4 from Tables 2-4 but uses a sample period 48 months in the pre-amendment period and 60 months in the post-amendment period, excluding observations from 2008. While we use observations that are of equal distance from the date of regulatory amendments in Panel A, the post-amendment period has lower statistical power because there are fewer observations in the post-amendment period subsample. On the other hand, in Panel B, both the pre-amendment and post-amendment period subsamples have the same statistical power but part of the observations in the post period are further away from the regulatory amendments. These two methodological choices are complementary and we analyze whether our results are sensitive to using alternative sample periods. Our results in both panels show that the coefficient on $[e \times POST]$ across all variables is negative, statistically significant and comparable to results presented in Tables 2-4. This robustness check shows that the choice of sample period does not drive our results.

### 3.2.5 Robustness: The Timing of Earnings News

In this section, we assess the robustness of our results to the timing of a firm's earnings announcements. The underlying driver behind our empirical methology is that firms which release their earnings news after the mid-month $REPDATE$ are not meaningfully different than the firms which release their earnings news after the end-of-month $REPDATE$. In support of this, in Table 1 we showed that the descriptive statistics of firm characteristics related to the magnitude of market reactions to earnings surprises are not significantly different depending on the timing of earnings announcements relative to short-interest announcements. In Tables 2-5, we controlled for these firms characteristics in our regressions, and in further tests following Michaely, Rubin and Vedrashko (2012), we also included stock fixed effects to take into account the role of unobservable firm characteristics on market reactions to earnings news. Our results remained robust.

To see whether the timing of of a firm's earnings announcements affect our results, in Table 6, we re-estimate column 4 from Tables 2-4 using a subsample of firms which have propensity to release their earnings news in the same period relative to the end-of month $REPDATE$ in both the pre- and post-amendment periods. More specifically, for each firm, we compute the average value of $e$ in the pre- and post-amendment periods. We then define the variable, *tendency_sameperiod*, which equals 1 if the firm has an average value of $e$ that is strictly higher than 0.5 in *both* the pre- and post-amendment periods or an average value of $e$ that is strictly lower than 0.5 in *both* the pre- and post-amendment periods. Firms where $tendency\_sameperiod = 1$ indicate that they have a tendency to announce their earnings in the same period relative to the end-of-month $REPDATE$ in the pre- and post-amendment periods. Columns 1 to 5 from Table 6 present the results with short-term price reactions captured by absolute value of $CAR[0,1]$, $TURNOVER$, $SPREAD$, $VOLATILITY$, and the long-term price reactions captured by the absolute value of $CAR[2,61]$, respectively. Similar to main results presented in Tables 2-4, we find that the coefficient on $[e \times POST]$ is negative, statistically significant and of comparable magnitude to the results presented in Tables 2-4. This robustness test shows that the timing of earnings announcements does not drive our results.

## 3.3 Which Stocks are More Affected?

In this section, we aim to understand the characteristics of stocks that are more affected by the SEC approved amendments which increased the frequency of short interest reporting. We re-estimate our baseline regression for different subsamples of stocks and draw comparisons between them. Table 7 reports our results conditional on these characteristics.

Stocks in a better informational environment are likely to have prices that are already informationally efficient; therefore the increase in informational efficiency due to the more frequent public disclosure of short interest is expected to be more pronounced for stocks in poorer informational environments. Following the academic literature, we argue that small stocks are likely to have worse informational environments than large stocks (e.g., Hong, Lim and Stein, 2000; Zhang, 2006). In columns 1 and 2 of Table 7, we compare stocks that are below and above the median size of stocks in our sample, and find that the impact of more frequent public disclosure of short interest is indeed larger for small stocks.

Negative news diffuses slowly amongst investors (Hong and Stein 1999; Hong, Lim and Stein, 2000), and since short interest conveys pessimistic information to investors, more frequent disclosure of short interest should help investors learn about short-sellers' private information more promptly. Through this learning channel, the diffusion and incorporation of this negative private information into stock prices is hastened, improving informational efficiency (Diamond and Verecchia, 1987). In this spirit, we divide the sample of earning announcements taking place after the end-of-month $REPDATE$ in the post-amendment period ($[e \times POST]$=1) into two groups. The first group includes stocks with increases in short interest ($NEGNEWS = 1$), and the second group includes the stocks that have decreases in short interest ($POSNEWS = 1$). We re-run our analysis using each of these groups with the rest of the observations. Columns 3 and 4 of Table 7 show that the results are stronger in the sample of stocks with negative news (increases in short interest), thus providing evidence that negative information encapsulated in short interest is more quickly incorporated into prices after the regulatory amendments.[15]

[15]We form the subsamples of $POSNEWS$ and $NEGNEWS$ after the end-of-month $REPDATE$ only in the post-amendment period because we don't observe short interest on placebo $REPDATE$. In this analysis, we use data on short interest from Compustat, which reports the short interest that is disclosed to

In a similar vein, we analyze whether the stocks that short-sellers tend to target at experience a larger change in their information efficiency after the rule amendments. Related studies such as Dechow et al (2001) and Hanson and Sunderam (2014) document that short-sellers take larger positions in stocks with lower book-to-market ratios. Therefore, we expect to find larger effects for stocks with low book-to-market ratios than stocks with high book-to-market ratios. In columns 5 and 6 of Table 7, we rerun the analysis for stocks that are above or below median with respect to their book to market ratios, and document that this is in fact the case.

The academic literature has shown that short-sellers are informed prior to earnings announcements, in that short interest increases for stocks one week before negative surprises in earnings announcements (Boehmer, Jones and Zhang, 2015). In light of this, we would expect that short interest is likely to be more informative when short interest announcements are closer to earnings announcements. In this spirirt, we construct the measure, $DAYSBTW$, as the number of days between the earnings announcement (taking place after the short interest announcement) and the short interest announcement. We divide the sample at the median $DAYSBTW$. Columns 7 and 8 of Table 7 show that the impact of more frequent public disclosure of short interest is in fact larger for earnings announcements that take place soon after the short interest announcement.

## 3.4 Mechanism

### 3.4.1 Market Reactions to Short Interest Announcements

We have shown that increasing the frequency of short interest disclosure improves informational efficiency around earnings announcements. This is consistent with our hypothesis that investors learn about short sellers' private information and are subsequently less surprised when firms announce their earnings. In this section, we examine the market reaction around short interest announcements to provide evidence of this channel. Diamond and Verrecchia (1987) and Cornelli and Yilmaz (2015) show that, due to costly short-selling, short-sellers'

the public. Therefore, while using Compustat provides the advantage of precisely capturing the information that becomes public, it allows us to observe short interest only on actual report dates.

information diffuses slowly. Therefore, changes in short interest that is not public yet contain new information that can help investing public improve their inferences, and this leads to a price adjustment on announcement days.

To examine this, we calculate the price reactions to changes in short interest announcements, $\Delta SHORT$ for each stock. Specifically, $\Delta SHORT$ is the change in short interest between two successive short interest announcements, scaled by stock's shares outstanding at the end of the month. We use changes in short interest, as opposed to the levels of short interest, as we expect the market to react to new information (Diamond and Verrecchia, 1987). Using data on short interest from Compustat (which is extracted from the public disclosure of short interest on the exchanges' websites), we form 10 portfolios based on changes in short interest on each short interest announcement date, $REPDATE$.[16] For consistency, we continue to use our sample stocks from January 2003 to December 2012 (excluding 2008); however, the universe of stocks in this analysis is the merged CRSP-Compustat universe as we do not use any information from I/B/E/S. The bottom decile portfolio has $\Delta SHORT$ below the 10th percentile, and the top decile portfolio has $\Delta SHORT$ above 90th percentile. Thus, the former portfolio includes stocks with large decreases in short interest, which can be considered as positive news; and the latter group includes stocks with large increases in short interest, which can be considered as negative news. Since short-selling conveys pessimistic information, we expect a negative relationship between changes in short interest and stock returns.

Panel A in Table 8 reports the average 2-day announcement returns. Since short interest is disclosed after 4:00 p.m. Eastern Time on each $REPDATE$, we calculate the average returns in [1,2] trading days after the $REPDATE$. Panel A reports abnormal returns adjusted by size and book-to-market ratio, and alphas estimated from a 3-factor and a 4-factor model. Using all three measures, we find a negative relationship between changes in short interest and announcement returns. The relationship between changes in short interest and announcement returns is monotonic and the differences between the decile portfolios are

[16] We do not observe short interest on the placebo $REPDATE$. Thus, in pre-amendment period, $\Delta SHORT$ is the monthly changes in the short interest, and in the post-amendment period, it captures the bi-monthly change in short interest.

significant. For instance, a strategy that buys the stocks in the bottom decile portfolio and sells the stocks in top decile portfolio earns an average daily 4-factor alpha of 0.15% (approximately a monthly alpha of 3%) and is significant at the 1% level.[17] As short interest conveys pessimistic information, price reactions (in absolute terms) are much larger for the top decile portfolio than for the bottom decile portfolio. This shows that market reactions to short interest announcements are mostly due to stocks that experience increases in short interest, as one would expect.

To visualize the market reactions to short interest announcements, we also plot the alphas around the short interest announcements. Figure 1 show the cumulative 4-factor alphas for the top and bottom deciles starting from 7 trading days prior to the $REPDATE$ until 10 trading days after the $REPDATE$. Consistent with the portfolio results reported in the Panel A of Table 8, we find a decline in prices for the top decile portfolio ("Increased Shorting") and increases in prices for the bottom decile portfolio ("Decreased Shorting"). Price declines for the top decile portfolio is evidently more prominent than the price increases for the bottom decile portfolio. Another interesting observation is that there is no notable pattern in alphas before the short interest announcements, suggesting that there is no front-running prior to the announcement of short interest. We also confirm this in portfolio tests reported in Panel B of Table 8, where we report 4-factor alphas up to 3 trading days prior to the short interest announcements for top and bottom decile portfolios. We do not find any significant differences, with the exception of alphas in the day before the announcement where the top decile portfolio appears to have a weakly higher alpha. Thus, if anything, the patterns prior to the short interest announcements are the opposite of what we observe after the announcements.

There are a number of studies which analyze the relationship between the levels of short interest and subsequent stock returns (e.g., Figlewski, 1981; Desai et al., 2002; Asquith, Pathak, and Ritter, 2005), and the common finding is that there is negative relationship

[17] A more recent literature examines the relationship between short volume and subsequent returns (e.g. Boehmer, Jones and Zhang, 2008; Diether, Lee, Werner, 2009; Kelley and Tetlock, 2016). Our results are both qualitative and quantitatively similar with this literature. For instance, Kelley and Tetlock (2016) reports that a H-minus-L portfolio constructed on quintiles of past retail daily short volume lead to a daily alpha of 0.07% in the next day.

between the degree of short interest and subsequent abnormal returns. Boehmer, Huszar and Jordan (2010) document that this predictability is driven by low levels of short interest predicting positive subsequent returns, as opposed to high levels of shorting predicting negative subsequent returns. As discussed by Boehmer, Huszar and Jordan (2010), this is puzzling because short-sales are expected to capture negative information. Our results in this section help reconcile this puzzle. We find that the relationship between short-selling activity and subsequent returns are as expected (e.g., high levels of shorting predict negative future returns) when one conducts the analysis using changes in short interest. This is consistent with Diamond and Verrechia (1987), which predict that the market should react to new information in short positions, which is captured by changes in short interest. Another important difference of our analysis from the related literature is that we look at price reactions around public announcements of short interest. Most of the previous papers use a calendar-time approach, for instance, forming portfolios on monthly short-selling activity. Our findings indicate that price effects are triggered by short interest announcements as we do not observe significant price effects prior to the public release of short interest filings. To the best of our knowledge, there is an older literature which aimed to examine price reactions to the public announcement of stock-level short interest (e.g., Vu and Caster, 1987; Senchack and Starks, 1993). Although this older literature face important data limitations (for instance, the data in these papers are hand-collected from major newspapers which publish short interest for a selected group of stocks), consistent with our findings, these papers also document a negative price reaction for stocks with large increases in short interest.

Next, we examine cross-sectional variation in the market reactions to short interest announcements. As discussed previously, small stocks tend to have poorer informational environments compared to large stocks (Hong, Lim and Stein, 2000; Zhang, 2006). Thus, short-sellers' private information is expected to matter more for smaller stocks and generate larger price reactions. Similarly, stocks with low book-to-market ratios are likely to experience larger reactions as short-sellers are shown to heavily target these stocks (Dechow et al, 2001; Hanson and Sunderam, 2014). To examine how cross-sectional variation in these characteristics impacts our results, we first form quintile portfolios according to stocks' market capitalization or book-to-market ratio, and within each bottom and top quintile portfolio,

we form 10 decile portfolios based on the stocks' changes in short interest. We use quintiles in the first step to make sure that each portfolio is well-populated. *Small* and *Large* are the bottom and top quintiles formed based on size, and $LowBM$ and $HighBM$ are the bottom and top quintiles formed based on book-to-market ratio. Panel C of Table 8 reports the 2-day 4-factor alphas for *Small* and *Large*, and $LowBM$ and $HighBM$ respectively. Consistent with our conjecture, we find that small stocks and stocks with low book-to-market ratios experience larger price reactions than large stocks and stocks with high book-to-market ratios. In Figure 3, we plot the cumulative 4-factor alphas for trading days [-7,10] for stocks in *Small* and *Large* (Panel A) and stocks in $LowBM$ and $HighBM$ (Panel B), and consistent with our portfolio results reported in Panel C of Table 8, we find that the effects around short interest announcements are more prominent for small stocks and stocks with low book-to-market ratios.

Finally, we check for the possibility that there might be an overreaction to short interest announcements. An overreaction to short interest may occur if investors believe that short interest is more informative than it actually is or if abusive short-sellers aim to manipulate other market participants' beliefs. The prior literature has documented limited evidence for manipulation, and the evidence which has been found has been concentrated around seasoned equity offerings (Henry and Koski, 2010). If investors overreact to short interest announcements or if manipulative short-selling is taking place, we would expect to find return reversals. To detect for a possible reversal effect, in Figure 4, we plot the cumulative 4-alphas over the next 60 trading days after the $REPDATE$ for stocks with large increases in short interest ("Increased Shorting"). First, we find that there are no reversals in the full sample. Additionally, we repeat this analysis for small stocks and stocks with low book-to-market ratios as these stocks experience a much larger initial reaction, some of which might be due to an overreaction or abusive short-selling. Figure 4 also plots the cumulative 4-factor alphas over the next 60 trading days for small stocks and stocks with low book-to-market ratios. Once again, we do not detect patterns of return reversals at longer horizons. These results indicate that price reactions due to short interest announcements have long-lasting effects.[18]

[18]There is an older literature arguing that public disclosure of short positions may lead to abusive behaviour and market manipulations (e.g., Fishman and Hagerty, 1995; John and Narayanan, 1997, Benabou and

Overall, the findings in Table 8 and Figures 2-4 indicate that the public disclosure of short interest provides valuable information for investors, particularly inferring private information from changes in short-sellers' positions. We find that abnormal returns are substantially higher for stocks with larger increases in short interest, stocks in poorer informational environments and stocks that are common targets of short-sellers.

### 3.4.2 Short-Sellers' Holding Periods and Risks

Short-sellers face important horizon risks – the risk that the mispricing can take too long to correct so that potential profits of arbitrageurs are eroded by accumulating transaction costs or become subject to an early liquidation risk due to adverse price movements (Barberis and Thaler, 2003; Abreu and Brunnermeier, 2002). For instance, short-sellers need to maintain margin requirements and pay short-selling fees to keep their positions open. If short-sellers' information is more quickly incorporated into prices with more frequent short interest announcements, we would expect a decline in the holding horizon of short sellers' positions. Furthermore, a faster diffusion of information would reduce the risk of experiencing adverse price movements and help short-sellers earn alphas more reliably. In this section, we analyze how short-sellers' holding periods and risks change after the regulatory amendments.

We start by measuring the holding horizon of short-sellers' positions using data from Markit. Markit reports the weighted average number of days that transactions have been open. We take the average of all loans for a stock between two consecutive short interest announcement days and run the following regression:

$$LOANLENGTH_{i,t+1} = \alpha_i + \theta_0 e_{i,t} + \theta_1 POST_{i,t} + \theta_2 [e \times POST]_{i,t} + \lambda X_{i,t} + \varepsilon_{i,t} \quad (5)$$

where $LOANLENGTH_{i,t+1}$ is the average loan tenure for a stock after a short interest

Laroque, 1992). Such abusive behavior aims to make profits by generating price swings around public disclosures of short positions. Our finding that there is no price reversals following public disclosures is inconsistent with this earlier theoretical literature, but in line with the recent empirical papers which analyze the issue of market manipulations around the public revelation of short positions but do not find any evidence for it (e.g., Ljungqvist and Qian, 2016; Jones, Reed and Waller, 2015). These results are also consistent with Huddart, Hughes, and Levine (2001), which show that the existence of manipulation in the older theoretical literature arises under somewhat restrictive parametric assumptions.

announcement and prior to the next short interest announcement. We include control variables for stock characteristics that might be related to short-sellers' holding period such as, $IVOL$, which is the standard deviation of idiosyncratic monthly returns; $BM$, the book-to-market ratio; $Size$, the stock's market capitalization; $ILLIQ$, computed following Amihud (2002), as the average ratio of the absolute value of daily returns to the stock daily volume; $PastReturn$ is cumulative monthly returns in the past six months. We also include year, month, day-of-week fixed effects. If the holding horizon of short sellers' positions is reduced due to public disclosure of short interest, then we expect $\theta_2 < 0$.

Table 9 reports the results. In column 1, we report the baseline results and in column 2, we control for stock characteristics. In both empirical specifications, $[e \times POST]$ is negative and statistically significant. In column 1, the coefficient on $[e \times POST]$ is -9.74 and it is -7.8 in column 2. For stocks in our sample, the average holding horizon of short sellers' positions is about 80 calendar days, thus these estimates corresponds to an approximate 9-12% decrease in short sellers' holding periods.

Next, we analyze the impact of the regulatory amendments on the Sharpe ratios of short-sellers' positions. If the regulatory amendments hasten the speed in which short-sellers' information is impounded into prices, then the risk of experiencing adverse price movements decrease, thus Sharpe ratios would increase. We test this prediction, again using the Markit database. Markit reports the total short positions taken on by its subscribers. For this analysis, we use data from Markit because it allows us to observe short positions on both actual and placebo report dates. Short interest from Compustat is what is disclosed to the public, thus it alllows us to observe short interest only on actual report dates.

Using Markit, on each $REPDATE$ (including both actual and placebo report dates), we form 10 portfolios based on changes in short interest from previous $REPDATE$. $\Delta SHORTINT-MARKIT$ is the change in short interest between two consecutive $REPDATEs$, scaled by shares outstanding at the end of the month. After forming the portfolios, we examine the subsequent size and book-to-market adjusted abnormal returns until the next $REPDATE$, and calculate the Sharpe ratios. Table 10 reports the results in a $2x2$ matrix form. In the first row, we present the Sharpe ratios of portfolios formed on $REPDATEs$ in the pre-

amendment period ($POST = 0$) when $e = 0$ or $e = 1$, and similarly, in the second row, we report the Sharpe ratios of portfolios formed on $REPDATEs$ in the post-amendment period ($POST = 1$) when $e = 0$ or $e = 1$. The results indicate that the new regulatory regime boosts the Sharpe ratios of short-sellers' positions. For instance, Sharpe ratios of portfolios formed after the settlement date at the end of each month (that is, when $POST = 1$ and $e = 1$) is about 30% higher than the Sharpe ratios of portfolios formed after the placebo settlement date at the end of each month in the pre-amendment period (that is, when $POST = 0$ and $e = 1$). Although the analysis uses data that covers only a group of short-sellers (the Markit subscribers), the results suggest that extra short interest disclosure after the settlement date at the end of each month in the post-amendment period boosts Sharpe ratios. Consistent with our previous results, the differences are much higher for the portfolio of stocks that are heavily shorted.

Overall, these results provide corroborating evidence for the importance of increased public disclosure in shorting market. The regulatory amendments appears to reduce short-sellers' holding periods and exposure to price risks; thus, short-sellers can reap off benefits from their private information faster and more reliably.

# 4 Conclusion

In this paper, we investigate the role that heightened disclosure requirements in the shorting market play for providing informational efficiency. This is an important question because a more common policy in the the aftermath of the recent financial crisis is to increase the disclosure requirements in the shorting market, instead of imposing restrictions or bans on short-selling.To analyze the impact of disclosure policies in the shorting market, we exploit SEC approved amendments to rules which increased the reporting requirements of short interest from once-a-month to twice-a-month as of September 2007. Theoretically, higher publicity can improve or deteriorate informational efficiency, and therefore, the effect of increased public disclosure in the shorting market on informational efficiency is ultimately an empirical question.

We estimate the changes to informational efficiency with more frequent reporting of short

interest using a differences-in-differences test. The identification strategy relies on placebo dates, that is, dates when short interest would have been publicly reported had broker-dealers been required to report their short interest positions at the end-of-month in the pre-amendment period. To quantify informational efficiency, we look at market reactions to earnings news that take place after the release of short interest filings. We capture the causal impact of more frequent reporting of short interest on informational efficiency by estimating the differences in market reactions to earnings news that are announced after the actual and placebo dissemination dates of short interest.

Our findings indicate that the new reporting regime has an important impact on a stock's informational environment. With more frequent disclosure, information encapsulated within short interest is more quickly incorporated into prices, thereby improving informational efficiency. Consistent with our main findings, we document significant market reactions to short-sales announcements, suggesting that investors learn from short interest announcements. Furthermore, the extra short interest disclosure reduces short-sellers' horizon risk and holding periods.

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**Table 1. Descriptive Statistics**

This table presents the descriptive statistics for our sample. We divide our sample into two sub-samples: $e = 0$ pertains to observations where the firm's earnings announcement occurs after the mid-month *REPDATE* and before the end-of-month *REPDATE*; $e = 1$ pertains to observations where the firm's earnings announcement occurs after the end-of-month *REPDATE* and before the mid-month *REPDATE* the following month. *NUMEST* is the natural logarithm of one plus the number of analysts giving EPS forecasts for the given firm in that quarter; *IO* is the fraction of all shares outstanding held by institutional investors for a given stock at the end of the quarter (in %); *FE* is the difference between the announced earnings and the consensus EPS forecast normalized by the firm's stock price at the end of the corresponding quarter; *EARNINGS_PERSIST* is the first-order autocorrelation coefficient of quarterly earnings per share during the past 4 years; *EARNINGS_VOL* is the standard deviation of quarterly EPS in the past 4 years; *NUMANN* is the natural logarithm of one plus the number of concurrent earnings announcements that occur on the same day as the earning's announcement for the given stock.

| | | Mean | Median | Standard Deviation |
|---|---|---|---|---|
| ***e* = 0** | *NUMEST* | 1.5093 | 1.6094 | 0.8896 |
| | *IO* | 56.9318 | 59.9246 | 26.7693 |
| | *FE* | 0.0073 | 0.0023 | 0.0170 |
| | *EARNINGS_PERSIST* | 0.2489 | 0.2370 | 0.3044 |
| | *EARNINGS_VOL* | 0.4646 | 0.2229 | 0.8796 |
| | *NUMANN* | 4.0884 | 4.2047 | 0.8442 |
| ***e* = 1** | *NUMEST* | 1.5143 | 1.6094 | 0.8181 |
| | *IO* | 60.5778 | 63.7538 | 25.2301 |
| | *FE* | 0.0074 | 0.0027 | 0.0162 |
| | *EARNINGS_PERSIST* | 0.2449 | 0.2252 | 0.2971 |
| | *EARNINGS_VOL* | 0.4951 | 0.2469 | 0.9265 |
| | *NUMANN* | 4.6722 | 4.8978 | 0.8584 |

**Table 2. Short-Term Price Reactions**

This table presents results for the short-term price reactions to earnings announcements. Panel A presents the regression results where the dependent variable, *CAR*[0,1] is the absolute value of 2-day cumulative abnormal return in the [0,1] days around the earnings announcement, defined as the difference between buy-and-hold returns of the stock and beta multiplied by the buy-and-hold return of the market. Panel B presents the regression results where the dependent variable, *CAR*[0,1] is the absolute value of 2-day cumulative abnormal return in the [0,1] days around the earnings announcement, defined as the difference between buy-and-hold returns of the stock and that of a size and book-to-market matched portfolio. The explanatory variables include: *POST* is a dummy variable that equals 1 for the firm's earnings announcement dates after September 7, 2007; *e* is a dummy variable that equals 1 when the firm's earnings announcement occurs after the end-of-month *REPDATE* and before the mid-month *REPDATE* the following month; *POST* x *e* is an interaction term between *POST* and *e*. In columns 2 to 4, we control for *NUMEST, IO, FE, EARNINGS_PERSIST, EARNINGS_VOL, NUMANN*, and include industry fixed effects. Column 4 also includes stock fixed effects. Control variables are defined in Table 1. All specifications include year, month and day-of-week fixed effects. We present ordinary least squares estimates with standard errors double-clustered by stock and earnings announcement day; *, **, *** indicate 10%, 5% and 1% level of significance respectively.

**Panel A. Short-Term Price Reactions: 2 Days, Beta-Adjusted Returns**

| | (1) *CAR*[0,1] | (2) *CAR*[0,1] | (3) *CAR*[0,1] | (4) *CAR*[0,1] |
|---|---|---|---|---|
| *POST* x *e* | -0.0030*** | -0.0025*** | -0.0023** | -0.0021*** |
| | (0.0010) | (0.0010) | (0.0010) | (0.0007) |
| *POST* | 0.0124*** | 0.0121*** | 0.0122*** | 0.0120*** |
| | (0.0018) | (0.0019) | (0.0019) | (0.0014) |
| *e* | 0.0032*** | 0.0027*** | 0.0034*** | 0.0028*** |
| | (0.0007) | (0.0006) | (0.0007) | (0.0005) |
| *NUMEST* | | -0.0051*** | -0.0051*** | -0.0016*** |
| | | (0.0004) | (0.0004) | (0.0005) |
| *IO* | | 0.0000*** | 0.0000*** | 0.0000* |
| | | (0.0000) | (0.0000) | (0.0000) |
| *FE* | | 0.1565*** | 0.1564*** | 0.0973*** |
| | | (0.0141) | (0.0141) | (0.0132) |
| *EARNINGS_PERSIST* | | 0.0031*** | 0.0032*** | 0.0033*** |
| | | (0.0008) | (0.0008) | (0.0008) |
| *EARNINGS_VOL* | | 0.0005* | 0.0005* | 0.0016*** |
| | | (0.0003) | (0.0003) | (0.0003) |
| *NUMANN* | | | -0.0015*** | -0.0017*** |
| | | | (0.0004) | (0.0003) |
| Observations | 78,317 | 59,020 | 59,020 | 59,020 |
| R-squared | 0.071 | 0.121 | 0.121 | 0.063 |
| Controls | No | Yes | Yes | Yes |
| Time FE | Yes | Yes | Yes | Yes |
| Industry FE | No | Yes | Yes | Yes |
| Stock FE | No | No | No | Yes |

**Panel B. Short-Term Price Reactions: 2 Days, SMB-Adjusted Returns**

| VARIABLES | (1) *CAR*[0,1] | (2) *CAR*[0,1] | (3) *CAR*[0,1] | (4) *CAR*[0,1] |
|---|---|---|---|---|
| *POST* x *e* | -0.0028*** | -0.0021** | -0.0019** | -0.0017** |
| | (0.0010) | (0.0010) | (0.0010) | (0.0007) |
| *POST* | 0.0125*** | 0.0120*** | 0.0121*** | 0.0119*** |
| | (0.0018) | (0.0019) | (0.0019) | (0.0013) |
| *e* | 0.0032*** | 0.0027*** | 0.0034*** | 0.0027*** |
| | (0.0007) | (0.0006) | (0.0007) | (0.0005) |
| *NUMEST* | | -0.0050*** | -0.0050*** | -0.0015*** |
| | | (0.0004) | (0.0004) | (0.0005) |
| *IO* | | 0.0000*** | 0.0000*** | 0.0000 |
| | | (0.0000) | (0.0000) | (0.0000) |
| *FE* | | 0.1581*** | 0.1580*** | 0.1003*** |
| | | (0.0139) | (0.0139) | (0.0129) |
| *EARNINGS_PERSIST* | | 0.0031*** | 0.0031*** | 0.0034*** |
| | | (0.0008) | (0.0008) | (0.0008) |
| *EARNINGS_VOL* | | 0.0006** | 0.0006** | 0.0017*** |
| | | (0.0003) | (0.0003) | (0.0003) |
| *NUMANN* | | | -0.0015*** | -0.0017*** |
| | | | (0.0004) | (0.0003) |
| Observations | 78,327 | 59,026 | 59,026 | 59,026 |
| R-squared | 0.071 | 0.119 | 0.119 | 0.062 |
| Controls | No | Yes | Yes | Yes |
| Time FE | Yes | Yes | Yes | Yes |
| Industry FE | No | Yes | Yes | Yes |
| Stock FE | No | No | No | Yes |

**Table 3. Short-Term Reactions: Other Variables of Interest**

This table presents regression results for the reaction of three different measures to earning announcements. The dependent variables are: in column (1), *TURNOVER* is average daily volume over the [0,1] days around the earnings announcement divided by shares outstanding at the end of the month; in column (2), *VOLATILITY* is difference between the highest and lowest share prices over the [0,1] days around the earnings announcement, normalized by an average of the two; in column (3), *SPREAD* is the daily average bid-ask spread over the [-4,-2] days before the earnings announcement. The explanatory variables include: *POST* is a dummy variable that equals 1 for the firm's earnings announcement dates after September 7, 2007; *e* is a dummy variable that equals 1 when the firm's earnings announcement occurs after the end-of-month *REPDATE* and before the mid-month *REPDATE* the following month; *POST* x *e* is an interaction term between *POST* and *e*. All regressions include the following control variables: *NUMEST*, *IO*, *FE*, *EARNINGS_PERSIST*, *EARNINGS_VOL*, *NUMANN*, and industry, stock, year, month and day-of-week fixed effects. Controls variables are defined in Table 1. We present ordinary least squares estimates with standard errors double-clustered by stock and earnings announcement day; *, **, *** indicate 10%, 5% and 1% level of significance respectively.

| | (1) | (4) | (4) |
|---|---|---|---|
| VARIABLES | *TURNOVER* | *VOLATILITY* | *SPREAD* |
| | | | |
| *POST x e* | -0.0011*** | -0.0209*** | -0.0126** |
| | (0.0003) | (0.0066) | (0.0057) |
| *POST* | 0.0010* | 0.0077* | 0.1061*** |
| | (0.0005) | (0.0045) | (0.0097) |
| *e* | 0.0009*** | 0.0149*** | 0.0079* |
| | (0.0002) | (0.0048) | (0.0044) |
| | | | |
| Observations | 59,934 | 59,425 | 59,904 |
| R-squared | 0.082 | 0.022 | 0.132 |
| Controls | Yes | Yes | Yes |
| Time FE | Yes | Yes | Yes |
| Industry FE | Yes | Yes | Yes |
| Stock FE | Yes | Yes | Yes |

**Table 4. Long-Term Price Reactions**

This table presents results for the long-term price reactions to earnings announcements. Panel A presents the regression results where the dependent variable, *CAR*[2,61] is the absolute value of 60-day cumulative abnormal returns in the [2,61] days after the earnings announcement, defined as the difference between buy-and-hold returns of the stock and beta multiplied by the buy-and-hold return of the market. Panel B presents the regression results where the dependent variable, *CAR*[2,61] is the absolute value of 60-day cumulative abnormal return in the [2,61] days after the earnings announcement, defined as the difference between buy-and-hold returns of the stock and that of a size and book-to-market matched portfolio. The explanatory variables include: *POST* is a dummy variable that equals 1 for the firm's earnings announcement dates after September 7, 2007; *e* is a dummy variable that equals 1 when the firm's earnings announcement occurs after the end-of-month *REPDATE* and before the mid-month *REPDATE* the following month; *POST* x *e* is an interaction term between *POST* and *e*. In columns 2 to 4, we control for *NUMEST, IO, FE, EARNINGS_PERSIST, EARNINGS_VOL, NUMANN*, and include industry fixed effects. Column 4 also includes stock fixed effects. Control variables are defined in Table 1. All specifications include year, month and day-of-week fixed effects. We present ordinary least squares estimates with standard errors double-clustered by stock and earnings announcement day; *, **, *** indicate 10%, 5% and 1% level of significance respectively.

**Panel A. Long-Term Price Reactions: 60 Days, Beta-Adjusted Returns**

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | *CAR*[2,61] | *CAR*[2,61] | *CAR*[2,61] | *CAR*[2,61] |
| *POST* x *e* | -0.0066** | -0.0083*** | -0.0080*** | -0.0075*** |
| | (0.0026) | (0.0026) | (0.0026) | (0.0027) |
| *POST* | 0.0309*** | 0.0269*** | 0.0270*** | 0.0269*** |
| | (0.0039) | (0.0043) | (0.0043) | (0.0041) |
| *e* | 0.0016 | 0.0042** | 0.0050*** | 0.0053*** |
| | (0.0019) | (0.0017) | (0.0019) | (0.0019) |
| *NUMEST* | | -0.0166*** | -0.0166*** | -0.0058*** |
| | | (0.0009) | (0.0009) | (0.0020) |
| *IO* | | -0.0003*** | -0.0003*** | -0.0005*** |
| | | (0.0000) | (0.0000) | (0.0001) |
| *FE* | | 0.8893*** | 0.8892*** | 0.5217*** |
| | | (0.0606) | (0.0606) | (0.0631) |
| *EARNINGS_PERSIST* | | 0.0071*** | 0.0072*** | 0.0085*** |
| | | (0.0021) | (0.0021) | (0.0030) |
| *EARNINGS_VOL* | | 0.0057*** | 0.0057*** | 0.0035** |
| | | (0.0008) | (0.0008) | (0.0015) |
| *NUMANN* | | | -0.0017 | -0.0061*** |
| | | | (0.0010) | (0.0013) |
| Observations | 74,733 | 56,609 | 56,609 | 56,609 |
| R-squared | 0.024 | 0.073 | 0.073 | 0.028 |
| Controls | No | Yes | Yes | Yes |
| Time FE | Yes | Yes | Yes | Yes |
| Industry FE | No | Yes | Yes | Yes |
| Stock FE | No | No | No | Yes |

**Panel B. Long-Term Price Reactions: 60 Days, SMB-Adjusted Returns**

| VARIABLES | (1)<br>*CAR*[2,61] | (2)<br>*CAR*[2,61] | (3)<br>*CAR*[2,61] | (4)<br>*CAR*[2,61] |
|---|---|---|---|---|
| *POST* x *e* | -0.0063** | -0.0075*** | -0.0071*** | -0.0060** |
| | (0.0025) | (0.0025) | (0.0025) | (0.0026) |
| *POST* | 0.0274*** | 0.0239*** | 0.0239*** | 0.0228*** |
| | (0.0038) | (0.0042) | (0.0042) | (0.0040) |
| *e* | 0.0001 | 0.0031* | 0.0041** | 0.0040** |
| | (0.0018) | (0.0016) | (0.0017) | (0.0018) |
| *NUMEST* | | -0.0147*** | -0.0147*** | -0.0045** |
| | | (0.0009) | (0.0009) | (0.0019) |
| *IO* | | -0.0003*** | -0.0003*** | -0.0004*** |
| | | (0.0000) | (0.0000) | (0.0001) |
| *FE* | | 0.8092*** | 0.8091*** | 0.4439*** |
| | | (0.0563) | (0.0563) | (0.0581) |
| *EARNINGS_PERSIST* | | 0.0057*** | 0.0057*** | 0.0084*** |
| | | (0.0020) | (0.0020) | (0.0029) |
| *EARNINGS_VOL* | | 0.0054*** | 0.0054*** | 0.0032** |
| | | (0.0008) | (0.0008) | (0.0014) |
| *NUMANN* | | | -0.0021** | -0.0068*** |
| | | | (0.0009) | (0.0012) |
| Observations | 74,734 | 56,609 | 56,609 | 56,609 |
| R-squared | 0.027 | 0.073 | 0.073 | 0.031 |
| Controls | No | Yes | Yes | Yes |
| Time FE | Yes | Yes | Yes | Yes |
| Industry FE | No | Yes | Yes | Yes |
| Stock FE | No | No | No | Yes |

**Table 5. Robustness: Alternative Sample Periods**

This table presents results reported in Tables 2-4 using alternative sample periods. Panel A presents the regression results using a [-48,48] month event window around the regulatory amendments on September 7, 2007, excluding 2008. Panel B presents the regression results using a [-48,60] month event window around the regulatory amendments on September 7, 2007, excluding 2008. Both panels use the following dependent variables: in column (1) *CAR*[0,1] is the absolute value of 2-day cumulative abnormal return in the [0,1] days around the earnings announcement, defined as the difference between buy-and-hold returns of the stock and beta multiplied by the buy-and-hold return of the market; in column (2) *TURNOVER* is average daily volume over the [0,1] days around the earnings announcement divided by shares outstanding at the end of the month; in column (3) *SPREAD* is the daily average bid-ask spread over the pre-event time window [-4,-2]; in column (4) *VOLATILITY* is difference between the highest and lowest share prices over the event time window [0,1], normalized by an average of the two; in column (5) *CAR*[2,61] is the absolute value of 60-day cumulative abnormal return in the [2,61] days after the earnings announcement, defined as the difference between buy-and-hold returns of the stock and beta multiplied by the buy-and-hold return of the market. The explanatory variables include: *POST* is a dummy variable that equals 1 for the firm's earnings announcement dates after September 7, 2007; *e* is a dummy variable that equals 1 when the firm's earnings announcement occurs after the end-of-month *REPDATE* and before the mid-month *REPDATE* the following month; *POST* x *e* is an interaction term between *POST* and *e*. All regressions include the following control variables: *NUMEST, IO, FE, EARNINGS_PERSIST, EARNINGS_VOL, NUMANN*, and industry, stock, year, month and day-of-week fixed effects. Controls variables are defined in Table 1. We present ordinary least squares estimates with standard errors double-clustered by stock and earnings announcement day; *, **, *** indicate 10%, 5% and 1% level of significance respectively.

**Panel A. [-48,48] Month Event Window Around the Regulatory Amendments (Excluding 2008)**

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| VARIABLES | *CAR*[0,1] | *TURNOVER* | *SPREAD* | *VOLATILITY* | *CAR*[2,61] |
| | | | | | |
| *POST* x *e* | -0.0027*** | -0.0012*** | -0.0139** | -0.0193*** | -0.0078*** |
| | (0.0008) | (0.0003) | (0.0057) | (0.0073) | (0.0029) |
| *POST* | 0.0125*** | 0.0011** | 0.0887*** | -0.0132 | 0.0264*** |
| | (0.0014) | (0.0005) | (0.0096) | (0.0119) | (0.0042) |
| *e* | 0.0030*** | 0.0009*** | 0.0097** | 0.0122** | 0.0061*** |
| | (0.0006) | (0.0002) | (0.0040) | (0.0052) | (0.0018) |
| | | | | | |
| Observations | 47,687 | 48,436 | 48,425 | 48,055 | 46,747 |
| R-squared | 0.063 | 0.076 | 0.070 | 0.022 | 0.023 |
| Controls | Yes | Yes | Yes | Yes | Yes |
| Time FE | Yes | Yes | Yes | Yes | Yes |
| Industry FE | Yes | Yes | Yes | Yes | Yes |
| Stock FE | Yes | Yes | Yes | Yes | Yes |

**Panel B. [-48,60] Month Event Window Around the Regulatory Amendments (Excluding 2008)**

| VARIABLES | (1) *CAR*[0,1] | (2) *TURNOVER* | (3) *SPREAD* | (4) *VOLATILITY* | (5) CAR[2,61] |
|---|---|---|---|---|---|
| *POST* x *e* | -0.0023*** | -0.0012*** | -0.0108* | -0.0221*** | -0.0062** |
| | (0.0008) | (0.0003) | (0.0063) | (0.0070) | (0.0029) |
| *POST* | 0.0120*** | 0.0008 | 0.1233*** | -0.0121 | 0.0282*** |
| | (0.0014) | (0.0005) | (0.0100) | (0.0116) | (0.0042) |
| *e* | 0.0024*** | 0.0008*** | 0.0034 | 0.0152*** | 0.0036* |
| | (0.0005) | (0.0002) | (0.0047) | (0.0047) | (0.0019) |
| Observations | 54,912 | 55,814 | 55,778 | 55,423 | 53,973 |
| R-squared | 0.061 | 0.083 | 0.190 | 0.019 | 0.030 |
| Controls | Yes | Yes | Yes | Yes | Yes |
| Time FE | Yes | Yes | Yes | Yes | Yes |
| Industry FE | Yes | Yes | Yes | Yes | Yes |
| Stock FE | Yes | Yes | Yes | Yes | Yes |

**Table 6. Robustness: The Timing of Earnings News**

This table presents results reported in Tables 2-4 for a subsample of firms, which tend to release its earnings news during the same window relative to the short interest announcement (either $e = 0$ or $e = 1$ at each *REPDATE*) in both the pre- and post-amendment periods. The dependent variables are: in column (1) *CAR*[0,1] is the absolute value of 2-day cumulative abnormal return in the [0,1] days around the earnings announcement, defined as the difference between buy-and-hold returns of the stock and beta multiplied by the buy-and-hold return of the market; in column (2) *TURNOVER* is average daily volume over the [0,1] days around the earnings announcement divided by shares outstanding at the end of the month; in column (3) *SPREAD* is the daily average bid-ask spread over the pre-event time window [-4,-2]; in column (4) *VOLATILITY* is difference between the highest and lowest share prices over the event time window [0,1], normalized by an average of the two; in column (5) *CAR*[2,61] is the absolute value of 60-day cumulative abnormal return in the [2,61] days after the earnings announcement, defined as the difference between buy-and-hold returns of the stock and beta multiplied by the buy-and-hold return of the market. The explanatory variables include: *POST* is a dummy variable that equals 1 for the firm's earnings announcement dates after September 7, 2007; *e* is a dummy variable that equals 1 when the firm's earnings announcement occurs after the end-of-month *REPDATE* and before the mid-month *REPDATE* the following month; *POST* x *e* is an interaction term between *POST* and *e*. All regressions include the following control variables: *NUMEST*, *IO*, *FE*, *EARNINGS_PERSIST*, *EARNINGS_VOL*, *NUMANN*, and industry, stock, year, month and day-of-week fixed effects. Controls variables are defined in Table 1. We present ordinary least squares estimates with standard errors double-clustered by stock and earnings announcement day; *, **, *** indicate 10%, 5% and 1% level of significance respectively.

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| VARIABLES | *CAR*[0,1] | *TURNOVER* | *SPREAD* | *VOLATILITY* | CAR[2,61] |
| *POST* x *e* | -0.0027*** | -0.0009*** | -0.0136** | -0.0314*** | -0.0082*** |
| | (0.0009) | (0.0003) | (0.0069) | (0.0081) | (0.0030) |
| *POST* | 0.0135*** | 0.0014** | 0.0928*** | 0.0026 | 0.0286*** |
| | (0.0016) | (0.0007) | (0.0115) | (0.0140) | (0.0051) |
| *e* | 0.0033*** | 0.0008*** | 0.0097* | 0.0219*** | 0.0033 |
| | (0.0007) | (0.0003) | (0.0057) | (0.0062) | (0.0023) |
| Observations | 39,171 | 39,734 | 39,710 | 39,362 | 37,519 |
| R-squared | 0.064 | 0.086 | 0.144 | 0.024 | 0.033 |
| Controls | Yes | Yes | Yes | Yes | Yes |
| Time FE | Yes | Yes | Yes | Yes | Yes |
| Industry FE | Yes | Yes | Yes | Yes | Yes |
| Stock FE | Yes | Yes | Yes | Yes | Yes |

**Table 7. Which Stocks are More Affected?**

This table presents the main result reported in Table 2 for different subsamples. In columns 1 and 2, we divide the sample according to *SIZE*, measured as market capitalization (in millions), where *SMALL* and *LARGE* are the below and above median subsamples respectively; in columns 3 and 4, we divide the sample according to increases and decreases in the most recent short interest (*NEGNEWS* and *POSNEWS* respectively); in columns 5 and 6, we divide the sample accord to *BM*, book to market ratio, where Low *BM* and High *BM* are the below and above median subsamples respectively; in columns 7 and 8, we divide the sample according to *DAYSBTW*, measured as the number of days between the short interest announcement and the earnings announcement taking place after it, where Low *DAYSBTW* and High *DAYSBTW* are the below and above subsamples respectively. The dependent variable, *CAR* [0,1] is the absolute value of 2-day cumulative abnormal return in the [0,1] days around the earnings announcement, defined as the difference between buy-and-hold returns of the stock and beta multiplied by the buy-and-hold return of the market. The explanatory variables include: *POST* is a dummy variable that equals 1 for the firm's earnings announcement dates after September 7, 2007; *e* is a dummy variable that equals 1 when the firm's earnings announcement occurs after the end-of-month *REPDATE* and before the mid-month *REPDATE* the following month; *POST* x *e* is an interaction term between *POST* and *e*. All specifications include year, month and day-of-week fixed effects. We present ordinary least squares estimates with standard errors double-clustered by stock and earnings announcement day; *, **, *** indicate 10%, 5% and 1% level of significance respectively.

| Dependent variable: *CAR*[0,1] | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| VARIABLES | *SMALL* | *LARGE* | *NEGNEWS* | *POSNEWS* | Low *BM* | High *BM* | Low *DAYSBTW* | High *DAYSBTW* |
| *POST* x *e* | -0.0032*** | -0.0026** | -0.0035*** | -0.0028* | -0.0032*** | -0.0025*** | -0.0033*** | -0.0026** |
| | (0.0011) | (0.0012) | (0.0012) | (0.0016) | (0.0010) | (0.0009) | (0.0011) | (0.0012) |
| *POST* | 0.0125*** | 0.0133*** | 0.0116*** | 0.0129*** | 0.0138*** | 0.0118*** | 0.0145*** | 0.0116*** |
| | (0.0021) | (0.0016) | (0.0015) | (0.0014) | (0.0017) | (0.0021) | (0.0018) | (0.0020) |
| *e* | 0.0039*** | 0.0031*** | 0.0035*** | 0.0029*** | 0.0052*** | 0.0018*** | 0.0049*** | 0.0017* |
| | (0.0007) | (0.0006) | (0.0004) | (0.0004) | (0.0006) | (0.0007) | (0.0006) | (0.0009) |
| Observations | 37,617 | 37,713 | 61,912 | 62,661 | 36,451 | 36,246 | 41,353 | 37,054 |
| R-squared | 0.034 | 0.102 | 0.068 | 0.068 | 0.089 | 0.064 | 0.067 | 0.082 |
| Time FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

**Table 8. Market Reactions to Short Interest Announcements**

This table presents the price reactions to the announcement of short interest for our sample of stocks. Short interest is publicly disclosed after 4pm at each *REPDATE*. We form 10 portfolios based on changes in short interest (Δ*SHORT*) at each report date. Δ*SHORT* is the change in short interest between two successive short interest announcements, scaled by shares outstanding at the end of the month. The bottom decile portfolio (Decile 1) has a Δ*SHORT* below the 10$^{th}$ percentile, and the top decile portfolio (Decile 10) has a Δ*SHORT* above the 90$^{th}$ percentile. In Panel A, we report the average 2-day return (in %) in the [1,2] days after the short interest announcement. In column 1, we report size and book-to-market adjusted abnormal returns; in columns 2 and 3, we present 3-factor and 4-factor alphas respectively. In Panel B, we report the 4-factor alphas in the {-3,-2,-1,0} days prior to the short interest announcement (we include the day of the announcement because short interest is disclosed after 4pm). In Panel C, we show cross-sectional variation in the market reaction to short interest announcements, by forming quintiles according to market capitalization (*SIZE*) and book-to-market ratio (*BM*). Within each quintile of *SIZE* or *BM*, we form decile portfolios of Δ*SHORT*. We present average 4-factor alphas in the [1,2] days after the short interest announcement for Low *SIZE* and High *SIZE* (the bottom and top quintiles of *SIZE* respectively); and Low *BM* and High *BM* (the bottom and top quintiles of *BM* respectively). In all tests, we use Newey-West standard errors with 5 lags (reported in parentheses); *, **, *** indicate 10%, 5% and 1% level of significance respectively.

**Panel A. Announcement Day Returns: [1,2] days after *REPDATE***

| | (1) | (2) | (3) |
|---|---|---|---|
| Decile | SMB | 3-factor Alpha | 4-factor Alpha |
| 1 | 0.0432*** | 0.0479*** | 0.0477*** |
| | (0.0137) | (0.0124) | (0.0125) |
| 2 | 0.0209* | 0.0340** | 0.0341** |
| | (0.0123) | (0.0115) | (0.0114) |
| 3 | 0.0155 | 0.0378** | 0.0389** |
| | (0.0172) | (0.0180) | (0.0182) |
| 4 | 0.0102 | 0.0069 | 0.0100 |
| | (0.0075) | (0.0226) | (0.0228) |
| 5 | 0.0104 | 0.0177 | 0.0209 |
| | (0.0065) | (0.0173) | (0.0170) |
| 6 | -0.0264 | 0.0265 | 0.0252 |
| | (0.0153) | (0.0182) | (0.0182) |
| 7 | -0.0240* | 0.0059 | 0.0015 |
| | (0.0108) | (0.0252) | (0.0236) |
| 8 | -0.0357* | -0.0068* | -0.0105* |
| | (0.0187) | (0.0212) | (0.0197) |
| 9 | -0.0304** | -0.0196** | -0.0222** |
| | (0.0145) | (0.0137) | (0.0127) |
| 10 | -0.1060*** | -0.1008*** | -0.1031*** |
| | (0.0188) | (0.0160) | (0.0155) |
| Diff | -0.1492*** | -0.1487*** | -0.1508*** |
| | (0.0172) | (0.0171) | (0.0166) |

**Panel B. Pre-Announcement Returns: {-3,-2,-1,0} days before *REPDATE***

| Decile | $t = 0$ | $t = -1$ | $t = -2$ | $t = -3$ |
|---|---|---|---|---|
| 1 | -0.0021 | -0.0151 | -0.0035 | -0.0263 |
| | (0.0227) | (0.0211) | (0.0165) | (0.0247) |
| 10 | -0.0056 | 0.0345 | -0.0201 | 0.0060 |
| | (0.0225) | (0.0261) | (0.0189) | (0.0204) |
| Diff | -0.0036 | 0.0497* | -0.0167 | 0.0323 |
| | (0.0222) | (0.0256) | (0.0185) | (0.0264) |

**Panel C. Announcement Day Returns: [1,2] days after *REPDATE* conditioned on *SIZE* and *BM***

| Decile | Small | Large | Low BM | High BM |
|---|---|---|---|---|
| 1 | 0.0582** | 0.0430** | 0.0724*** | 0.0515** |
| | (0.0229) | (0.0209) | (0.0227) | (0.0227) |
| 10 | -0.1864*** | -0.0659*** | -0.1215*** | -0.0716*** |
| | (0.0392) | (0.0189) | (0.0272) | (0.0222) |
| Diff | -0.2446*** | -0.1088*** | -0.1939*** | -0.1231*** |
| | (0.0413) | (0.0189) | (0.0324) | (0.0299) |

**Table 9. Short Sellers' Holding Periods**

The table presents the impact the regulatory amendments have on short sellers' holding periods using the Markit database. The table presents the regression results where the dependent variable, *LOANLENGTH* is the average loan tenure for short-sale positions after a short interest announcement and before the next short interest announcement. The explanatory variables include: *POST* is a dummy variable that equals 1 for observations in the post-amendment period; *e* is a dummy variable that equals 1 when the firm's earnings announcement occurs after the end-of-month *REPDATE* and before the mid-month *REPDATE* the following month; *POST* x *e* is an interaction term between *POST* and *e*. In column 2, we include a number of stock controls: *IVOL* is the standard deviation of idiosyncratic monthly returns over the past 2-year window (in %), where idiosyncratic monthly returns are the residuals in a regression of a stock's monthly return on the three Fama and French (1993) factors; *BM* is the book-to-market ratio; *SIZE* is the stock's market capitalization; *ILLIQ* computed following Amihud (2002), as the average ratio of the absolute value of daily returns to the stock daily volume in the past six months; *PASTRETURNS* is cumulative monthly returns over the past six months. All regressions include year, month and day-of-week fixed effects. We present ordinary least squares estimates with standard errors double-clustered by stock and short-interest announcement days; *, **, *** indicate 10%, 5% and 1% level of significance, respectively.

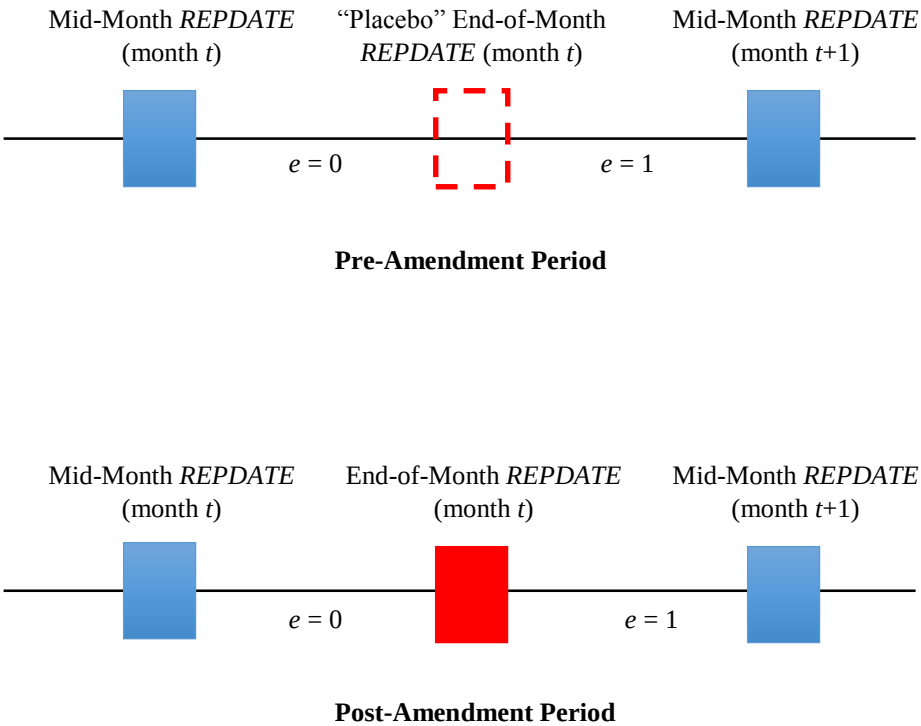
| VARIABLES | (1)<br>*LOANLENGTH* | (2)<br>*LOANLENGTH* |
|---|---|---|
| *POST* x *e* | 9.7404** | -7.8024** |
| | (4.4669) | (3.9206) |
| *POST* | 1.5024 | 1.1408 |
| | (1.7949) | (2.0459) |
| *e* | -9.8724** | 7.0284* |
| | (4.3735) | (3.9206) |
| *IVOL* | | -0.6670*** |
| | | (0.0568) |
| *BM* | | 0.7566*** |
| | | (0.2830) |
| *SIZE* | | -0.0023*** |
| | | (0.0002) |
| *ILLIQ* | | -0.2013*** |
| | | (0.0303) |
| *PASTRETURNS* | | -3.4484*** |
| | | (1.0381) |
| Observations | 319,096 | 267,251 |
| R-squared | 0.012 | 0.033 |
| Time FEs | Yes | Yes |
| Controls | No | Yes |

**Table 10. Short Sellers' Risks**

This table presents the impact of the regulatory amendments on the Sharpe ratios of short-sellers' positions using the Markit database. Markit reports the total short positions taken on by its subscribers (*Short Int-Markit*). On each *REPDATE*, we form 10 portfolios based on changes in short interest (Δ*SHORT-Markit*). Δ*SHORT-Markit* is the change in short interest between two consecutive *REPDATEs* (including the placebo *REPDATE*), scaled by shares outstanding at the end of the month. The bottom decile portfolio (*P1*) has a Δ*SHORT* below the 10$^{th}$ percentile, and the top decile portfolio (*P10*) has a Δ*SHORT* above the 90$^{th}$ percentile; *P1-P10* is the difference between the two portfolios. After forming the portfolios, we examine the subsequent returns (in %) until the next *REPDATE*. *POST* is a dummy variable that equals 1 for observations in the post-amendment period; *e* is a dummy variable that equals 1 when the firm's earnings announcement occurs after the end-of-month *REPDATE* and before the mid-month *REPDATE* the following month; *POST* x *e* is an interaction term between *POST* and *e*. Returns are size and book-to-market adjusted abnormal returns; we use Newey-West standard errors with 5 lags.

| | *e = 0* | | *e = 1* | |
|---|---|---|---|---|
| *POST = 0* | **P1** | 1.2143 | **P1** | 1.1047 |
| | **P10** | -1.9632 | **P10** | -1.3247 |
| | **P1-P10** | 2.0050 | **P1-P10** | 1.5038 |
| *POST = 1* | **P1** | 1.0682 | **P1** | 1.1250 |
| | **P10** | -1.9320 | **P10** | -1.9870 |
| | **P1-P10** | 2.0183 | **P1-P10** | 1.9811 |

**Figure 1. Diagrammatic Explanation of Empirical Methodology**




The identification in our paper comes from the additional end-of-month short interest announcement in the post amendment period (red square). We look at differences between the end-of-month and placebo end-of-month short interest announcements in the pre-amendment period (red dashed square). There is no change in reporting regime for mid-month short interest announcements in pre- and post-amendment period. As such, $e = 0$ when the firm's earnings announcement occurs between the mid-month *REPDATE* and the end-of-month *REPDATE*, and $e = 1$ occurs when the firm's earnings announcement occurs between the end-of-month *REPDATE* and mid-month *REPDATE* the following month.

**Figure 2. Market Reactions to Short Interest Announcements in the Full Sample**

This figure presents the price reactions to short interest announcements. Short interest is publicly disclosed after 4pm at each *REPDATE* ($t$ = 0). At each *REPDATE*, we form 10 portfolios based on Δ*SHORT*, which is the change in short interest between two successive short interest announcements, scaled by stock's shares outstanding at the end of the month. The bottom decile ("Decreased Shorting") portfolio has a Δ*SHORT* below the 10th percentile, and the top decile portfolio ("Increased Shorting") has Δ*SHORT* above 90th percentile. The figure shows the cumulative 4-factor alphas (in %), starting from 7 trading days prior to the short-interest announcements until 10 trading days after the short-interest announcements.

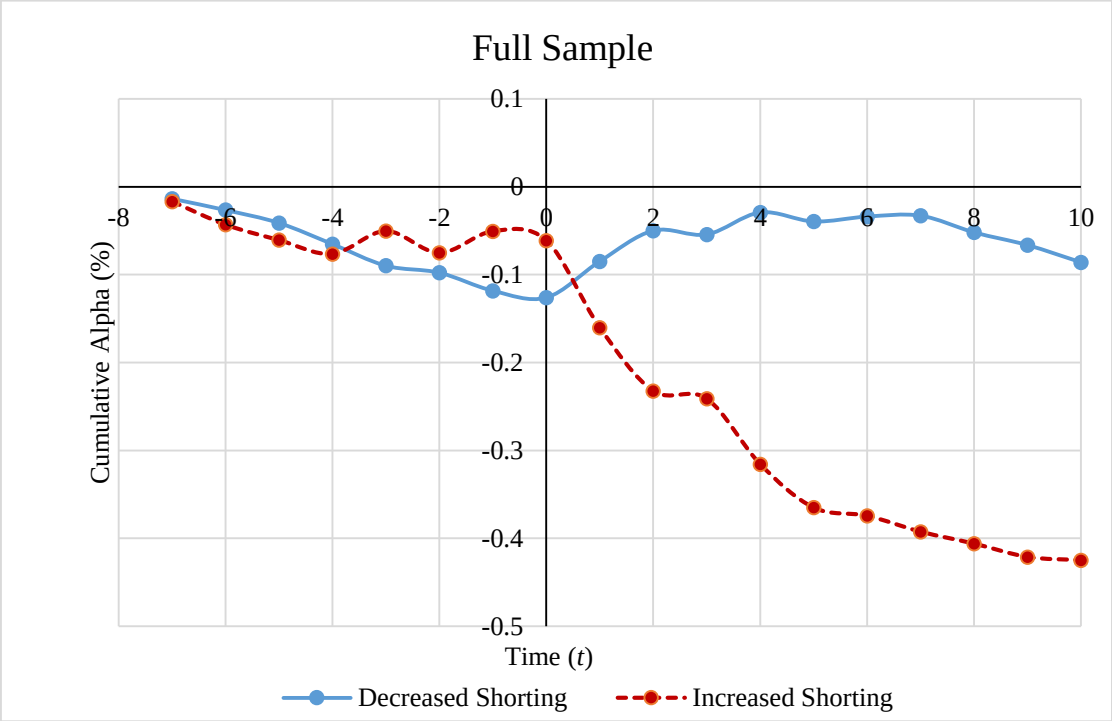
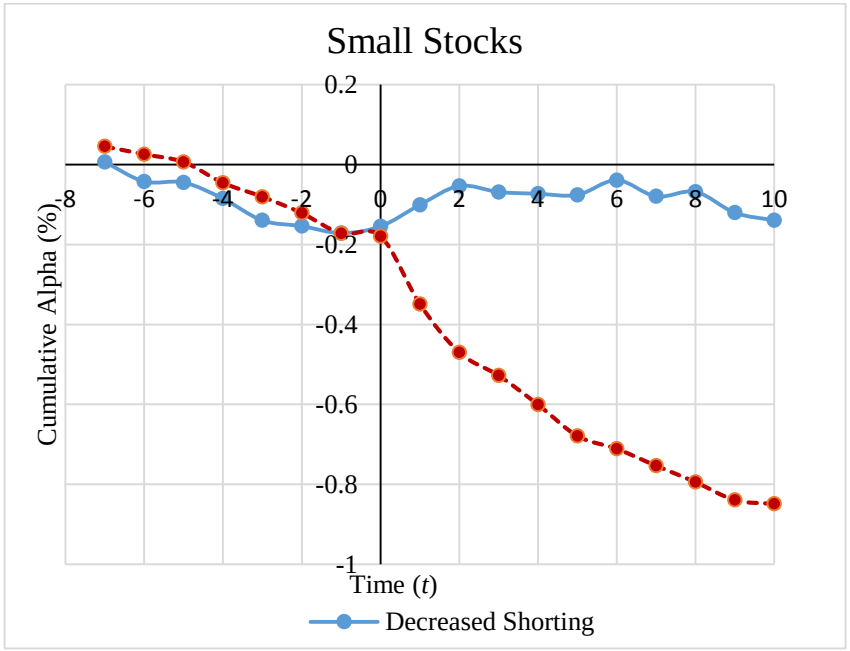
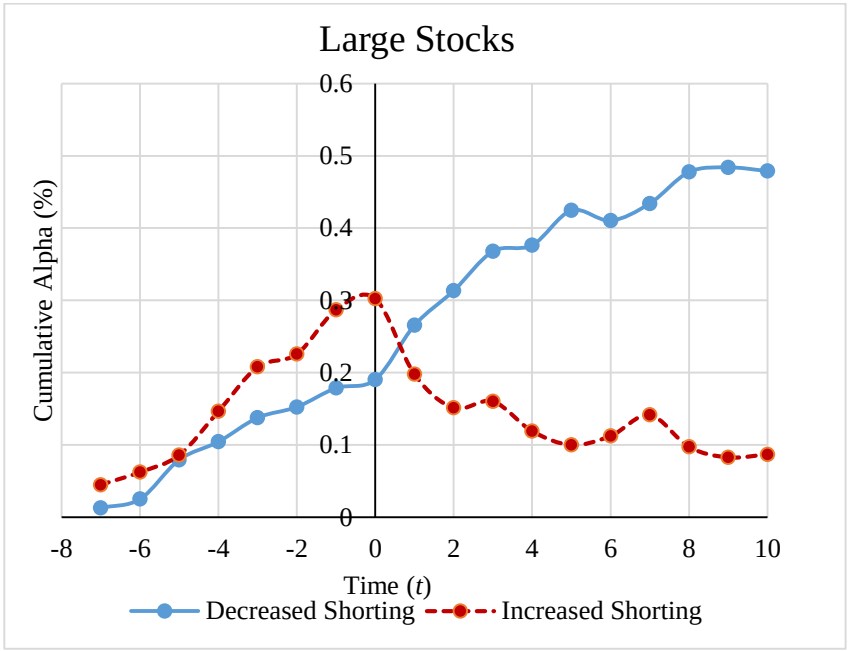


**Figure 3. Market Reactions to Short Interest Announcements: Cross-Sectional Variation**

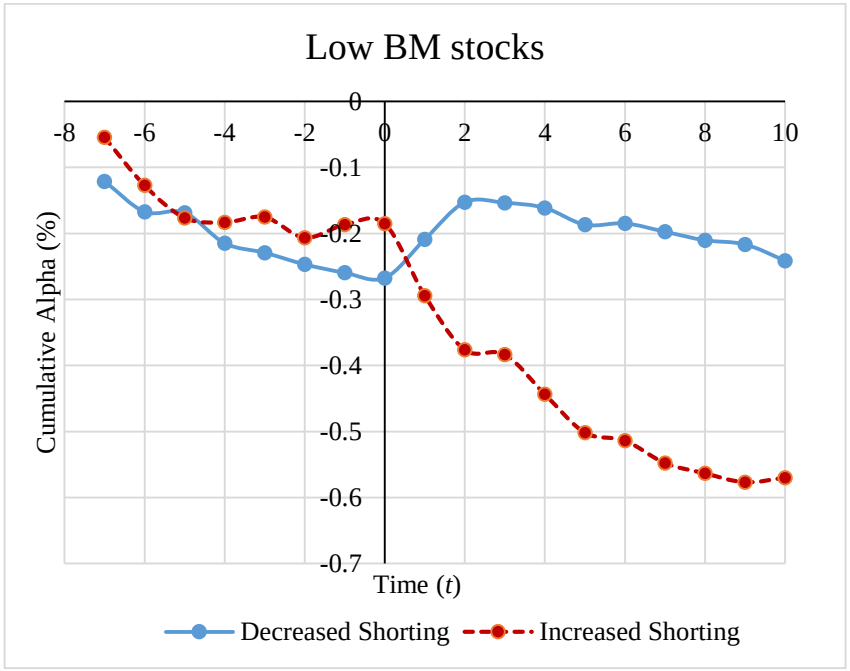
This figure presents the cross-sectional variations in price reactions to short interest announcements. Short interest is publicly disclosed after 4pm at each *REPDATE* (*t* = 0). At each *REPDATE*, we form quintiles according to stock market capitalization (*SIZE*) or book-to-market ratio (*BM*). Within each quintile, we form 10 portfolios based on (Δ*SHORT*). Δ*SHORT* is the change in short interest between two successive short interest announcements, scaled by stock's shares outstanding at the end of the month. The bottom decile ("Decreased Shorting") portfolio has a Δ*SHORT* below the $10^{th}$ percentile, and the top decile portfolio ("Increased Shorting") has Δ*SHORT* above $90^{th}$ percentile. Small Stocks and Large Stocks are the bottom and top quintiles formed based on *SIZE* (Panel A), and Low BM and High BM are the bottom and top quintiles formed based on *BM* (Panel B). The figure shows the cumulative 4-factor alphas (in %), starting from 7 trading days prior to the announcements until 10 trading days after the announcements.

**Panel A. Small versus Large Stocks**



**Panel B. Low BM versus High BM stocks**



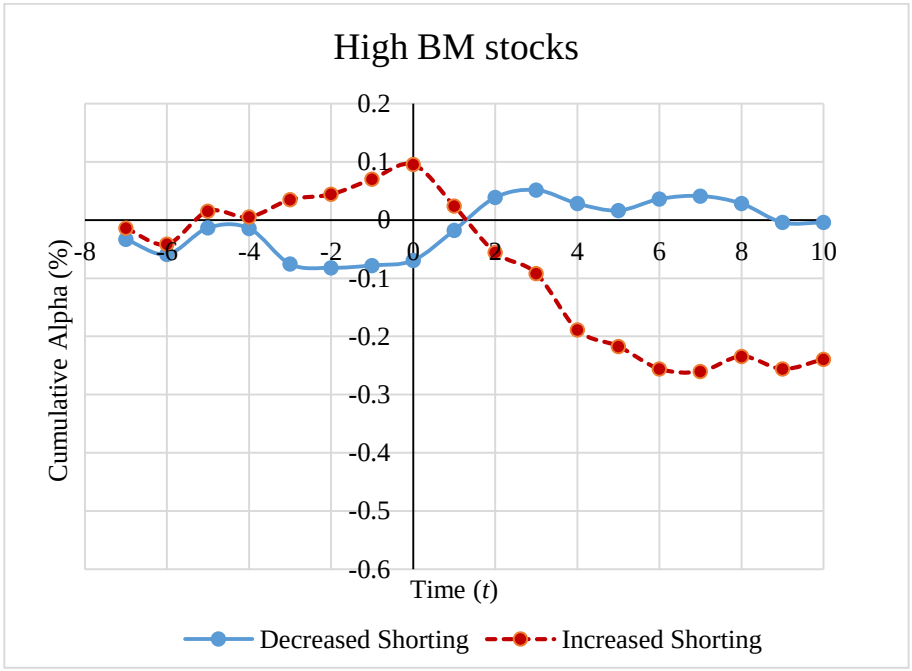



**Figure 4. Market Reactions to Short Interest Announcements: Long-run Effects**

This figure presents the long-run price reactions to short interest announcements. Short interest is publicly disclosed after 4pm at each *REPDATE* ($t$ = 0). At each *REPDATE*, we form 10 portfolios based on Δ*SHORT*, which is the change in short interest between two successive short interest announcements, scaled by stock's shares outstanding at the end of the month. The bottom decile ("Decreased Shorting") portfolio has a Δ*SHORT* below the 10th percentile, and the top decile portfolio ("Increased Shorting") has Δ*SHORT* above 90th percentile. The figure shows the cumulative 4-factor alphas (in %), starting from 7 trading days prior to the short-interest announcements until 60 trading days after the short-interest announcements. The blue line shows cumulative alphas for the "Increased Shorting" portfolio in the full sample. The grey and red lines show for the "Increased Shorting" portfolio within *SMALL* (stocks with market capitalization in bottom quintile) and *LOW BM* (stocks with book-to-market ratios in bottom quintile), respectively.